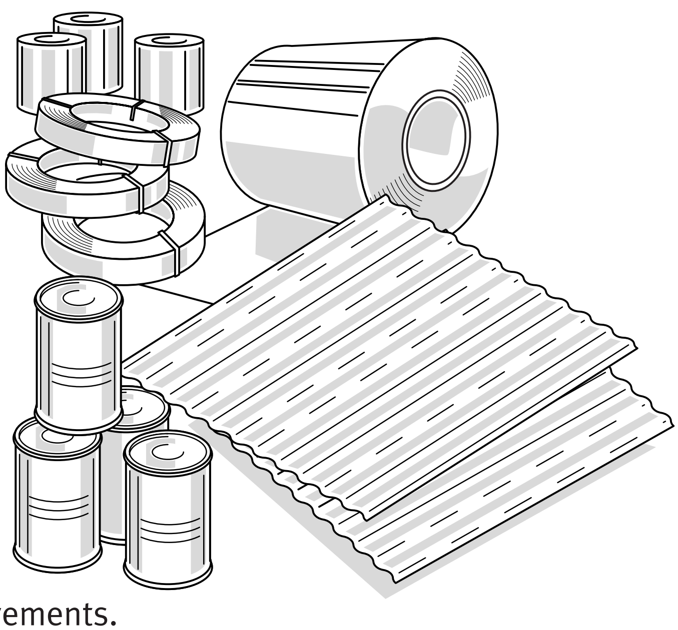
# Reduce Energy Use at Primary Metal Processing Facilities

- Compressed Air
- Process Heat
- Cooling
- Motors
- Lighting

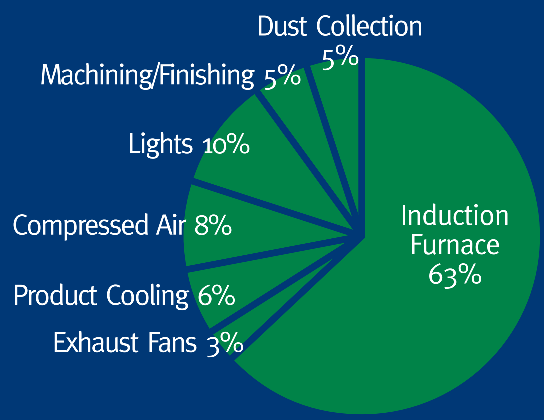


This publication will help you identify the cost-saving opportunities in your metal processing facility and guide you in undertaking a program to improve your bottom line through energy-efficient improvements.

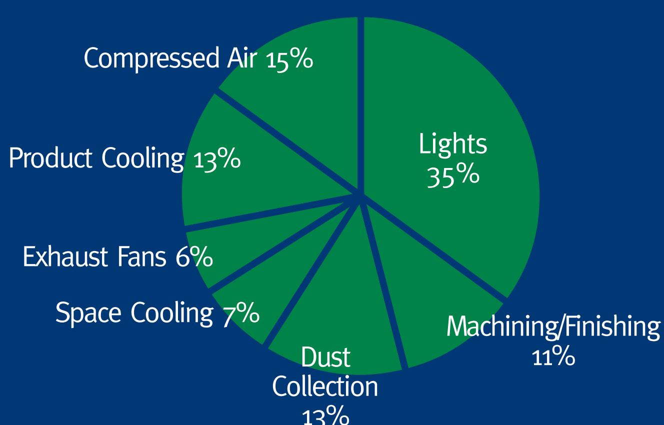
Metal processing facilities are an important segment of Vermont's economy. These facilities typically involve high energy costs, making them ideal candidates to benefit from greater energy efficiency. One facility recently upgraded to premium efficiency when replacing eight 20 hp motors. Efficiency Vermont contributed the additional cost of $1,000 for National Electrical Manufacturers Association (NEMA) Premium™ motors. As a result, this facility has reduced their annual electricity costs by $7,000. The facility's investment is paying off by lowering energy operating costs and a better bottom line with a 176% internal rate of return. The motor installation yielded a 3-month payback.

# What metal processing equipment uses the most energy?

## Primary Metals: Typical Electric Use for a Foundry with an Induction Furnace




## Primary Metals: Typical Electric Use for a Gas-heated Forge




### Electricity Users

In forges and foundries, the main energy requirement is heating or melting the product. In facilities with electric induction furnaces, the furnace typically represents the largest single energy use in the plant. Although energy usage profiles vary from plant to plant, the first chart below shows a typical breakdown of electric use in a foundry with an induction furnace and forced air product cooling. Other facilities with induction heating will have a similar profile. Other major energy users are fans, which are used in a variety of applications, including heat rejection, product cooling, facility ventilation and dust collection. In facilities that manufacture and assemble finished consumer products, compressed air generation may represent another major component. The breakdown can be seen in the two charts that follow.

