Massachusetts

# Farm Energy

## Best Management Practices for

# Maple Sugaring

Massachusetts Farm Energy Program
Conservation • Efficiency • Renewables

# Massachusetts Farm Energy Best Management Practices

Berkshire-Pioneer Resource Conservation & Development Area
GDS Associates
Massachusetts Department of Agricultural Resources
Massachusetts Farm Energy Program
USDA Natural Resources Conservation Service

Amherst, Massachusetts · 2012

## MASSACHUSETTS FARM ENERGY GUIDES BY FARM SECTOR

This guide is part of a series of farm energy Best Management Practice guides, available for the following sectors and topic areas:

Dairy Farms

Greenhouses

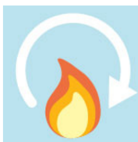
Maple Sugaring

Orchards & Vegetable Farms

Renewable Energy

## BEST MANAGEMENT PRACTICES FOR MAPLE SUGARING

In this guide, you will find the following best management practices:



Heat Recovery & Steam-Enhanced Units



High Efficiency Evaporators

Reverse Osmosis (RO) Systems

Energy Efficient Lighting


Whether you are a new or experienced farmer, energy expert, or agricultural service provider, we created this guide to save you time, effort, and ENERGY!
Jessica Cook, BP RC&D, 2010

# **Welcome** to the Massachusetts Farm Energy Best Management Practices Guide

### Practical solutions & entry points

This guide is about practical steps you can take immediately, with a focus on the most common and cost-effective equipment upgrades and systems currently available for farms in our region.

For farmers who are managing a constant flow of weather events and day-to-day business needs, we offer an entry point to on-farm energy savings and renewable systems that make use of the technical skills and systems-thinking of our local community.

### Thinking of systems from the start

The farm energy guide is organized by sector, focusing on retrofits that work for existing farming operations. However, farmers can also apply the guidance provided in these pages to incorporate energy issues into the planning and initial design stages of new agricultural businesses.

There is an increasing amount of interest in energy among the state's farmers, and examples in this guide can provide a launchpad for more innovative energy systems in the future.

**The goals of these energy best management practices are to:**

**Strengthen farm businesses**
by lowering operating costs, reducing labor, and increasing profits over time.

**Reduce environmental impacts**
of the agricultural sector, with a focus on lowering carbon emissions.

**Help farms transition**
into the next generation by utilizing efficient technology and forward-thinking design.

Jessica Cook, BP RC&D, 2010

### Sometimes you just need a place to start—
### —based on good information and solid economics.

We hope that by breaking things down by process or technology—looking at average savings and commonly recommended measures—we offer readers a place to start their projects.

We know for many farms economic feasibility is the first question when it comes to on-farm energy projects—is the investment worthwhile?

We have highlighted estimated payback periods in the following pages, identifying the number of years an upgrade will take to pay for itself.

While we calculate the dollar savings in fossil fuels or other energy sources, it's important for you to consider other benefits on the farm, such as reduced farm labor or increased sales resulting from greener systems.

The examples in this guide are drawn from real life, based on averages across farms in Massachusetts who have worked with MFEP, so payback numbers are directly applicable to the scale of farms in our region.

### Encouraging climate and resources

Forward-thinking energy policies at the state level have combined with supportive agencies and utility programs, financial incentives, and good partners to provide fertile ground for farm energy projects in Massachusetts.

We are enthusiastic about the energy future of the agricultural community in our region, and acknowledge the motivated farmers who are open to sharing their experiences, the willing auditors, and the proactive installers who are getting projects up and running.

*We encourage you to take advantage of these key resources to move ahead with your own farm energy project!*

*— the Massachusetts Farm Energy Program team*

## Acknowledgements

This Farm Energy Best Management Practices Guide was compiled and written by GDS Associates, Inc. (GDS) for the Massachusetts Farm Energy Program (MFEP). Specifications and recommendations in this document are based on industry-specific research and informed by the audits and projects implemented with the assistance of the Massachusetts Farm Energy Program (MFEP) between 2008 and 2010.

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Catherine Ulitsky, NRCS, 2009

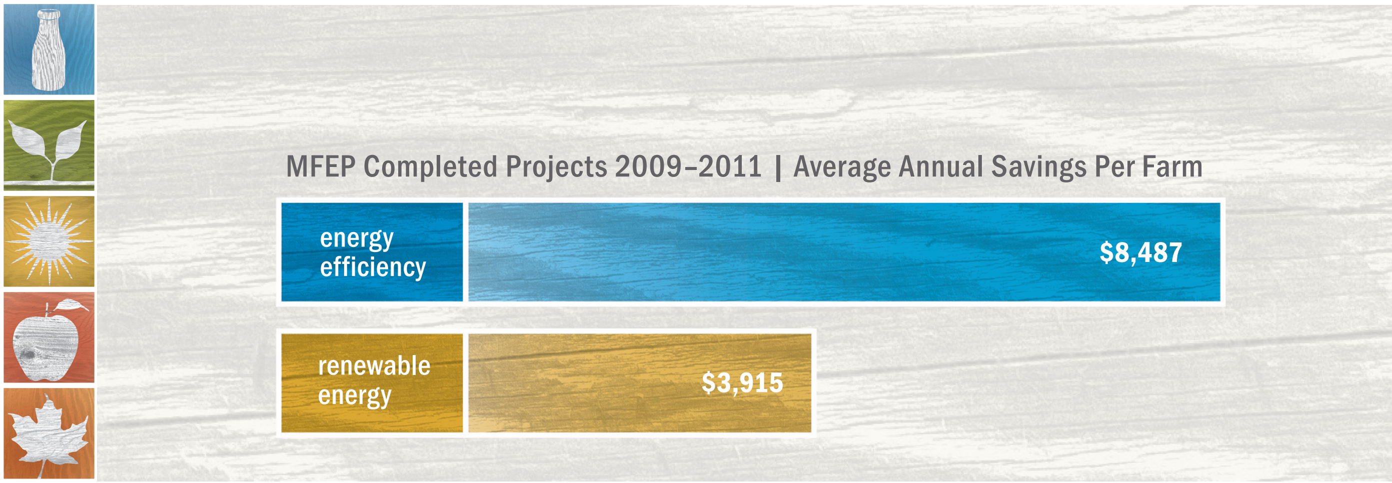
# Introduction

The *Massachusetts Farm Energy Best Management Practices Guides* provide the Commonwealth's agricultural community with resources and methods to reduce energy use and produce renewable energy on farms. These recommended on-farm energy upgrades improve farm viability and minimize the environmental impact of the agricultural industry in Massachusetts by reducing energy consumption, operating costs, emissions, and dependence on fossil fuels.

These guides focus on conventional energy best management practices (BMPs)—cost-effective practices that offer significant environmental and economic benefits—for the four primary agricultural sectors represented in the Commonwealth: greenhouses, dairy farms, orchards and vegetable farms, and maple sugaring. They also cover considerations for on-farm renewable energy options, including wind, solar thermal, solar photovoltaic and biomass.

This document aims to be a practical resource for farmers and service providers alike, organized to help readers understand farm energy use, evaluate potential equipment upgrades, and prioritize energy efficiency and renewable energy applications. These recommendations can also be used to inform policy, technical assistance programs, and government agency and public utility cost-share programs for energy efficiency and renewable energy on farms.

The information in this guide is based on industry-specific research and Massachusetts Farm Energy Program (MFEP) data from more than fifty energy projects implemented between 2008 and 2010. For applications not covered in this document, additional information can be found by contacting MFEP.




## Environmental Impact of Energy Use

Energy conservation and renewable energy systems on farms can help reduce the use of fossil fuels and related greenhouse gas emissions, and mitigate the contribution of Massachusetts agriculture to point-source pollution and global climate change.

Massachusetts' farmers can set an example for other industries in the region by making viable business decisions that improve operations and profitability while reducing negative environmental impacts of "business as usual."

MFEP's experience illustrates farms' improved environmental performance—through reduced carbon dioxide emissions—as a result of energy efficiency and renewable projects.


## Economic Benefits of Energy Savings

New England farmers pay 23-56% higher rates for energy resources than the U.S. average. As farmers identify the source of their energy demand and make improvements to their systems, they can reduce their dependence on fossil fuels and improve their bottom line. MFEP's work with has assisted farmers do exactly that, thus having a direct impact on the financial viability of many Massachusetts farms.

