Evaporator Energy Efficiency

For Maple Farms

Maple farms can use less energy, save money, and be more resilient with equipment upgrades that can pay for themselves

There are several measures and technologies available that can help New York State maple farms—whether small with tens or hundreds of taps, or large with thousands of taps—reduce energy and save money.

On maple farms, evaporators are one of the main energy consumers. Efficient evaporator technology can reduce costs, increase production capacity, and improve long-term environmental outcomes. Energy used by the evaporator can be reduced by 1) pre-concentrating the sap through reverse osmosis (RO); 2) pre-heating the sap; and 3) improving evaporator efficiency. The energy source used to power evaporators also affects costs, operations, and environmental impacts.

Pre-concentrating sap

Even factoring in the installation and maintenance costs, pre-concentrating sap with electricity (through RO) is much cheaper than concentrating in the evaporator. Adding RO is the first way to save energy in a maple operation. See the NYSERDA Energy Best Practices for Agriculture factsheet on Maple General Energy Efficiency to learn more about RO systems.

Pre-heating sap

Sap preheaters have different designs, but the idea is generally the same: steam is captured over the flue pan and its heat is used to warm sap. In heat recovery systems, a series of pipes carries cold sap through hot steam. In steam-enhanced systems, steam is routed through pipes submersed in cold sap. In both cases, sap leaves the preheater warmed (sometimes near boiling temperatures) and hot condensate is collected separately for other uses (cleaning equipment, warming surfaces). Reports indicate that a properly sized pre-heater will increase the efficiency of an evaporator by 15–20%. More advanced devices use high pressure to cause water vapor to leave the sap before it reaches its boiling point or enters the flue pan. In these systems, sap is both preheated and concentrated before entering the flue pan, further improving efficiency.

Sap preheaters do add maintenance to the farm workload. Preheating devices need to be regularly cleaned and sap should not be left in the preheater between runs. Steam-Aways and similar units require more effort to clean. Adequate overhead space and a safe system for lifting hoods and pans make it easier to access and clean sap preheaters.

Evaporator efficiency improvements

In addition to RO and preheating with steam recovery, there are evaporator features that can reduce waste heat. Examples include an air-tight door (on wood-fueled evaporators), an insulated arch, a forced draft unit, barometric dampers, and a flue pan with maximum surface area. For more guidance on high-efficiency evaporator features, see Atkinson, H. & Marchetti, L. (2010) or MFEP (2012). When considering a new evaporator, the most cost-effective selection over the life of the device tends to be an evaporator with a pre-heater and a high-efficiency arch.

NEW YORK STATE | NYSERDA

Powering the evaporator

Energy sources vary in their cost, availability, environmental impact, and operating requirements. With the aim to strengthen New York State businesses, improve environmental impacts, and increase farm resilience to volatile energy markets, certain energy sources stand out as likely fuels of sugar shacks in the future.

On smaller scales, firewood harvested using ecological forestry can be a sustainable part of the carbon cycle and an affordable, reliable option for maple farms. This is especially true with proper firewood management (see Metz, 2010). Propane may also have a place in some sugar shacks, where wood or electric power and evaporators are not suitable.

For larger farms that are ready to upgrade or replace equipment, electric evaporators offer many benefits: electric power can be sourced from various means; electric evaporators recover all energy contained in sap; no emissions are produced on-site; electrical devices can be automated and integrated with RO and Brix equalizer systems; and given operating efficiencies, costs of production per gallon of syrup can be lowest.

Table 1. Energy cost per gallon of syrup, using different fuels and efficiency technologies.

Open Pan Evaporator	Preheat	SteamAway	Reverse Osmosis (10 Brix)	RO and SteamAway
Wood	$9.28	$5.62	$1.75	$1.09
Wood/air tight arch	$5.71	$3.46	$1.10	$0.69
Fuel oil	$15.31	$9.28	$2.85	$1.75
Natural gas	$6.19	$3.75	$1.19	$0.75
LP gas	$18.21	$11.04	$3.38	$2.07

Table Notes:

1. *This table is derived from Winship (2001) using more recent estimates of fuel prices: $250/full cord of wood, $4.64/gallon of fuel oil, $1.36/therm of natural gas, $3.72/gallon of LP gas, and $0.16/kWh electricity. Price of wood is assumed as cost for maple producers to process their own firewood; prices of other energy sources are NYS averages of residential prices in March 2022, based on NYSERDA energy price monitoring programs. Fuel oil price is midway between max. and min. price, September 2021-2022.*
2. *This table assumes the Brix of sap concentrated through reverse osmosis will be 10%.*

References:

- *Atkinson, H. & Marchetti, L. 2010. Guidelines for the Improvement of Combustion Efficiency for Maple Producers. Thunderbolt Research Corp. Available at: https://mapleresearch.org/pub/combeffic/*
- *Heiligmann, R.B., Koelling, M.R., Perkins, T.D., & van den Berg, A.K. 2022. North American Maple Syrup Producers Manual. Available at: https://mapleresearch.org/pub/manual/*
- *Massachusetts Farm Energy Program (MFEP). 2012. Best Management Practices for Maple Sugaring. Massachusetts Department of Agricultural Resources, Amherst, MA. Available at: https://massfarmenergy.com/wp-content/uploads/2014/03/Maple%20Sugaring%20Best%20Practices.pdf*
- *Metz, G. 2010. Learn to Burn: Your Guide to Heating With Wood. Cornell Cooperative Extension Tompkins County. Available at: http://ccetompkins.org/resources/learn-to-burn*
- *New York State Energy Research and Development Authority (NYSERDA). 2022. Maple General Energy Efficiency. Energy Best Practices for Agriculture factsheet. Available at: https://agenergyny.org/factsheets/*
- *Winship, C. 2001. Maple Sap Concentration Processes and Variable Cost of Different Fuels: A spreadsheet to calculate costs of operating evaporators with a range of fuel types. Cornell University. Available at: https://mapleresearch.org/pub/evapeffic/*

Resources

Energy efficiency resources are being developed for farmers by Cornell Cooperative Extension and the New York State Energy Research and Development Authority, in collaboration with topic-experts in New York State. Visit AgEnergyNY.org to find cost-saving resources for farms:

- Recommendations for energy-efficient technologies
- Conservation practices to optimize energy use
- Easy access to funding resources

SCAN ME

Ready to get started?

Visit AgEnergyNY.org to learn more and to get advice on energy efficiency and farm operations, learn about available grants and incentives, or obtain a free energy audit of your farm operations.

NEW YORK STATE | NYSERDA