Refrigeration

For Vegetable Farms

Farms can use less energy, save money, and be more resilient through equipment upgrades that pay for themselves

There are several measures and technologies available to help vegetable farms reduce energy use and save money. Vegetable farms include single-item farms such as onions or potatoes as well as multi-product farms growing vegetables such as tomatoes, peppers, cucumbers, cabbages, green peas, snap beans, squash, sweet corn and more.

Refrigeration Best Practices

A refrigeration system is necessary to store produce until ready for distribution. You can purchase pre-made cooling units setup for energy efficiency when expanding or replacing equipment, or implement best practices to improve the performance of existing refrigeration systems. Because energy-saving upgrades require capital expenditures, these best practices are most appropriate in areas where refrigeration operates for several months annually.

1. Scroll Compressors

In comparison with other types of compressors, scroll compressors are more efficient and less prone to mechanical failure since there are only two moving parts – a fixed and an orbital scroll. Scroll compressors can reach 100% volumetric efficiency and operate more smoothly and quietly because of the absence of gas compression pistons. Switch to scroll compressors when you need to replace or get a new compressor or refrigerator – scroll compressors save money by reducing energy use, while improving performance.

2. Refrigeration Controls

Electronic controls of refrigeration components can precisely adjust compressor and fan operations in response to real-time conditions, to improve energy efficiency and overall system performance. Most refrigeration systems do not need advanced electronic controls to operate efficiently. However, complex systems with multiple compressors call for more elaborate refrigeration controls.

3. Strip Curtains

Consistently keeping the walk-in cooler doors closed is the best way to maintain desired temperature and moisture levels. Strip curtains can be installed as a low-cost measure to reduce energy loss when cooler doors are open.

4. Brushless Motors

Old and worn standard-efficiency motors should be replaced with high-efficiency options – the more hours a motor operates, the more cost-effective it is to replace it with a high-efficiency electronically commutated (EC) motor, also known as a brushless motor. Compared with standard brushed or induction motors, brushless motors use less raw materials to build, are less prone to mechanical failure, dissipate less heat, and are smaller and more energy efficient. These features make brushless motors better for the environment and long-term operations. Although the upfront cost may be more, the return on investment tends to be quick, especially for motors that run for many hours.

5. Disconnect Defrost Heaters in Walk-In Coolers Kept Above Freezing

Electric defrost systems use heating elements installed next to a refrigerator's evaporator coils. These are used during defrost cycles to melt accumulated ice which would otherwise degrade refrigerator performance. The electrical heating elements are energized in defrost cycles and the refrigerator blows hot air around those elements over the evaporator coil to melt the ice.

If you use a walk-in cooler for refrigeration above freezing temperature, the built-in evaporator fans can melt the ice sufficiently. Disconnecting electric defrost systems will prevent them from becoming energized during the defrost cycle, avoiding unnecessary energy use and costs.

6. Install a Hot Gas Defrost System

Hot gas defrost systems use heat from a refrigerator's compressor to melt any frost on the evaporator coil. This defrost system consumes less energy than heating air with electric heating elements. Hot gas defrost also heats the entire evaporator coil, and only a small amount of that energy warms the refrigerated area, meaning the refrigerator has to do less work to stay cool through defrost cycles.

Hot gas defrost generates less moisture compared to electric defrost because the evaporator coil is heated using air already in the refrigeration system. Hot gas defrost also tends to have a shorter defrost time, because hot gas is immediately available from the compressor when the defrost cycle begins. Shorter defrost cycles help reduce temperature variations throughout a refrigerator's operating cycles and also reduce strain on the compressor, improving the lifespan of refrigerator parts. Hot gas defrost uses more complicated piping and tends to be more costly to design and install. It is recommended that this technology be installed when replacing or expanding refrigeration systems.

	High-efficiency Refrigeration System	Compressed Air Optimization	Preventative Maintenance – Refrigeration Tune Up	Preventative Maintenance – Scroll Compressors
Description	Well insulated, high-efficiency, walk-in cooling. Include controls (temp/humidity/air exchange rate/etc.), strip curtain, EM motors, scroll compressors, etc.	Setpoints should be closer to 90 psi (110 psi max); lead-lag arrangements should be tuned; a new variable speed compressor should be installed when the base load is sufficient to warrant the expense.	Clean and inspect condenser coils; clean and inspect evaporator coils; clean drain pan; clean and inspect fans; clean or replace screens, grills, filters, and drier cores; tune defrost cycles.	Inspect and replace oil level, oil filter, and inlet screen. See equipment manuals for specific instructions.
General Operational Requirements	Higher cost items require annual use of more than just a seasonal four months.	For farms with compressed air needs beyond general shop uses	N/A	N/A
Potential Energy Savings[1]	9-44%	5-30%	1-5%	1-5%
Typical Simple Payback[2]	1-9 years	1-7 years	1-3 years	1-3 years
Possible Barriers	Cost.	Cost; unique compressed air requirements.	Equipment access (which should be corrected).	Equipment access (which should be corrected).

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Non-Energy Benefits	Improved produce quality.	Reduced wear and tear on the compressor.	Avoiding premature equipment failure.	Avoiding premature equipment failure.
Industry Information and References	MFEP 2012.	DOE 2003.	Wisconsin Focus on Energy 2020, and 2015.	DATCP 2006, Langston 2011.

Table Notes:

*1. The row for **Potential Energy Savings** represents the potential savings as a percentage of the total energy use for each technology category. For example, if refrigeration was 10% of a farmer's electricity usage, and the table showed a Potential Energy Savings of 25%, the net effect would be a 2.5% overall electricity energy savings. A farmer can then predict **Annual Cost Savings** by estimating 2.5% off their annual bill. If that farmer's annual electricity bill is $10,000 then the potential cost savings for implementing HE refrigeration would be $250 per year.*

*2. Simple Payback is the installation costs divided by the potential energy cost savings, showing how long it takes for annual cost-savings from an upgrade to pay for the initial costs. A farmer can use this information to predict the **Expected Implementation Cost** by taking the annual cost savings from note #1 and multiplying it by the Simple Payback for the technology being investigated. If the HE refrigeration example had an annual cost savings of $250 and had a Typical Simple Payback of 3.0 years, then the estimated implementation cost for that upgrade would be $750.*

References:

- *Langston, D. 2011. The Case for a Refrigeration Preventative Maintenance Program. Aire Rite Air Conditioning and Refrigeration, Inc. Available at: https://cdn.ymaws.com/www.rfmaonline.com/resource/resmgr/rfma_conference_presentation_archives/the_case_for_a_refrigeration.pdf*
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- *U.S. Department of Energy (DOE). 2003. Improving Compressed Air System Performance: A Sourcebook for Industry. Office of Energy Efficiency and Renewable Energy (EERE). Available at: https://www.energy.gov/sites/default/files/2014/05/f16/compressed_air_sourcebook.pdf*
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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 NYS. 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

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