The average net income of a Massachusetts farmer is just over $12,000 according to the National Agricultural Statistics Service. At the same time, average annual energy savings from farm energy efficiency projects facilitated through MFEP average out at $12,000 per farm in 2009–2010, thus making energy efficiency improvements a sound business decision that can have a significant impact on overall farm viability. The economic benefit of these savings is further multiplied as farmers reinvest in the local economy in a variety of ways as they maintain and build their businesses.

It is important to note that energy projects result in different rates of financial returns for farms, either through reduced energy use or offsetting fossil fuel use with renewable energy. Renewable projects can work out favorably in terms of overall return on investment for farms, particularly with the support of grant and payment programs. However, efficiency projects save 2.5 times more energy on average than renewable systems replace per dollar invested.


## About the Massachusetts Farm Energy Program

### What is the Massachusetts Farm Energy Program?

The Massachusetts Farm Energy Program (MFEP) is a full-service program for technical and financial assistance for farmers and agricultural businesses. It is a statewide collaborative effort, bringing together federal, state, industry, and private support to streamline resources available to Massachusetts farmers in order to:

1. increase on-farm energy conservation and efficiency,
2. promote alternative and renewable energy strategies for on-farm energy generation,
3. improve farm viability by reducing energy consumption and costs, and
4. reduce agricultural greenhouse gas emissions.

MFEP has offered a range of services to the farming community, including technical assistance, audits and consultations, financial incentives, and facilitation to leverage funds to bring projects from initial concept to implementation.

MFEP is a joint project of the following partners:

**Massachusetts Department of Agricultural Resources (MDAR)**
www.mass.gov/agr

**USDA – Natural Resources Conservation Service (NRCS)**
www.ma.nrcs.usda.gov

**Berkshire-Pioneer Resource Conservation & Development Area (BPRC&D)**
www.berkshirepioneerrcd.org

### Why MFEP?

Electricity and fossil fuel costs have increased by approximately 30% in the last few years. The impact on farms has meant a dramatic increase in costs related to power, refrigeration, heating, ventilation, lighting, transportation, fertilizer, and feed. Rising energy costs reduce profit margins for all farmers and directly threaten the viability of farms across the Commonwealth.

The agricultural community has not maximized energy savings in part due to challenges in navigating an ever-changing landscape of support programs. MFEP streamlines these resources and provides direct technical assistance through energy audits, renewable energy assessments, and incentives for implementation of audit recommendations, including those recommended by public utility programs.

As a result of complex partnerships between farm business owners, government agencies, for-profit practitioners, and public programs, farm energy upgrades are contributing to the region's environmental goals and stability and resilience of our agricultural communities.

Massachusetts Farm Energy Program
Conservation • Efficiency • Renewables

## In terms of actual fuel consumption, it is common to compare how many gallons of fuel oil (or equivalent wood) it takes to produce 1 gallon of maple syrup.

For all the following calculations in this guide, it is assumed that the sap has a 2% sugar content and that 42 gallons of water need to be evaporated. It is important to keep records of seasonal fuel consumption, gallons of sap collected, and brix values in order to determine actual efficiency of your current evaporator and potential fuel savings.

The following table compares approximate fuel usage based on efficiency of evaporator and fuel saving upgrades. Please note that these are only approximate values and actual savings may vary.

| Efficiency of evaporator | Gallons of fuel oil consumed per gallon of syrup (evaporator only)* | Gallons of fuel oil consumed per gallon of syrup (with RO)** | Gallons of fuel oil consumed per gallon of syrup (with RO & Steam-Away)*** |
|---|---|---|---|
| 60% | 4.8 | 1.7 | 1.0 |
| 65% | 4.4 | 1.6 | 0.9 |
| 70% | 4.1 | 1.4 | 0.9 |
| 75% | 3.9 | 1.3 | 0.8 |
| 80% | 3.6 | 1.3 | 0.8 |
| 85% | 3.4 | 1.2 | 0.7 |

* Assuming no reverse osmosis system is present, consuming 400,000 BTUs for every gallon of maple syrup (approximate energy required to evaporate 42 gallons of water), and energy content of fuel oil of 138,500 BTUs.

** Assuming reverse osmosis system is present and removes 65% of the water, so only 15 gallons need to be evaporated.

*** Assuming a Steam-Away unit has 40% fuel savings

## Best Management Practices for Maple Sugaring

**Maple sugaring farms are a small but important part of Massachusetts agriculture—** producing 41,250 gallons of syrup according to 2007 census data. **Proper energy management can help maple farms decrease costs and increase profitability.**

The first step in proper energy management is to learn about best practices. This handbook will help you consider potential options and whether they may be applicable to your maple sugaring operation.

The second step is to consider an energy audit. An energy audit can help determine which energy efficiency measures would be most applicable for your business, based on existing conditions and equipment. The audit will point out the major energy users and ways to save money through energy conservation and efficiency.

To decrease fuel costs associated with evaporation, reverse osmosis has been the most common recommendation for operations with high enough production (at least 200 taps), followed by a steam-away unit.

A reverse osmosis system can remove 65% of the water before it enters the evaporator, saving 2.5 to 3 gallons of fuel oil for every gallon of syrup produced (or decrease wood consumption by about two-thirds). A steam-away can provide a 40% reduction in fuel use. It is recommended to complete an audit and work with a trade ally to determine installed cost for equipment and which energy efficient practices will provide the best return on investment.

Other options that may be more suitable for smaller operations include using a forced draft unit to increase the combustion efficiency for wood-fired arches. Purchasing a new evaporator to increase efficiency can result in higher paybacks but should be considered if the existing evaporator is near the end of its useful life.

Jessica Cook, BP RC&D, 2011

Heat recovery paired with a high efficiency wood fired evaporator reduces emissions and farm labor.

## Heat Recovery & Steam-Enhanced Units

### At a Glance:

- A pre-heater produces 13% fuel savings
- A steam-enhanced unit has 40% fuel savings
- Both units increase evaporation rates, resulting in reduced labor and increased production capacity


Marion Welch, 2011

Maple sugaring is an important source of income for many Massachusetts farmers. Practical equipment upgrades can significantly improve profitability through energy savings.

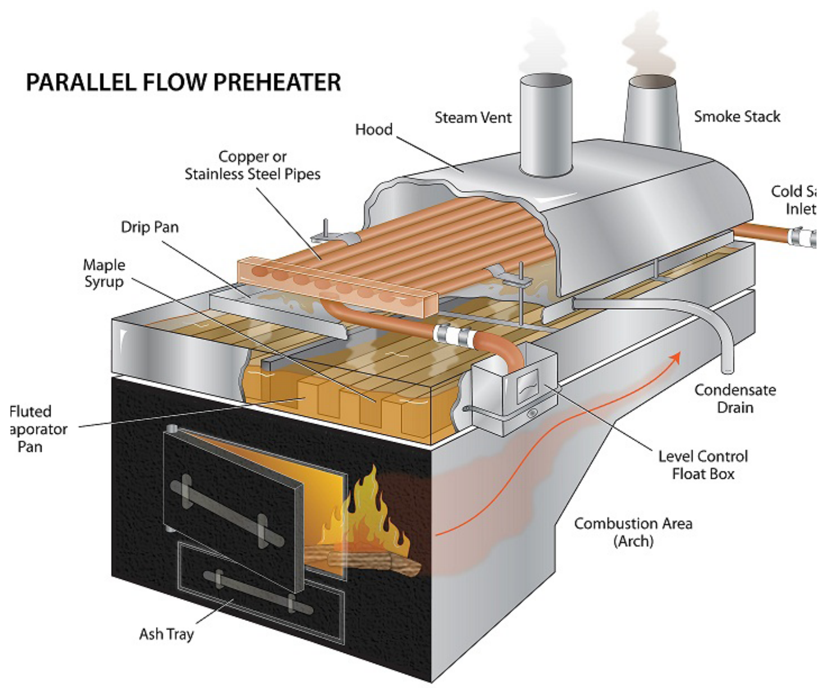
## Pre-heater (heat recovery)

A pre-heater can be used to capture heat from the evaporator's steam exhaust to preheat the sap. A sap pre-heater is a heat exchanger that uses tubing suspended above the steam and underneath a hood.

Cold sap comes in through the tubing and steam condenses on the cooler pipe surface, transferring heat to the sap. The sap exits the tubing at near boiling temperatures. A drip pan is used to collect the condensate to prevent it from dripping back into the maple syrup.

The resulting condensed distilled water can be used to clean the equipment after the batch is processed.