### Fuel Users

In a gas-fired forge, the major fuel user is obviously the forge. A secondary use in primary metals facilities is space heating, but in many cases, the forge or furnace provides so much heat that additional heat is not required except during shutdowns. Although Efficiency Vermont's mission focuses on reducing the use of electricity, the option of using heat recovery from the forge or furnace for other process or space-heating requirements is likely to be cost-effective for metals processors.

### Electric Induction Furnaces

There are primarily two types of electrically-heated furnaces used for processing metal: induction furnace and salt bath treatment. Both types use a significant amount of electrical energy to power a device that heats the metal. Induction furnaces typically melt the material using electricity to induce heat, while salt baths use electrodes to create convective heat.

To reduce electric energy use in either furnace type, there are a number of cost-effective improvements.

Match your equipment to the task. The power supply should be matched to the induction coil, and the coil should be selected based on the type and amount of metal that is to be melted in each charge. Ask your electrical equipment supplier or project engineer about new technologies in power supply, such as variable reactance transformers, that offer energy efficiency improvements.

Ensure the sides of the crucible (as well as a lid in many applications) are well insulated. The insulation should be maintained regularly to prevent unnecessary losses to the ambient air. The seals around doors or lids should also be well maintained.

For applications where metals are heated or melted prior to other process steps, optimize your process by minimizing the holding time in the furnace. This can reduce the standby energy requirement of the furnace.

# Lighting

Recommended light levels for metal processing vary between 20 footcandles (fc) and 200 fc, depending on the use of the space. Product inspection and quality control areas usually require the highest light levels, whereas warehouse areas and other processing areas operate with lower levels.

Manufacturing facilities are often lit to provide a constant light level throughout. This wastes energy in overlit spaces and may result in underlighting of critical task areas, potentially reducing productivity and affecting quality assurance. Lighting system upgrades can reduce overall lighting usage to less than 1 watt per square foot in many manufacturing facilities.

New lighting technologies make it cost-effective for you to retrofit or replace existing fixtures and bulbs with energy-efficient models. For example, a one-for-one replacement of standard four-foot T-12 fluorescent lamps and ballasts with new T-8 lamps and electronic ballasts will reduce energy use by as much as 25%, while providing equivalent light output. Similarly, new 320-watt pulse-start metal halide fixtures provide light output equal to that of 400-watt standard metal halides. This type of retrofit can reduce fixture energy use (including ballast energy) by 20%.

You can further reduce lighting power use with proper lighting design. For example, you can reduce or eliminate lighting demands in certain areas by incorporating daylight into new and renovated buildings and by using photosensors that will automatically control lighting fixtures in response to natural sunlight. Occupancy sensors can automatically turn off or dim lights in intermittently occupied parts of the plant, such as warehouse aisles.

# Compressed Air

Typical facilities in the metals industry use between 8% and 15% of their total electricity requirements to make compressed air. Because electricity is responsible for upward of 75% of the lifetime operating cost of an air compressor, some typical compressed air improvements can provide payback in less than two years and generate better performance at a lower operating cost.

The two most cost-effective improvements for compressed air systems are repairing leaks and replacing equipment that uses air inefficiently. You can also reduce energy use by selecting energy-efficient compressors and dryers and by installing air storage in conjunction with efficient part load controls. Depending on the installation, these types of capital equipment improvements have paybacks of three to eight years, and are most cost effective to implement when you are already planning to make new equipment purchases.

### 1. Repair leaks

In industrial facilities that do not have leak detection and repair programs, as much as 30% of the compressed air demand in the plant can be attributed to leaks. A properly implemented leak detection program with regular follow-up can reduce a facility's compressed air demand 5-10%. Efficiency Vermont can assist you with the initial leak detection and repair effort, which typically pays for itself in a matter of months with reduced energy bills. Once a leak detection program is in place, ongoing maintenance costs are low. Facilities with high leakage rates can also benefit by fixing existing leaks and reducing inappropriate uses of compressed air, often eliminating the need for purchasing additional compressors, even when new production equipment is installed. If you are planning to purchase a new compressor in the near future, you should institute a leak detection and repair program beforehand. This will reduce the overall air demand on the new compressor, and can possibly save capital costs if you can select a smaller compressor to meet your air requirements.

## An example of how a Vermont facility is **REDUCING COSTS FOR A PART DRYING OPERATION**

**Conditions:** An air knife fabricated by drilling a series of holes in a section of pipe is used to dry parts after they pass through a washing process. The process runs 2,000 hours per year. The air knife uses 50 cfm of compressed air at 80 psig.

