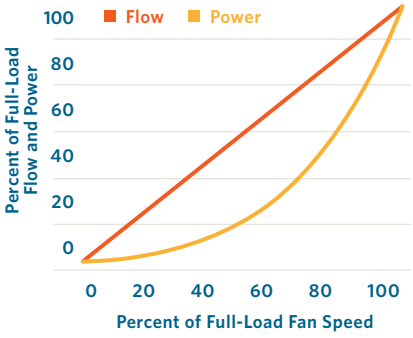
Cold Storage Facilities Energy Savings Guide

Oregon cold storage facilities face challenges of rising operating costs, rigorous product and safety standards, evolving environmental regulations and outdated equipment and facilities. Throughout the state, cold storage facilities continuously look for ways to control costs. Because cold storage requires a significant energy input, energy efficiency offers an expanding opportunity to trim operating costs.

Energy Trust of Oregon is dedicated to helping you identify options for continuous energy improvement. We can show you how energy is used in a typical cold storage facility and can help you understand where to focus your efforts. We've also compiled a list of "next steps" for you to review. Talk with your Program Delivery Contractor, PDC, about which of these steps could have the biggest impact on energy savings at your business.

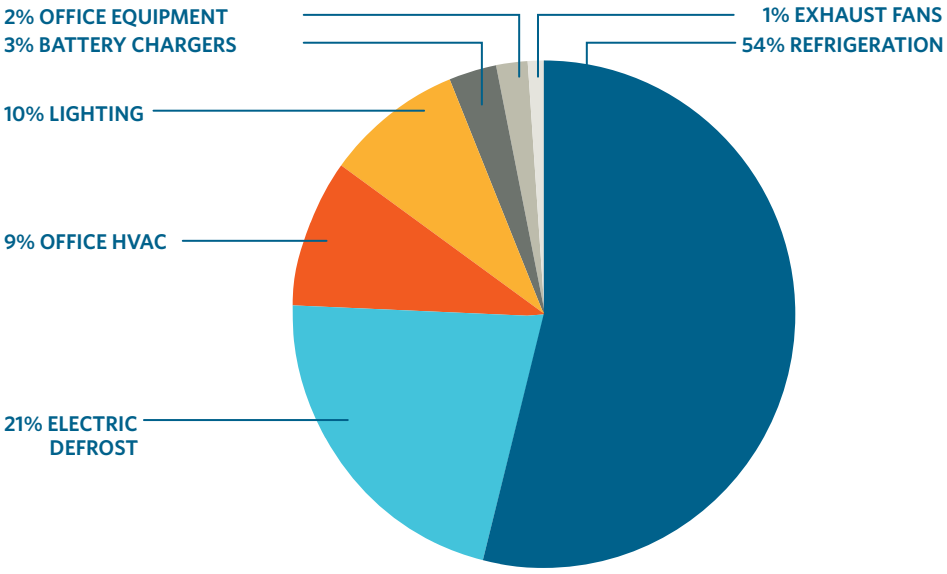
Energy Trust of Oregon

FAN AFFINITY LAWS



Variable Frequency Drives improve pump and fan efficiency by reducing motor shaft speed to the minimum revolutions per minute, rpm, necessary to satisfy flow requirements. A graph of the affinity laws shows that the flow produced by a pump or fan is directly proportional to shaft speed, while the power requirement for that flow is proportional to shaft speed cubed. For example, at 80 percent of full-load flow, a pump or fan operates at 80 percent of full-load rpm, but uses only 51 percent of full-load power, yielding a steady state energy cost reduction of 49 percent. At 50 percent of full-load flow, the pump or fan operates at 50 percent of full-load rpm, but uses only 13 percent of full-load power, yielding an energy cost savings of 87 percent.

ENERGY USE PROFILE FOR A TYPICAL COLD STORAGE FACILITY



REFRIGERATION SYSTEM

Could control strategies optimize the energy efficiency of existing refrigeration systems? Control systems vary in complexity from small programmable logic controllers to full-system controllers. Controls can optimize one part of the refrigeration cycle or control a variety of parameters to optimize energy use for the entire system.