A properly sized pre-heater will increase the efficiency of an evaporator by 15%–20%.[1]




Source: Leader Evaporator, Inc.

## Steam-Enhanced Unit

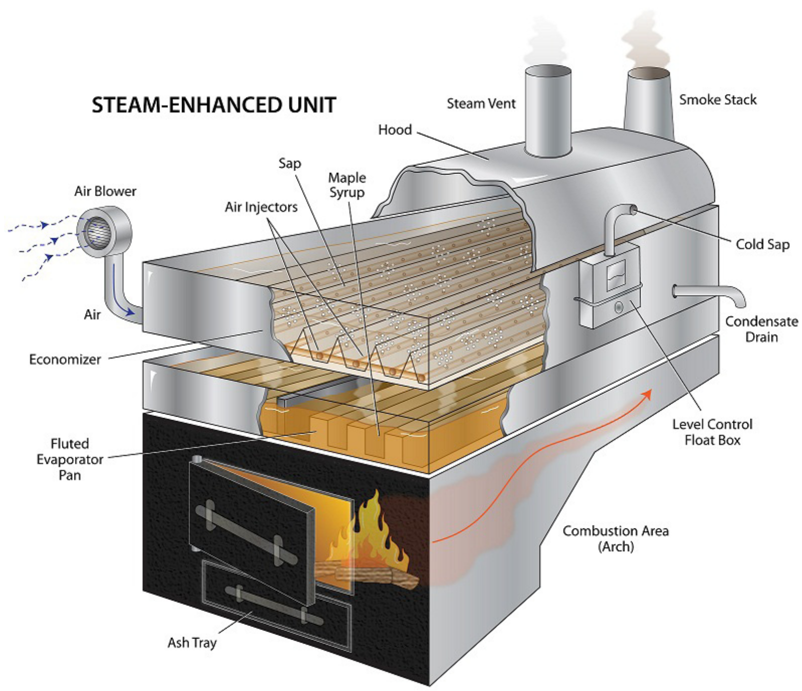
A steam-enhanced unit, commonly called a Steam-Away (brand name from Leader Evaporator) or a steam pan, can be added to an evaporator to increase evaporation rates.

A series of small pipes is submersed into shallow V-shaped trays filled with cold raw sap. As steam is released it hits the bottom of the V trays and heats the sap. The steam condenses back to water and is drained out. But in addition, high pressure air is sent through a set of air lines located in the sap.

This dry air is used to agitate the sap (making it appear as if it was boiling) and to gather humidity. The air will leave the sap at 100% relative humidity, thus eliminating water in the sap at a temperature lower than the boiling point. The sugar content of the sap can be increased from 2% up to 4% or more by the time it enters the evaporation pan.

A steam enhanced unit results in sap that is pre-heated to 190°F–200°F and has been concentrated before it enters the flue pan. The collected condensate, at 200°F can be used to clean equipment. Testing from Leader Evaporator for the Steam-Away unit showed a 65-75% increase in evaporation rate. (These savings estimates are based upon a vendor analysis. There is a lack of independent research conducted on these processes.)

While information is available on how to maximize maple syrup evaporation and production with individual upgrades, there is very little analysis on the interaction of the various technologies.




Source: Leader Evaporator, Inc.

## Applications & Limitations

Both the pre-heater steam enhanced units require the use of a hood. If a hood is not currently used, this component can increase the overall price of the system, limiting cost-effectiveness for smaller farms.

To determine if either unit can work on an existing evaporator, contact the manufacturer of the unit to ensure applicability before purchasing.

## Minimum Standards & Recommendations

A steam enhanced unit is usually recommended over a pre-heater except when there is an issue with height. The steam-enhanced unit requires at least 9 feet from floor to ceiling, while a pre-heater can be installed in sugarhouses with lower ceiling heights.

Due to the weight of the steam-away unit, a support kit is required to suspend the unit over the flue pan. In order to install the support kit, there must be a strong enough structure to support the weight. Typically the rafters within the sugar house are used if they are strong enough.

It is recommended to work with the equipment provider to determine how to best support the steam pan unit.

## Energy Savings

A pre-heater will increase the efficiency of the evaporator by 15%–20%, leading to a 13%–17% savings in energy. See example to the right.

A steam-away unit will increase the efficiency of the evaporator by 65%–75%, leading to a 40%–43% in energy savings. See example to the right.

## Environmental Impact & Other Benefits

The fuel savings achieved by increasing efficiency will result in a reduction of greenhouse gas (GHG) emissions, reducing the environmental footprint of the sugarhouse.

For every gallon of fuel oil conserved, 138,000 BTUs of energy are saved and 22 lbs. of $CO_2$ are not released into the atmosphere.

Utilizing a renewable energy resource like wood will reduce carbon emissions due to its renewable production through forest regeneration.

Increasing the evaporation rate shortens the process time, which can reduce labor costs, and may provide an opportunity for the sugarhouse to increase syrup production.

## Economic Benefits

To determine the simple payback, divide the estimated cost of the unit by the annual fuel savings ($/year). Simple payback will be largely affected by total syrup production.

Estimated cost for a pre-heater unit ranges from $850 for a 2' x 3' unit to $3,400 for a 6' x 10' unit. Estimated cost for a steam-away unit ranges from $4,500 for a 2' x 6' evaporator to $14,200 for a 6' x 16' evaporator. [2]

The example analysis is based on a traditional system with a production of 500 gallons of syrup a year and using a baseline of 4 gallons of fuel oil for every gallon of syrup.

A steam exhaust heat recovery unit results in 15% energy savings, reducing fuel oil use by 300 gallons and $750 at $2.50/gallon (or 2.07 full cords of wood).

However, the even more efficient steam enhanced unit with a 40% energy savings would save about 800 gallons of fuel oil a year, or $2,000 (5.5 full cord of wood).

Based on an evaporator with an evaporation rate of about 144 gph, a steam enhanced unit will cost about $10,000, for a simple payback of 5 years.


An efficient evaporator at Ioka Valley Farm in Hancock, Massachusetts.

## High Efficiency Evaporators


### At a Glance:

- New flue pan designs increase surface area, increasing evaporation rate by 50% and fuel efficiency by 20%
- Forced draft system can increase BTU output by 10 to 20% and decrease wood consumption by 30%

Evaporation is an extremely energy intensive process. A high efficiency evaporator will both reduce the fuel usage and increase evaporation rates, reducing the labor and energy input per gallon of syrup produced.

An energy-efficient evaporator is designed to use more BTUs from the fuel source and provides a larger flue pan surface area to increase evaporation. This will result in the maximum amount of evaporation for the least amount of fuel.

A new unit can be a big investment. Depending on current equipment, it may be possible to retrofit an existing unit by replacing only the firebox or only the flue pan and achieve significant savings.

**Zawalick's Sugar House exhibits their efficient arch and heat recovery equipment in Florence, Massachusetts.**

## Options for High Efficiency Evaporators

The following should be considered when looking at improving the efficiency of evaporation or purchasing a new evaporator:

### Choosing an efficient arch (firebox)

- Make sure the firebox is totally insulated. Industry standard is to use a ceramic blanket, which comes in different weights: 4, 6, and 8 pounds. Eight pounds is recommended (2,600°F rating) to reduce heat loss and increase overall efficiency.
- An air-tight front is important for correct operation of a forced draft system (see below). The firebox should have a latching system to ensure no air leakage.

### Forced draft unit

A forced draft unit can be added to the combustion process for a wood-fired arch to augment the natural draft, in order to increase the oxygen level. This will increase the BTUs released from the wood, resulting in an increase in fuel efficiency and evaporation rate, and a reduction in annual wood consumption and labor.

The unit will use a fractional horsepower fan, controlled by a rheostat that can control the speed of the fan to ensure that the correct amount of air is forced through the holes in the grate for complete combustion of the wood. Manufacturers claim a forced draft unit can increase the BTU output of the wood by 10–20% and reduce wood consumption by 30–50%.

### Retrofitting a wood-fired arch

It is possible cut fuel use by 25–50% by retrofitting a wood-fired arch to improve the combustion process.

- Provide adequate air supply. If a unit releases black smoke, it is a sign that more oxygen is needed for complete combustion. Most units are naturally drafted, but a forced draft unit can be installed to increase the evaporator's efficiency.
- Increase turbulence in the firebox. A forced air unit's specially designed holes increases the speed and spin of incoming air, similar to a vortex. This will help ensure complete combustion, resulting in a cleaner and much hotter fire.
- For other guidelines to improve combustion efficiency, please refer to: www.uvm.edu/~pmrc/Combustion.pdf.

