The high-tech industry is a crucial and dynamic part of Oregon’s economy that is expected to grow faster than other industries over the next decade. Working in a highly competitive market, operations managers at Oregon fabrication plants continually look for ways to reduce costs, while improving production efficiency and product quality. Because fabs require 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 to improve the energy efficiency of your facility over time. The chart on the next page shows how energy is used in a typical fab 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 plant.
High-tech facilities operate up to 24 hours per day and are among the largest energy users in today's economy. They are characterized by large base loads, continuous operation and high energy-use intensities, offering opportunities for substantial energy savings.

**Energy Plays a Major Role in Manufacturing**

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.

**TYPICAL HIGH TECHNOLOGY ENERGY USE DISTRIBUTION**

- 34% FACILITY HVAC
- 23% PROCESS HEATING
- 17% MOTOR DRIVES AND PUMPING
- 7% FACILITY LIGHTING
- 6% PROCESS COOLING AND REFRIGERATION
- 5% OTHER PROCESS USES
- 4% OTHER
- 4% OTHER FACILITY SUPPORT
CLEANROOM HVAC

How efficient is the recirculation system? Recirculation systems filter and condition a large quantity of air to maintain precise conditions. Optimizing cleanroom recirculation systems can significantly improve energy efficiency.

- Control airflow of less-efficient recirculation fans with Variable Frequency Drives, VFDs, and air quality sensors that determine when airflow reductions are possible. Typical simple payback of one to three years.
- Add recirculation setback controls to existing recirculation systems. Typical simple payback of less than one year.
- Replace inefficient fan filter units with high-efficiency models with electronically commutated motors.
- Use low-pressure drop filters in recirculation systems to reduce system static pressure.

Could making operation improvements to, or capital investments in, cleanroom makeup air systems lead to robust savings? Replacing or retrofitting lower-efficiency equipment could reduce energy use while improving product quality and throughput.

- Retrofit cleanroom makeup air systems with VFDs that use sensors to optimize makeup air fan speed. Typical simple payback of one to three years.
- Optimize airflow by installing timers, motion sensors, or CO2 sensors that reduce airflow during unoccupied hours.
- Adjust preheat and reheat set points in makeup air units to eliminate simultaneous heating and cooling.
- Repair economizers and calibrate set points. Typical simple payback ranges from a few weeks to a few months.
- Optimize the quantity of outside air used for cleanroom pressurization and ventilation.

Does your cleanroom humidity control system use too much energy? Optimize set points or use new technology that improves humidity control while saving energy.

- Optimize preheating of the humidity control system to levels that reduce energy use. This can reduce chiller loads and yield significant energy savings.
- Retrofit existing dry-steam humidity systems with steam-line and nozzle insulation to reduce heat loss.
- Upgrade to higher efficiency adiabatic humidification. Typical simple payback as short as two years.

Does your scrubber function as well as it could? Scrubber systems could be wasting energy 24/7 if they are old and inefficient or if set points are not optimized. Changes to scrubber systems can also reduce energy use for makeup air that supports the cleanroom.

- Add VFDs and air quality sensors to exhaust fan motors to optimize the speed of scrubber fans.
- Switch to a lower pressure drop scrubber filter media so exhaust fans operate with less resistance.
- Install air-to-air heat exchanges to recapture heat from fab exhaust for use in heating processes within the fab.

Does your facility have fume hoods? Capital improvements to existing fume hood systems can increase energy efficiency. According to Lawrence Berkeley National Laboratory, new energy-efficient hood systems use 75 to 80 percent less energy than older designs.

- Determine if fume hoods are pulling more air than necessary to exceed minimum air quality standards. Reducing airflow reduces the amount of makeup air for the conditioned space.
- Replace inefficient fume hood models with more energy-efficient models.
- Integrate fume hood sash systems with controls that detect worker activity. When inactive, the fume hood sash closes and airflow is reduced.
CHILLERS

Could your chilled water system benefit from low-cost O&M improvements? Adjustments to your chilled water system can reap big energy savings, delivering a typical simple payback of two weeks to several months.

- Optimize chilled water temperature set points while providing proper process water temperature. Typical payback of several weeks to one year.
- If you have multiple chillers, stage controls to allow one chiller to handle loads up to the point of highest efficiency before additional chillers go online. This takes advantage of better part-load efficiencies for the same cooling output.
- Use VFDs to optimize the speed of the pump to the demand for pressure or flow, rather than running constantly at full speed.
- Reduce pump differential pressure in secondary chilled water. Typical simple payback as short as one month.
- Clean cooling tower coils and chiller tubes to improve efficiency.

Are there opportunities to save energy through capital improvement to your chilled water system? Replacing inefficient and aging equipment is often a cost-effective investment.