- ❏ Use localized programmable logic controllers to continuously adjust individual components of the refrigeration system for maximum efficiency.
- ❏ Install a centralized control system to optimize energy efficiency in the entire system. Supervisory control also improves the ease and quality of complete refrigeration system oversight. Typical simple payback as short as two years.
- ❏ Implement floating-head pressure control to optimize condensing temperature based on ambient temperature, which can significantly reduce compressor load. Typical simple payback of one to three years.
- ❏ Improve energy efficiency by using floating suction pressure control to continually optimize suction pressure set points based on cooling requirements.
- ❏ Optimize the freezer temperature set point to raise temperatures in refrigerated spaces while maintaining safe product temperatures.
- ❏ Add variable frequency drives, VFDs, to motors operating at variable rpm that is less than full load, or for motors operating at constant rpm that is a fraction of full-speed operation.

Are there opportunities to reduce compressor energy use through operations and maintenance, O&M, or capital improvements? Compressors typically consume more energy than any other component in a cold storage facility. Compressor improvements can significantly improve refrigeration energy efficiency.

- ❏ Decrease the head pressure set point and increase the suction pressure set point to the greatest extent that conditions allow. Increased suction pressure and decreased head pressure reduce compression ratio or lift, which reduces energy use.
- ❏ Stage compressor operation to fit the refrigeration load of the facility over the entire range of operating conditions. Operate with one or more compressors at full load, and use a compressor with efficient part-load performance as a trim unit. Typical simple payback of one to five years.
- ❏ Install compressors with different capacities and program controls to maximize staging efficiency.
- ❏ Consider installing a reciprocating compressor with cylinder unloading as the trim unit in a multi-compressor system. Reciprocating compressors are able to match varying loads more closely than screw compressors that are not VFD-equipped.
- ❏ Switch existing reciprocating refrigerant compressors to a cylinder unloading strategy to improve energy efficiency.
- ❏ Add VFDs to existing screw compressors that regularly operate at part load, or for screw compressors that operate as the trim unit in multi-compressor systems.
- ❏ Implement a two-stage refrigeration cycle when the facility maintains separate freezer and cooler spaces. Although the upfront cost of this improvement is higher than single-compression cycle systems, a two-stage system can provide cooling for two different temperature ranges, improving energy efficiency for the entire process.

Could improvements in evaporator energy efficiency reduce energy use of the entire refrigeration system? Evaporators are typically an energy intensive component in industrial refrigeration equipment. Several proven energy-efficiency opportunities are available for evaporator fans and coils.

- ❏ Fine tune the floating suction pressure set point to optimize compressor efficiency.
- ❏ Clean the evaporator coil regularly to improve heat-transfer efficiency. Typical simple payback of several weeks.
- ❏ Install controls to change constant- speed evaporator fans to an on/off cycle to reduce evaporator fan run time.
- ❏ Install VFDs on evaporator fans in refrigerated spaces that have a variable refrigeration load. When combined with proper control systems, evaporator fan speed can be continually optimized for dynamic refrigeration loads. Typical simple payback of one to four years.
- ❏ Optimize the minimum-speed setting for evaporator fans using VFD control.
- ❏ Reduce the frequency and duration of timed defrost to the minimum required to ensure that the evaporator coil remains free of ice. Defrost cycles can be adjusted and controlled by season to reduce cycling during periods with lower ambient temperature.
- ❏ Add sensor control for evaporators as a replacement for timed-defrost systems. This improvement decreases the amount of heat added to the cold storage space to the minimum required to insure a properly defrosted evaporator coil. Typical simple payback of two to four years.

❏ Retrofit with high-efficiency evaporators. Using evaporators that extract heat from the refrigerated space using a minimum of fan energy improves energy efficiency in the whole refrigeration system.

❏ Use evaporators that defrost with water or hot gas instead of electric resistance defrost.

❏ Install evaporators with electronically commutated, EC, motors when evaporator fans have a fractional horsepower rating.

❏ Replace existing shaded-pole evaporator fan motors with EC motors to reduce energy use by up to 65 percent. Typical simple payback of one to three years.

Have condensers and related systems been improved to optimize system energy efficiency? Condenser systems account for a sizable portion of cold storage energy use. Energy-efficiency upgrades range from simple O&M measures to capital investments.

❏ Program control systems to optimize the floating head pressure set point.

❏ Optimize the minimum speed setting for condenser fans.

❏ Adjust fixed condensing pressure set point to the lowest possible safe setting.