## Options for High Efficiency Evaporators (continued)

### Higher efficiency oil-fired arches

- If fuel oil consumption is higher than 4.5 gallons of fuel oil for every gallon of maple syrup produced (less than 65% efficient), the evaporator may not be running as intended. Have a certified oil burner technician troubleshoot any problems that may increase the efficiency without having to purchase a new evaporator.
- If considering a new evaporator, purchase a high efficiency oil-fired arch evaporator (80% efficient or higher).

### Use a flue pan with maximum surface area

A 7.5" flue size is industry standard for high capacity evaporators. The only larger option currently on the market is a hybrid flue design with 11.5" flue depth (MAX flue pans from Leader Evaporator), reported to increase evaporation by 45–50%, making it 20–25% more fuel efficient than other standard-sized pans. These pans can fit most existing arches with some minor modifications.

## Applications & Limitations

A new high efficient evaporator can be an expensive purchase if the current evaporator is still working. It may be possible to retrofit only the arch or flue pan. If the existing evaporator is nearing the end of its life, consider purchasing a new higher efficiency evaporator instead of a standard evaporator. The gain in efficiency will typically make economic sense.

## Minimum Standards & Recommendations

- It is recommended to have an energy audit completed to weigh the different options of improving the efficiency of an existing unit or purchasing a new high efficiency evaporator, a pre-heater, a steam away, or a reverse osmosis system. Be sure to work with an expert to determine the optimum setup as this can vary on a case by case basis.
- It is recommended to have a certified oil burner technician install, check, and maintain the oil burner and its settings.
- Follow the manufacturer's recommendations on how to properly fire a wood evaporator. Improper firing can significantly decrease efficiency.
- Use only dry seasoned wood in wood-fired arches.

## Energy Savings

There is a scarcity of published performance information on oil-fired evaporators, resulting in inconsistent information from one manufacturer representative to another. In order to model the energy consumption of this equipment accurately, it is essential to have good performance information from independent, certified labs. If performance information is known, it is possible to calculate the efficiency of the evaporator.

**Comparison of Fuel Oil Use in Various High-Efficiency Evaporators**

| Efficiency of evaporator | Gallons of fuel oil consumed per gallon of syrup (without RO)** | Gallons of fuel oil consumed per gallon of syrup (with RO)** |
|---|---|---|
| 60% | 4.8 | 1.7 |
| 65% | 4.4 | 1.6 |
| 70% | 4.1 | 1.4 |
| 75% | 3.9 | 1.3 |
| 80% | 3.6 | 1.3 |
| 85% | 3.4 | 1.2 |

* Assuming no reverse osmosis system is present, consuming 400,000 BTUs for every gallon of maple syrup (approximate energy required to evaporate 42 gallons of water), and energy content of fuel oil of 138,500 BTUs.
** Assuming reverse osmosis system is present and removes 65% of the water, so only 15 gallons need to be evaporated.
Please note that these are only approximate values.

Getting an energy audit or working with an equipment provider can help determine actual energy savings based on current equipment and suggested improvements.

## Environmental Impact & Other Benefits

The fuel savings achieved by increasing efficiency will result in a reduction of greenhouse gas (GHG) emissions, reducing the environmental footprint of the sugarhouse. For every gallon of fuel oil conserved, 138,000 BTUs of energy are saved and 22 lbs of $CO_2$ are prevented from release to the atmosphere. Utilizing a renewable energy resource like wood will reduce carbon emissions by 100% due to its renewable production through forest regeneration.

Increasing the evaporation rate also shortens the process time, reducing labor costs, and providing and opportunity for expanded production.

## Economic Benefits

Due to the large range of options and price ranges, it is best to determine economic benefits through an energy assessment of a facility's current equipment. Replacing an existing evaporator with a higher efficiency evaporator usually results in a high simple payback (greater than 20 years), but should be considered if the current evaporator needs replacement. Increasing the evaporation rate can also lower labor costs and might allow for expanded production.

Estimated cost for a new evaporator can range from $4,000 for a 2' x 6' complete unit with arch, flue pan and firebox, to $30,000 for a 6' x 16' unit. The efficiency, cost, and feasibility of an evaporator is dependent on the components included in the evaporator package like the arch, flue pan, and/or forced air draft unit.

The first thing to consider is the local availability of fuel sources. For facilities that can utilize seasoned hardwood at a low cost, an engineered wood arch should be considered. However, for facilities that may not have wood availability or want to maximized production and optimize evaporation performance, an oil-fired arch should be considered. The arch alone can range from $1,700 to $8,400.

For a traditional operation producing 100 gallons of syrup per year, a forced draft unit would save on average 40% energy. This would result in 240 gallons, $600 of fuel oil at $2.50 gallon (1.65 full cords of wood).Estimated cost for a forced draft unit can range from $450 ( 24"wide evaporator) to $2,700 (72" evaporator).

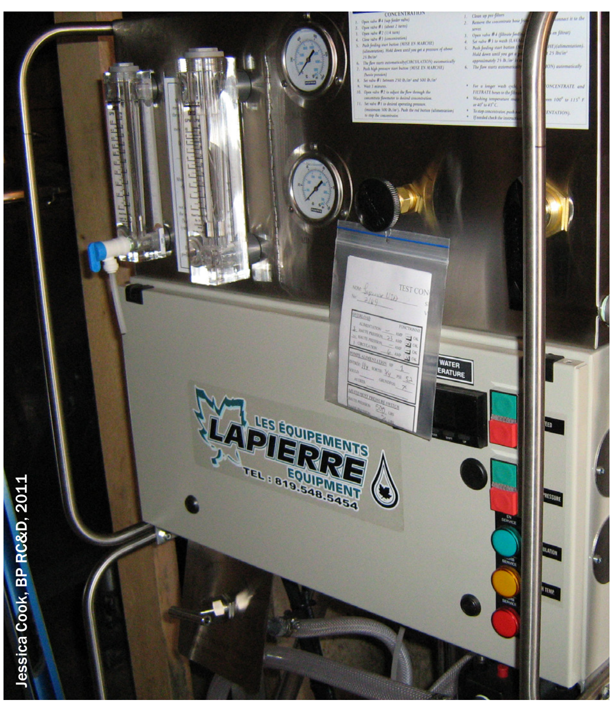
The above operation producing 100 gallons of syrup with a flue pan will result in 150 gallons, $375 of fuel oil (1.04 full cords wood). A flue pan alone can range from $2,500 to $21,500.


Devon Whitney-Deal, CISA, 2012

Maple syrup fills the shelves at Paul's Sugarhouse in Williamsburg, Massachusetts.

## Reverse Osmosis (RO) System

Steve Anderson, Anderson's Pure Maple Syrup




Jessica Cook, BP RC&D, 2011

### At a Glance:

- Can remove up to 75% of the water
- Reduces energy costs by 50% to 75%
- Allows for increased expansion by shortening time and energy needed to produce a given output of syrup
- Wide range of sizes, from 50 to 4,000 gallons/hr, can handle most applications

A reverse osmosis (RO) system is one of the best solutions to reduce expenses and combat rising fuel costs for maple syrup producers. Used commercially in maple syrup production since the 1970s, reverse osmosis uses filter membranes that allow water to pass through but not sugar molecules.

In an average year, maple sap has a sugar content of about 2%; the finished product has sugar content of about 66%. On average, 42 gallons of water must be evaporated to create one gallon of syrup (based on the "rule of 86" and sap that is 2% sugar content it takes 43 gallons of sap to produce 1 gallon of syrup). An RO system is typically designed to remove about 75% of the water, concentrating the sap from a Brix value of 2% to 8% on average. At 8% sugar content, only 10-11 gallons need to be evaporated to get to a brix value of 66%. A typical oil-fired evaporator consumes 3.5–4.5 gallons of fuel oil per gallon of maple syrup. With a reverse osmosis system, it is possible to achieve a production efficiency of 1 gallon of fuel oil (or the equivalent in wood) per gallon of maple syrup produced. This reduces energy costs by 65%–75%.

It is possible to pass the syrup through the additional filter membranes to remove more water, obtaining brix values up to 16%, but it is important to note that a concentration greater than 12% from the RO system will minimize the amount of caramelization that takes place in the evaporator, resulting in syrup with less flavor.