- Add VFDs to cooling towers to reduce fan speed while meeting the needs of the chiller.
- Install a water-side economizer. Free cooling allows the cooling tower to provide chilled water cooled by ambient air when outdoor conditions allow.
- Consider installing an oversized cooling tower to take greater advantage of free cooling.
- Replace existing chillers with new, high-efficiency models to boost chilled water system efficiency by up to 50 percent, while reducing maintenance costs and improving the system function.

COMPRESSED AIR

Can the efficiency of your compressed air system be improved? Adjusting compressed dry air system settings and changing compressed air utilization can trim energy costs, resulting in simple payback periods of as little as a few weeks.

- Identify and reduce leaks in your compressed air system to decrease compressor load.
- Optimize compressed air system pressure. For every two psi in pressure reduction, energy use decreases by one percent.
- Adjust controls for cylinder unloading to improve efficiency of reciprocating compressors.
- Adjust regulators and valves to optimize flow and pressure for a given process.
- Reduce or minimize open blowing to avoid unnecessary compressor cycling.
- Replace conventional nozzles with engineered nozzles to reduce wasted compressed air.

Would compressed air capital improvements deliver substantial energy savings? New energy-efficient compressor technology can reduce energy use and produce a fast return on investment.

- Invest in a new VFD-equipped compressor. The simple payback of a VFD-equipped compressor typically is one and a half to four years.
- Install VFDs on compressors operating as trim units or at varying less-than-full loads.
- Upgrade inefficient compressed air dryers to more efficient systems.
- Explore replacement of oversized compressed air systems with equipment appropriate for the pressure, flow and end-use requirements.
- Upgrade to compressed air piping that is more free flowing for better system and energy performance.
- Install sequencing controls on systems with multiple compressors so the most efficient compressor supports base load and additional compressors go online only when the primary compressor is at full load.
**PUMPING**

**Can energy be saved in process pumping?** Pumps are often sized improperly or are fully powered when partial power would ensure high system performance.

- Reduce head pressure for process pumping to lessen the load and reduce energy use.
- Remove excess pumps from service.
- Install VFDs to match the pump speed to system demand.
- Trim the impeller on oversized pumps to optimize pump pressure and flow and reduce load.
- Install controls on existing vacuum pump systems so pumps go into idle mode based on sensor feedback from process tools.
- Replace inefficient vacuum pump systems with variable speed technology.

**LIGHTING**

**Do lighting systems need an upgrade?** Lighting that has not been recently upgraded offers an easy opportunity to cut energy costs.

- Use occupancy sensors to turn off lamps in unoccupied spaces and trim lighting energy substantially.
- Upgrade older T12 and first-generation T8 linear fluorescent systems to more efficient options, such as high-performance T8 with electronic ballasts, T8 task lighting and T5 high-bay lighting.
- Replace High Intensity Discharge lighting with new energy-efficient technologies that save energy and improve visibility in critical production areas. Switching from Metal Halide or Sodium Vapor to T5 or T8 lighting can trim lighting energy by up to 50 percent.
- Upgrade to LED lighting, which combines ultra-high efficiency with excellent performance and extremely long life. Switching to LED lights also reduces cooling loads.

**SERVER ROOMS**

**Could operational or capital improvements to server room equipment lead to substantial energy savings?** O&M improvements often reap energy savings with a minimum of investment. Capital investments can drastically reduce energy use.

- Develop strategies for turning off servers not in use.
- Adjust economizers to optimize free cooling.
- Install blanking panels in server racks not being used to improve airflow and cooling efficiency.
- Develop an efficient server room layout using hot- and cold-isle configuration.
- Replace older servers with new models that use the latest processors to improve performance while producing less heat. New, faster models also may enable a reduction in the total number of servers.
- Install VFDs on computer room air handlers so the speed of air handler fans matches cooling needs in the data center.
- Install air- or water-side economizers on server room HVAC units to take advantage of free cooling.

**FAB TOOLS**

**Are there options for upgrading fab process tools?** Although process-specific tools can be challenging to alter with respect to energy efficiency, some strategies can be successfully applied within the cleanroom. Discuss your production equipment needs with your PDC. If energy-efficient tool options exist, your PDC will work with you to determine how upgrades might qualify for Energy Trust cash incentives.

- Reclaim heat from process tool cooling systems to preheat and reheat other processes within the fab.
- Consider installing point of use (POU) chillers near process tools.

**ENERGY TRUST INCENTIVES MAY REDUCE PAYBACK PERIODS LISTED IN THIS GUIDE BY AS MUCH AS 50 PERCENT ON CAPITAL UPGRADES.**
MANUFACTURING FACILITIES IN OREGON ARE COMPETING IN A GLOBAL MARKETPLACE BY COMBINING MATERIALS WITH HUMAN INGENUITY.

In manufacturing, energy plays a central role in harnessing machines, materials and people.

Energy Trust can help your industrial facility take control of your energy costs and reduce the cost impacts 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 what works in your business and how to make the most of energy-saving opportunities. Energy Trust PDCs are located throughout Oregon, so they understand your local economy and industry.

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.