❏ Clean condenser surfaces to improve the efficiency of heat transfer. Typical simple payback of one month to one year.

❏ Descale water-cooled condenser tubes to improve water flow and heat transfer.

❏ Retrofit with condenser fan VFDs and associated controls to optimize condenser fan speed. Typical simple payback of one to two years.

❏ Install on/off controls on single-speed condenser fans, or high/low/off controls on two-speed condenser fans.

❏ Upgrade from an air-cooled condenser to an evaporative condenser.

❏ Consider installing an oversized condenser to decrease head pressure and improve compressor efficiency.

❏ Recover heat from the condenser for use in the glycol slab-heating system.

PUMPING

Could improvements to pumping and refrigerant circulation yield substantial energy savings? Inefficient pumping as well as heat and friction losses in piping can lead to unnecessary energy use for refrigerant circulation.

❏ Add VFDs to refrigerant pumps for applications that require reduced or varying fluid flow. A VFD matches pump speed to system need, optimizing pump energy consumption.

❏ Improve insulation on refrigerant piping to reduce refrigerant heat-gain.

LIGHTING

Consider upgrading plant lighting. Lighting systems offer a two-fold opportunity to reduce energy use. High-efficiency lighting requires less energy to produce a given light level, while producing less heat that must be removed by refrigeration systems.

❏ Upgrade to LED lighting technology. LEDs are increasingly popular in cold storage facilities because of their unmatched energy efficiency, excellent cold temperature performance and minimal heat generation during normal operation. Because LEDs have superior cold-temperature restrike capability, they work well with occupancy sensors installed in freezer environments and in extremely cold environments where lighting switches on an off repeatedly.

❏ Replace High Intensity Discharge lighting with high-bay linear fluorescents such as T5 and T8. Linear fluorescent lighting is a low-cost energy-efficient replacement for HID technologies such as High Pressure Sodium or Metal Halide. High-bay fluorescent lighting is up to 50 percent more energy efficient and introduces considerably less heat into the refrigerated space. Fluorescent lighting may struggle to quickly restrike in extremely cold environments, making LEDs attractive for applications where lighting switches on and off repeatedly.

❏ Install occupancy sensors in intermittently used areas to cut lighting energy by up to 75 percent.

❏ Control lighting by the individual aisle with occupancy sensors. Group goods together in aisles by storage and retrieval timeline to minimize activity and lamp run time.

❏ Optimize coverage areas for all existing occupancy sensors and photo sensors.

❏ Use photo sensors to turn off interior lighting in areas with ample natural light.

❏ Adjust timer-controlled lighting to minimize operating hours.

❏ Retrofit older office lighting with today's technology. Replacing T12 fluorescent lighting and older T8 lighting with improved lamp and ballast options significantly reduces energy use and has a rapid payback.

❏ Control outdoor lighting with photo sensors to turn off lighting during daylight hours.

BUILDING ENVELOPE

Look for ways to reduce heat loss through exterior doors and loading docks. Minimizing air infiltration through open doors and loading docks is a cost-effective way to improve energy efficiency.

❏ Repair malfunctioning freezer doors and strip curtains to decrease infiltration.

❏ Upgrade to high-speed doors on loading docks to reduce air infiltration from outdoors. Typical simple payback of three to six years.

❏ Install dock shelters to reduce warm-air infiltration into the facility. Typical payback period of five to six years.

❏ Retrofit existing loading docks with foam dock-seal systems. Although these systems are not as effective in reducing air infiltration as dock-shelter systems, their low cost can be attractive for some facilities.

❏ Install strip curtains in openings between cold storage spaces and conditioned spaces kept at higher temperatures.

❏ Configure the floor plan to minimize heat loss between storage spaces with different temperatures.

❏ For new construction, install a glycol slab heating system instead of less efficient electric resistance slab heating.

❏ Optimize the temperature set point for the slab heating system.

❏ Consider installing a pallet conveyer system to move product to and from the exterior of the freezer space to eliminate doorway passages and resulting heat gain.

❏ Consider upgrading to a fully automated storage and retrieval system with high- density storage capability. These systems are becoming more practical as the technology mature and can significantly reduce energy use.

OFFICE HVAC

Is your HVAC system functioning properly? HVAC systems that are not operating properly—whether from deferred maintenance or mechanical malfunction—decrease comfort and reduce energy efficiency.