## Applications & Limitations

Reverse osmosis systems come in a wide range of capacities, from 50 gallons per hour (gph) to 4,000 gph. These systems can be applied, in most cases, anywhere from small producers to large commercial producers. It may not be applicable for smaller hobby farms that have limited production (less than 200 taps or 50 gallons syrup annually). An energy assessment can help determine if an RO system is applicable.

RO performance is also based on a certain entering fluid temperature. Performance of ROs will change based on variance from this temperature. It's important to check with the manufacturer for the basis of their performance specification.[3]

The size of an evaporator has an impact on the efficiency and effectiveness of the RO system. It may not be applicable in cases where an evaporator is grossly oversized for the current production levels. In this case, either the RO system would also have to be oversized (increasing the cost of the system) or the evaporator would have to be downsized to meet current production levels. It is important to work with an expert in RO systems to determine the optimum setup.

There is a scarcity of published performance information on reverse osmosis equipment. Sometimes this results in inconsistent information from one manufacturer representative to another. In order to model the energy consumption of this equipment accurately, it is essential to have good performance information.

One limitation to RO technology being applied is access to electrical power. ROs require high pressure and circulation that is generated by electrical pumps that typically run between 3-5 horsepower. Ensure your existing electric service has the required capacity and electrical characteristics, i.e. voltage, spare breakers, etc. to be able to accept this additional electrical load.

Some maple sugaring facilities may be very remote and depend on a small generator for any electrical needs such as lighting. In this case, your generator will need to be checked to see if it can provide the necessary power. Any electrical modifications to install an RO should be included in your project budget.

Some maple farms have added photovoltaic (PV) electric panels to interface with their site power. You should review this potential before you upgrade and modify your electrical service to ensure the modifications could support any future PV add-ons as the cost for doing so is relatively inexpensive at that time.

## Minimum Standards & Recommendations

It is important to size the RO to the evaporator. As an example, for a producer that has about 1,500–2,000 taps with an evaporator rated at 165 to 175 gph of water removal, then a 600 gph RO system is typically recommended. It will produce about 150 gallons of concentrate per hour (removing 75% of the water), which the evaporator can adequately keep up with.

It is important to work with an expert in reverse osmosis technology and maple syrup production as every case is handled individually depending on the current equipment, operating conditions, and what the producer wants to accomplish.

Be sure to follow all recommendations in the operator's manual for installation and maintenance. Membranes have specific cleaning instructions to maintain efficiency. Also, there is a preparation procedure for the beginning of each season and an annual closing process at the end of each season to prevent freezing.


Jessica Cook, BP RC&D, 2012

## Energy Savings

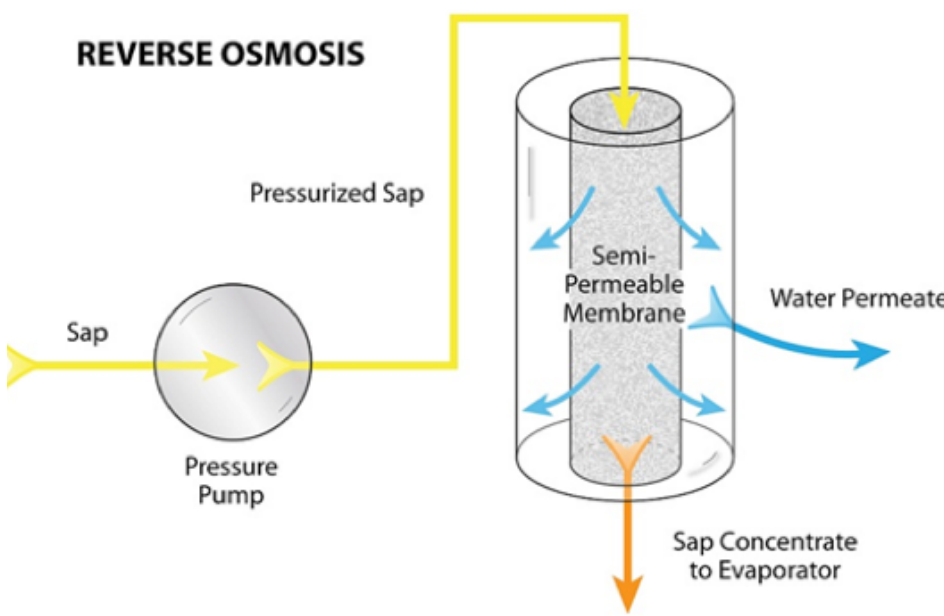
It is estimated to reduce fuel usage by 50%–75% over open pan evaporation. A 65% reduction in fuel usage (or approximately ⅔ less wood) is common. This will vary depending on the efficiency and setup of the current evaporator.

## Environmental Impact & Other Benefits

The concentration process of maple sap reduces the volume of greenhouse gases into the atmosphere due to reduced consumption of wood or fossil fuels, while greatly contributing to the conservation of long-term renewable energy sources.

A reverse osmosis system also shortens the process time, reducing labor costs and permitting an expansion of the maple operation, resulting in an increase in maple syrup production while reducing fuel oil use. It can also help produce a lighter grade of syrup as a result of a shortened boiling time in the evaporator.

## Schematic Diagram




Scott Sanford, 2011

## Economic Benefits

A reverse osmosis system can range in price from about $5,000 for a 50 gallon/hr machine to $75,000 for the 4,000 gallon/hr machine, plus additional costs for installation. A common unit, the 600 gph RO system is estimated at $18,000 for the unit and a total cost of about $25,000 for an installed price (including tanks and the necessary plumbing).

To determine a simple payback, take the estimated installed cost and divide by the annual fuel savings. For a more detailed analysis, an energy assessment should be completed. There is also a USDA-NRCS online energy tool for maple syrup production that can be used as a starting point located at: www.ruralenergy.wisc.edu.

**Estimated Annual Savings Based on Annual Gallons of Sap Collected**

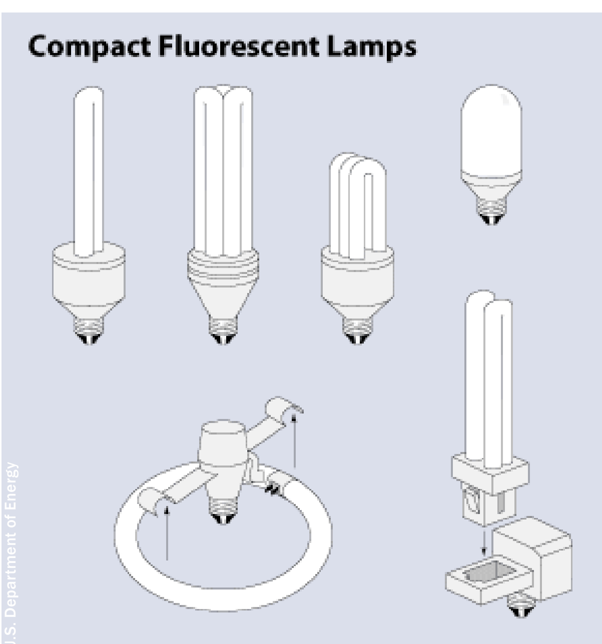
| Annual Gallons of Sap Collected | Annual Fuel Usage (gallons)* | Annual Fuel Savings (gallons)** | Annual Savings ($)*** |
|---|---|---|---|
| 2,000 | 190 | 124 | $310 |
| 5,000 | 480 | 312 | $780 |
| 10,000 | 960 | 624 | $1,560 |
| 15,000 | 1,430 | 930 | $2,320 |
| 20,000 | 1,910 | 1,242 | $3,100 |
| 25,000 | 2,390 | 1,554 | $3,880 |
| 30,000 | 2,870 | 1,866 | $4,660 |
| 40,000 | 3,820 | 2,483 | $6,210 |
| 50,000 | 4,780 | 3,107 | $7,770 |
| 60,000 | 5,740 | 3,731 | $9,330 |
| 70,000 | 6,690 | 4,349 | $10,870 |
| 80,000 | 7,650 | 4,973 | $12,430 |

* Based on sap collected with a brix value of 2%, removing 42 gallons of water per gallon of syrup, taking 400,000 BTUs per gallon of syrup (for every pound of water it takes 170 BTUs to raise from 40°F to boiling and 970 BTUs to turn from liquid to a vapor, for about 9,500 BTU/gallon), an energy content of #2 fuel oil of 139,000 BTUs, and a 70% efficient evaporator
** Based on 65% reduction in energy usage
*** Based on a fuel price of $2.50/gallon for #2 fuel oil

Additional notes: Due to the huge variability in the energy content of wood, the annual fuel usage in cords of wood has a wide range. To determine savings, the annual full cords of wood must be known. A full cord of wood measures 4' wide x 4' high x 8' long and 128 feet$^3$ in volume. The market value of wood is approximately $250 per cord. Take annual number of cords and multiply by $250, and then multiply by 0.65 to determine annual savings. Typically the retail financial value of a cord of wood is used in the analysis even if producers cut their own wood, because that wood could potentially be sold for a value. Annual electric usage for an RO machine is relatively small compared to fuel cost (300–600 kWh, or $50–$100 for the 600gph RO unit), but should also be considered.


Devon Whitney-Deal, CISA, 2012

## Energy Efficiency Lighting


### At a Glance:

- Recommended lighting upgrades can use 40-80% less energy
- New lamp types offer better quality light, longer lamp life, and lower operating costs
- Be sure to dispose of bulbs properly. Visit: www.epa.gov/bulbrecycling

Several things should be considered when evaluating the proper lighting for a maple sugaring operation.

First, the owner should consider the time of use and or seasonal use of the facilities. With maple sugaring's seasonal operations of three months or less, the use and payback must be seriously considered when making lighting upgrades.

Second, owners should consider the operations within the facility and the best style of light fixture to use. In facilities with a moist environment like evaporator, wash, and food processing rooms; sealed and gasketed, wet location fixtures should be used.

Also, Massachusetts recommends sealed and gasketed fixtures in food processing areas to minimize the potential for getting shattered glass and lamp contents in maple syrup/food production.

Replacing ineffecient incandescent and halogen lamps with more efficient HPT-8 lamps can reduce energy use by 60-75%. (Above)

Compact fluorescent lamps come in many shapes and sizes. (Below)

## Low Bay Lighting (< 12 feet)

The most common type of lighting found with ceilings less than 12' high (places such as sugar shacks, retail space, storage areas, and workshops) is the linear fluorescent tube or Edison style incandescent light bulbs.

Linear fluorescent lamps come in two different lengths (4' & 8') and in different diameters, measured in eighths of an inch. The old standard, found in facilities that have not updated their lighting in the past 5–10 years, is the T-12 (1.5 inches in diameter) that uses magnetic ballasts.

The best practice for low bay lighting is to install CEE certified HPT-8 light fixtures. It is also advised that these fixtures be moisture tight, enclosed fixtures in evaporator or wet location facilities containing steam evaporators or sanitation wash down facilities. HPT-8 is the most efficient and cost feasible lighting application for low ceiling facilities.

The Consortium for Energy Efficiency (CEE) is a nonprofit public benefits corporation that promotes the manufacture and purchase of energy efficient lighting. The CEE provides a listing of certified HPT-8 lamps and ballasts for 4-foot, 32-watt T-8 lighting systems and reduced-wattage T-8 systems.

State programs such as MassSAVE, implemented through the public utilities, require that new HPT-8 systems be certified by CEE in order to receive incentives.

Be sure to check with your electric utility provider to determine if you are eligible for any incentives.

Fluorescent lamps come in a range of colors, measured on the Kelvin scale. Use the following as a reference guide to pick the right color:[4]

| Warm & Soft White | Cool & Bright White | Natural or Daylight |
|---|---|---|
| Standard color of incandescent bulbs | Good for workspaces | Good for reading |
| 2700K — 3000K | 3500K — 4100K | 5000K — 6500K |

## Individual Edison Style Light Bulbs

Used for over 100 years and most common in older facilities, the Edison style incandescent lights bulbs are very inefficient, converting only 5–10% of the used energy to light, with the rest wasted as heat. They also have a short life span (600–2,000 hours) and can be purchased in enclosed fixture styles.

In maple sugaring facilities in dry locations that have existing incandescent light bulbs, it is recommended to replace these with Energy Star certified compact fluorescent lamps (CFLs). CFLs were made as an easy and direct replacement for incandescent bulbs. They use 75% less energy and have a life span of 6,000–10,000 hours (6–10 times longer).

**Guide to Replacing Incandescent Bulbs with Equivalent CFLs**

| Incandescent Bulb (Watts) | CFL (Watts) | Light Output (Lumens) | Energy Savings (Lamplife) |
|---|---|---|---|
| 40 | 13 | 490–510 | $17 |
| 60 | 15 | 870–950 | $33 |
| 75 | 20 | 1190–1300 | $42 |
| 100 | 23–27 | 1500–1690 | $62 |
| 120 | 26–30 | 1750–1920 | $67 |
| 150 | 32–40 | 2050–2600 | $70 |
| 200 | 45 | 2700 | $94 |
| 240 | 55 | 3600 | $114 |
| 300 | 68 | 4200 | $117 |

Energy Star-certified models come with a two-year warranty, have a minimum rated lifespan of at least 6,000 hours, and do not emit an audible noise (which can be common with cheaper CFLs). Also, CFLs come with various temperature ratings and it is important to look on the box before purchasing. They are typically rated for either 32°F or 0°F. CFLs operating near their rated temperature may take a few minutes to warm up to get to full output.

However, the CFL style of lighting is not recommended for new construction where standard HPT-8 installations are recommended.

## Individual Edison Style Light Bulbs (continued)


Cold cathode florescent lamp (CCFL)

Cold cathode fluorescent lamps (CCFLs) are also an option for cases where either a dimmable light is necessary or where an extremely long lamp life is important (rated for 25,000 hours). They are ideal for applications where reduced maintenance and energy costs are desired (especially in hard to reach lighting installations).

However, CCFLs are not feasible in facilities that are seasonally operated or have minimal use as expected in a maple syrup operation.

New linear fluorescent fixtures with electronic ballasts have many benefits over the older magnetic ballasts:

- Increased lamp-ballast efficacy (lumens/watt), meaning more light for less energy
- Operates at high frequency AC, eliminating the flicker associated with magnetic ballast when ambient air temperatures are cooler
- Quieter operation
- Lamps and ballasts are directly interchangeable with magnetic ballasts

## Outdoor Lighting

Incandescent floodlights and mercury vapor lamps are common for older outdoor lighting and are very inefficient. It is recommended to install high pressure sodium (HPS) lamps.

HPS lamps have a high efficacy of about 95 [lumens/watt] compared to 15–20 [lumens/watt] for incandescent floodlights and 50–55 [lumens/watt] for mercury vapor lamps, using 80% and 40% less energy respectively. They emit a yellow-orange light and are generally used for outdoor lighting where color differentiation is not important. They require 3–5 minutes to warm up, so may not be applicable for instant-on lighting applications.

For typical yard lights, about 30% or more of the light goes sideways or up, meaning it is not being used. Consider a full cut-off parabolic reflector such as the Hubbell Skycap to increase the amount of light that reaches the ground (by up to 50%). Using more of the light means it might be possible to use a lower wattage lamp and maintain the same level of illumination.

## Applications & Limitations

Lighting upgrades are applicable in most cases. Cost-effective upgrades may be more limited if lights have minimal use over the year (which can be common for sugarhouses that have limited seasonal use).

## Recommendation

### Replace Halogen Light Fixtures

The tungsten-halogen lamp (a type of incandescent lamp) is 15% more efficient than a standard incandescent lamp, but still very inefficient compared to other available lighting.

They can range from low wattage all the way up to 1500 watts. A halogen lamp can be replaced with any of the following depending on the application: CFL, HPT-8, pulse start metal halide (PSMH), or a high pressure sodium lamp.

These light fixtures will reduce energy usage by 60–75% compared to a halogen light.


Scott Sanford, 2011


Jessica Cook, BP RC&D, 2012

## Minimum Standards & Recommendations

- Install in accordance with national best practices in lighting design such as IESNA recommended practices as well as lighting power densities prescribed by local and state building codes. Follow all local electrical codes.
- In areas where fixtures need protection from water (including humid locations) install enclosed fixtures with an appropriate Ingress Protection (IP) rating. For more information about the ratings, please refer to: http://en.wikipedia.org/wiki/IP_Code.
- Choose HPT-8 lamps and ballasts that are CEE certified. It is recommended to choose a high lumen and long life lamp with minimum initial lumens of 3,100 and a rated life of 24,000 hours.
- Be sure to verify the temperature and humidity rating of the light fixture to ensure it will work as designed in the sugarhouse environment.
- Light levels gradually change as they age. Be sure to change lamps as recommended per the manufacturer to ensure adequate light levels are maintained as designed.
- Be sure to properly recycle all bulbs as required, including all fluorescent and high intensity discharge (HID) lamps such as metal halides and high pressure sodium (HPS). For more information about proper recycling, visit: epa.gov/bulbrecycling.