❏ Implement temperature setback for unoccupied hours.

❏ Install programmable thermostats to reduce unnecessary energy use during unoccupied hours and maintain comfort when employees are present.

❏ Optimize set points to ensure that existing HVAC systems are operating as efficiently as possible.

❏ Retrofit existing HVAC systems with economizers to take advantage of free cooling from outdoor air.

❏ Tune up demand controlled ventilation to optimize outside air based on occupancy.

❏ Update HVAC system controls to optimize systems such as demand controlled ventilation and economizers. Several retrofit options are available to improve the efficiency and efficacy of existing systems.

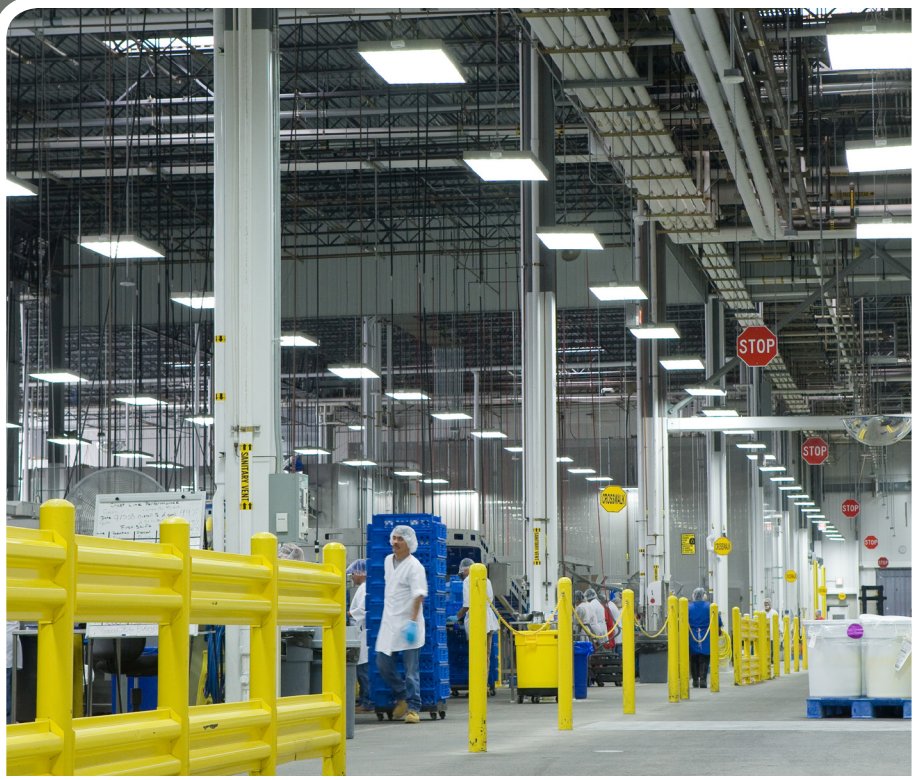
LIFT TRUCKS

Is it time to replace inefficient battery chargers? Improved battery charger technology can increase energy efficiency while reducing charging time.

❏ Upgrade to fast-charging battery systems for lift trucks. These systems may also improve the use of space within the facility by eliminating the need for extra batteries.

❏ Consider upgrading to an automated lift truck system to increase energy efficiency.

ENERGY TRUST INCENTIVES MAY REDUCE PAYBACK PERIODS LISTED IN THIS GUIDE BY AS MUCH AS 50 PERCENT ON CAPITAL UPGRADES.



ENERGY PLAYS A CENTRAL ROLE IN COLD STORAGE FACILITIES.

Energy Trust can help you take control of your energy costs and reduce the impact of energy on your bottom line.

Energy Trust provides cash incentives and technical services to help your facility improve energy efficiency and reduce operating costs. Our PDCs are highly skilled industrial energy experts who understand different types of cold storage systems, what will work in your facility and how to make the most of energy-saving opportunities. Energy Trust PDCs are located throughout Oregon and can work closely with your personnel to achieve your goals.

Discover how to continuously improve your energy performance.
Talk with your PDC, or call Energy Trust directly at **1.866.202.0576** or visit **www.energytrust.org/industrial-and-ag**.

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