## Energy Savings

When upgrading a T-12 system to HPT-8, electricity savings can be as high as 40%. Lighting systems meeting the CEE specifications are generally 10–20% more efficient than standard T-8 systems.

Energy savings of a fixture can be calculated by the following equation:

**Annual Energy Savings [kWh]=**

$$\left[\frac{\text{old [watts]} - \text{new [watts]}}{1000}\right] \times \text{daily hours of use} \times 365 \text{ days}$$

Please Note: The quantity and quality of lighting can vary greatly. For a more detailed description of various types of lights and potential energy savings, please refer to the Natural Resources Conservation Service (NRCS) online lighting energy self assessment, located at: www.ruralenergy.wisc.edu

## Environmental Impact & Benefits

The energy savings and offset of electrical production achieved by installing energy efficient lighting will result in a reduction of greenhouse gas (GHG) emissions.

Reducing energy use reduces the overall GHG footprint of the facility by minimizing the amount of emissions released from fossil fuel power plants.

For every kWh saved, 2.02 lbs of $CO_2$ are not being released into the atmosphere.

## Economic Benefits

The actual savings of installing new lighting can vary greatly depending on factors such as installed costs and annual hours of use.

To determine a simple payback, take the installed cost and divide by the annual energy savings as determined from the above equation or the online calculator from NRCS. New light fixtures that contain bulbs with a longer rated life can provide additional savings by decreasing maintenance and labor costs.

This is an example sugarbush lighting analysis of an operation with seasonal cooking, processing, but a full-time commercial store operation.

The operation would have three facilities: shop area, evaporator and processing facility, and woodshed. The first thing to consider in the analysis is time of use for lighting in these facilities. As a retail, the shop would see the most extensive use, assuming about 2000 hours per year if open eight hours a day, five days a week. This should then be compared to the processing room and woodshed which would be used much less —960 and 120 hours, respectively.

In the case of the retail shop that has eight standard T-12 eight foot fluorescent low-bay fixtures, replacing these fixtures with eight T-8 four foot fluorescent open fixtures would result in about 900 kWh and $100 energy savings.

At a cost of $45 per open fixture, the payback for the replacements would be just under 4 years.

## Economic Benefits (continued)

However, the replacement of eight T-12 fixtures in the processing and evaporator room may not be as feasible due to their reduced time of use and added cost of an enclosed, sealed and gasketed T-8 four foot fixture. With a seasonal use of only 960 hours, the new fixtures would save 430 kwh, $47 annually, but the simple payback is over eight years.

While there are energy savings, replacing the lighting fixtures in the processing room is not feasible on an energy savings basis. The wood shed would see even less use, only a few hours a day during the cooking season. The payback on replacing four old 200 watt incandescent lights in the woodshed with new T-8 light fixtures would be more than 10 years. However, if the operation were to install a cold-weather 34 watt CFL, the feasibility of the replacement is improved to 5.5 years assuming 120 hours of use. The CFLs would save 80 kWh, $9 a year.

It is usually recommended to replace light fixtures when the simple payback is less than 5–7 years.

**Typical Costs for Various Light Fixtures**[5]

| Light/Fixture | Cost* |
|---|---|
| 23 watt CFL | $4 |
| Retrofit, 2 x 4’ HPT-8 Lamp and 1 electronic ballast | $65 |
| 2-lamp, 4' HPT-8 | $120 |
| 4-lamp, 4' HPT-8 | $140 |
| 6-lamp, 4' HPT-8 | $240 |
| 320 PSMH | $250 |
| 400 watt HPS | $200 |
| 1000 watt HPS | $350 |

*Costs will vary by type of enclosure, manufacturer, installation costs, as well as other factors and should be confirmed if considering a lighting upgrade.

Reviewing the *Massachusetts Farm Energy Best Management Practices Guide* is the first step in reducing energy use and saving money.

Below are some steps to keep in mind for successful energy management:

1. **Learn about energy conservation, energy efficiency, and renewable energy.**
   Learning about your energy use and ways to reduce it or supplement it with renewable energy is the first step. There is much information available about reducing energy use as well as case studies of farms that have taken action.

2. **Apply for a farm energy audit or renewable energy assessment.**
   An energy audit can help determine where energy is being wasted by inefficient equipment and practices and can recommend solutions. After reading about energy audits on the Berkshire Pioneer RC&D website, complete an application to apply for an MFEP energy audit or renewable energy assessment. The application can be found at: www.berkshirepioneerrcd.org/mfep/forms/application.php.

3. **Apply energy conservation practices.**
   The easiest and most cost effective method of achieving energy savings is through energy conservation. Energy conservation means using energy wisely and eliminating energy waste, such as running a heater or a ventilation fan when it's not necessary.

4. **Apply recommended energy efficiency practices.**
   Energy efficiency means using less energy to produce the same end result. This manual focuses on conventional energy efficiency measures using current applicable technology. Energy efficiency measures should be taken before considering renewable energy. Reducing the amount of energy used is more cost effective than purchasing renewable energy to power inefficient devices.

5. **Focus on Time-of-Use management (for cost savings, if applicable).**
   With proper Time-of-Use energy management, it is possible for agricultural producers to reduce their energy bills. Load demands change dramatically throughout the day, but utility companies must have the capacity to provide enough electricity for on-peak demand (typically aligning with summer months and daylight hours). In order to spread out this peak demand more evenly over the 24-hour day, electric utility companies provide a Time-of-Use (TOU) pricing structure. In a TOU billing structure, kWh prices are increased during on-peak hours and are reduced during off-peak hours to encourage customers to change behavior by using energy intensive equipment outside of peak hours.

6. **Install renewable energy.**
   After the previous steps have been exhausted, renewable energy is the final step. Renewable energy has a much lower environmental impact than conventional sources of energy production and decreases the US dependence on a fossil fuel economy. It also helps stimulate the economy and create job opportunities. Money spent on renewable energy is spent on materials and staff that build and maintain the equipment instead of importing non-renewable fossil fuels. This manual focuses on solar thermal, photovoltaic, wind, and biomass. Other technologies include, but are not limited to, anaerobic waste digesters (biogas), geothermal, and hydro.

## Where to Start—Information & Resources

### Massachusetts Farm Energy Program (MFEP)

www.berkshirepioneerrcd.org/mfep

413-256-1607

MFEP provides technical assistance and funding referrals for farmers looking for financial resources to support energy efficiency or renewables projects. MFEP staff are up-to-date on the evolving funding opportunities and offer an initial one-stop shop for funding resources for farm energy projects.

### Massachusetts Department of Agricultural Resources (MDAR)

www.mass.gov/agr/programs/energy

617-626-1703

MDAR offers energy related grant opportunities through the Ag-Energy Grant Program from May to June of each year, in addition to farm viability and business development grants that may consider energy projects as a component. MDAR also offers support for farms interested in energy efficiency, conservation, and renewables through their renewable energy coordinator position.

More information and technical resources are available online.

### Farm Energy Discount Program

www.mass.gov/agr/admin/farmenergy.htm

617-626-1733

All agricultural ratepayers in Massachusetts enjoy a mandated 10% reduction on their energy bills for electricity and natural gas supplied by public utilities as a result of legislation enacted to restructure the utility industry.

Individual and corporations that are "principally and substantially engaged in the business of production agriculture or farming for an ultimate commercial purpose" are eligible.

A two-page application is available online.

### DSIRE—Database of State Incentives for Renewables and Efficiency

www.dsireusa.org

This online database provides up-to-date resources on financial incentives for renewables and efficiency projects from state and federal sources, many of which are applicable to farm businesses.

### Installers and Contractors

Independent equipment installers, dealers, and contractors are a good source of information related to financial incentives for energy projects. Particularly in the case of renewable energy, installers need to track funding programs and realistically estimate how they affect the payback period for the project in order to maintain a competitive advantage in their field.

## Energy Efficiency Financial Resources | Massachusetts State Resources

### Public Utility Energy Efficiency Programs

Contact your municipal utility company

Customers of investor-owned public utility companies pay into conservation, efficiency, and renewable energy funds and therefore have access to energy efficiency programs. These "public" energy conservation programs are regulated by the MA Department of Public Utilities. Typically utilities offer energy assessments, performed by employees or contractors, as well as financial incentives (cost-share) on cost-effective energy efficiency measures.

There are four investor-owned electric utility companies in Massachusetts: National Grid, NSTAR, Unitil (Fitchburg Gas & Electric), and Western Massachusetts Electric Company. In addition, Cape Light Compact operates the regional energy efficiency program for the Cape and islands. Natural gas companies include Berkshire Gas, Columbia Gas of Massachusetts (formerly Bay State Gas), National Grid (formerly Keyspan Gas), and NSTAR.

For contact information related to farm energy assessments and incentives, look online or call the Massachusetts Farm Energy Program.

### Municipal Utilities

Contact your municipal utility company

Customers that are serviced by the 40 municipal electric and gas utility departments in the state typically do not pay into conservation or renewable energy funds. Some municipal utility companies have developed fee for service audit programs. Contact your individual municipal utility company to see what programs are available.

## Energy Efficiency Financial Resources | Federal Resources

### USDA-Rural Energy for America Program (REAP)

www.rurdev.usda.gov/BCP_Reap.html

Contact your local USDA-RD office

USDA-Rural Development (RD) administers competitive grants for energy efficiency and renewable energy projects at 25% of eligible project costs, as well as guaranteed loans, to farmers and rural small businesses.

Energy efficiency project applications to REAP require an energy assessment or audit, and renewable projects require technical reports from installers. Farmers are strongly encouraged to prepare REAP applications during slower seasons on the farm. In addition, MFEP strongly encourages producers to work on preparing the application during slower seasons on the farm.

For more information, look online or contact your local USDA-Rural Development Area Office.

### USDA-Environmental Quality Incentives Program (EQIP)

www.ma.nrcs.usda.gov/programs/airquality/

Contact your local USDA-NRCS office

Under the 2008 Food, Conservation and Energy Act the USDA Natural Resources Conservation Service (NRCS) can provide eligible producers with program support through the Environmental Quality Incentives Program (EQIP) to implement cost-effective and innovative practices that improve air quality.

Individuals, groups and entities who own or manage farmland, pastureland or non-industrial forest land are eligible to apply. Producers with an annual minimum of $1,000 of agricultural products produced and/or sold from their operation are eligible to apply.

In 2009, EQIP provided funding for specific conservation practices related to anaerobic digestion, greenhouse energy screens and horizontal air flow, and cranberry auto-start systems.

## Renewable Energy Financial Resources | Massachusetts State Resources

### Department of Public Utilities (DPU) Net Metering

Contact your local utility company

Net metering for wind, solar and agricultural energy installations encourages public utility customers to install solar panels and wind turbines, by allowing them to earn credit on their electric bills if they generate more power than they need. Farms are also encouraged to install additional renewable technologies such as anaerobic digesters.

Under the Green Communities Act signed by Governor Patrick in 2008, utility companies must compensate their customers for up to two megawatts of excess electricity at the retail rate rather than the lower wholesale rate. Additionally, customers may allocate their credits to other customers.

To find out how you can apply for net metering contact your local eligible utility (NGrid, NSTAR, WMECO or Unitil), or work through your renewable energy installer.

Municipal utility customers planning to install a renewable energy project to produce electricity will need to contact their suppliers to review net metering and interconnection policies.

### Massachusetts Clean Energy Center (MassCEC)

www.masscec.com

617-315-9355

The Green Jobs Act of 2008 created the Massachusetts Clean Energy Center (MassCEC) to accelerate job growth and economic development in the state's clean energy industry. The Renewable Energy Generation division of MassCEC is responsible for supporting renewable energy projects throughout the Commonwealth.

MassCEC has awarded funds to hundreds of businesses, towns, and non-profits for feasibility and/or design and construction of solar panels, wind turbines, biomass systems, hydroelectric systems, and other clean energy systems.

Contact MassCEC to learn about current programs like Commonwealth Wind and Commonwealth Solar.

## Renewable Energy Financial Resources | Massachusetts State Resources (continued)

### Renewable Energy Certificates (RECs)

www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/

RECs are a means by which the environmental benefits, also known as the renewable attributes, of energy production by eligible renewable energy technologies can be sold to retail electric suppliers (RES) who are required to buy a minimum amount of these attributes to meet Massachusetts' renewable portfolio standard (RPS) requirements. For more details regarding eligible technologies and how prices are determined, refer to the MA Department of Energy Resources (DOER).

### Solar Renewable Energy Certificates (SRECs)

www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/

The SRECs program is a market-based incentive program to support the development of 400 MW of solar photovoltaic (PV) infrastructure across the Commonwealth. SRECs are a means by which solar energy producers can sell the environmental attributes of solar generation to public utilities which are required to buy a minimum amount to meet Massachusetts' renewables portfolio standard (RPS) requirements. The sale of these certificates allows for a consistent cash flow for a ten-year period.

### Massachusetts State Tax Deduction

www.dsireusa.org

Contact a tax consultant for details

Businesses in Massachusetts may deduct from net income, for state excise tax purposes, the installed cost of renewable energy systems. See DSIRE or contact a tax consultant for more details.

## Renewable Energy Financial Resources | Federal Resources

### USDA-Rural Energy for America Program (REAP)

www.rurdev.usda.gov/BCP_Reap.html

Contact your local USDA-RD office

The Section 9007 of the 2008 Farm Bill provides funding for renewable energy systems and energy efficiency improvements. USDA-Rural Development (RD) administers these funds and offers competitive grants at 25% of eligible project costs, as well as guaranteed loans, to farmers and rural small businesses.

The annual application deadline is generally in the spring. For more information, look online or contact your local USDA-Rural Development Area Office.

### Business Investment Tax Credit (ITC) and American Recovery and Reinvestment Act of 2009 (ARRA)

www.irs.gov/newsroom/article/0,,id=206871,00.html

Contact a tax consultant for details

The federal business energy investment tax credit available under 26 USC § 48, and expanded by the Energy Improvement and Extension Act of 2008 (H.R. 1424) in October 2008 and the American Recovery and Reinvestment Act of 2009 in February 2009, provides tax credits for a range of renewable energy projects, ranging from 10%-30% of the eligible costs of renewable energy projects.

*Deadlines: Credit Termination Dates vary by technology, but are generally available for eligible systems placed in service before January 1, 2017 (with the exception of large wind 1/1/13 and biomass 1/1/14).*

### Federal Accelerated and Bonus Depreciation

www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06F

Contact a tax consultant for details

Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation.

## Disclaimers

Mention of trade names and products is for information purposes only and constitutes neither an endorsement of, recommendation of, nor discrimination against similar products not mentioned.

Although this guide contains research-based information and the contributors have used their best efforts in preparing this guide, the contributors make no warranties, express or implied, with respect to the use of this guide. Users of this guide maintain complete responsibility for the accuracy and appropriate application of this guide for their intended purpose(s).

In no event shall the contributors be held responsible or liable for any indirect, direct, incidental, or consequential damages or loss of profits or any other commercial damage whatsoever resulting from or related to the use or misuse of this guide.

The contributors emphasize the importance of consulting experienced and qualified consultants, advisors, and other business professionals to ensure the best results.

Project costs presented in this report are estimates only, based upon available pricing information at the time of compiling this report. Actual costs will likely vary due to many different variables.

## Energy and Fuel Prices

Energy and fuel prices are constantly fluctuating. Actual prices will affect the economic feasibility of a project. The following energy prices have been used for purposes of the calculations throughout this manual:

- $0.15/kWh
- $1.10/therm
- $2/gallon propane (LP)
- $2.5/gallon fuel oil
- $200/full cord of wood (measured as 4' x 4' x 8')

For more information, contact the Mass Farm Energy Program at Berkshire-Pioneer RC&D: www.berkshirepioneerrcd.org/mfep or 413-256-1607.

Massachusetts Farm Energy Program
Conservation • Efficiency • Renewables

## Notes

1. Based on information provided from the USDA NRCS Energy Self Assessment Tool. Available at http://www.ruralenergy.wisc.edu.

2. Based on information provided from the *Leader Evaporator On-line Catalog*. Available at http://www.leadereveporator.com/pdf_files/current-Leader-Eveporator-catalog.pdf.

3. From Joseph Marcucio, Fuss & O'Neill.

4. Data and concept from the Focus on Energy Program.

5. Taken from *Compact Fluorescent Lighting on Farms*, Focus on Energy. Available at http://www.focusonenergy.com/files/Document_Management_System/Business_Programs/cflsonfarms_technicalsheet.pdf.

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