**Improvement:** Replace the air knife with a medium-pressure centrifugal blower. The blower uses only 3.3 brake horsepower (bhp), whereas the air compressor requires 14.7 bhp to do the same job.

**Alternate Improvement:** If the installation of a dedicated blower is not practical, similar savings are available from high-efficiency engineered nozzles or air knives. These devices entrain ambient air into the airstream, reducing the amount of compressed air that is required to do the job. Engineered nozzles should be investigated wherever compressed air is used for blowoff. Automatic control of blowoff based on whether parts are present is also cost-effective.

**Benefits:** Plant electric bills are reduced by $1,447 per year.

### Costs and Savings

| | |
|---|---|
| Annual electricity savings | 17,027 kWh |
| Electricity cost savings | $1,447 |
| Installation cost | $3,500 |
| Incentive from Efficiency Vermont | $875 |
| Net installation cost | $2,625 |
| Payback period | 1.8 years |

## 2. Eliminate inappropriate end uses

Because making compressed air uses so much energy relative to the work output of any end use, careful attention to appropriate application of compressed air can also result in a quick payback. Examples of inappropriate uses of compressed air are open or unregulated blowoff, venturi vacuum pumps, diaphragm pumps and timer-controlled condensate drains. The use of engineered nozzles, cam- or timer-operated valves, and regulated compressed air delivery where blowoff is required will usually pay costs back in six months to two years. Low-pressure electric blowers are also a possible retrofit for blowoff applications. An electrically driven vacuum or liquid pump uses only about 20% of the electrical input required to do the same work with compressed air-driven equipment, and is usually a cost-effective retrofit. Zero-loss (level-actuated) condensate drains remove unwanted moisture from the system without wasting valuable compressed air.

## 3. Install efficient equipment and controls

New rotary screw air compressors are available with a variety of energy-saving features, including part-load controls, multiple stages of compression and automatic sequencing. On models 25 hp and larger, efficient part-load control is usually available, and is a cost-effective upgrade from standard modulating inlet valve controls, especially when the demand for compressed air in the plant varies. Variable speed drive (VSD), variable displacement air-end (turn valve) and load/unload are three widely available examples of efficient part load control. If the typical demand is 70% of the compressor's rated output, load/unload control with proper storage capacity can reduce energy use by 10% compared to modulating control, and VSDs and turn valve control can offer even greater savings. On compressors greater than 100 hp, two-stage machines are more efficient than single-stage alternatives. Automatic sequencing controls are cost effective for both new and existing equipment. These controls automatically operate the most efficient combination of compressors to meet a given load while maintaining plant pressure requirements.

## 4. Increase air storage

Additional storage capacity can help reduce inadvertent running of a trim compressor to satisfy momentary surges in demand. Properly sized air storage capacity is also essential for efficient part-load control, and will reduce the frequency of compressor unloadings, which waste compressed air. A good rule of thumb is to install 4 gallons of storage for every cfm of compressor capacity, so a 40 hp compressor that makes 250 cfm at full load should usually be equipped with 1,000 gallons of storage. System-wide pressure regulators, often called demand expanders, should be installed to maximize the effectiveness of storage capacity.

## An example of how a Vermont facility is REDUCING PRODUCT COOLING COSTS

**Conditions:** A foundry uses a series of 25 hp blowers to cool its castings at a controlled rate. The blowers operate for two shifts, or 4,000 hours per year. Airflow requirements vary by time of year, based on ambient air temperature and other parameters. Over an entire year, the average required airflow is 60% of the rated output of the blower. At present, operators manually modulate flow rate by adjusting discharge dampers.

**Improvements:** Install a VSD to modulate fan speed. Remove the dampers, or operate the blowers with dampers locked wide open.

**Benefits:** Plant electric bills are reduced by $2,036 per blower per year. Other benefits include reduced setup time and the potential for improved part quality due to automatic control of cooling airflow.

### Costs and Savings (Per Blower)

| | |
|---|---|
| Annual electricity savings | 23,957 kWh |
| Electricity cost savings | $2,036 |
| Installation cost | $6,500 |
| Incentive from Efficiency Vermont | $1,625 |
| Net installation cost | $4,875 |
| Payback period | 2.4 years |

## An example of how a Vermont facility is REDUCING DUST COLLECTION COSTS

**Conditions:** The plant uses a centralized dust collection system that serves five pieces of equipment. The operation runs 4,000 hours per year. The blower is served by a 75 hp motor. The fan runs at 80% of nameplate power. Investigation of the system reveals that the blower was originally selected for 10% more flow than is actually required for all five machines, and that on average, only four of the five machines are running at one time.

**Improvement**: Optimize the operation of the blower with a VSD and automatic slide gates at each machine. Because the equipment is oversized, blower speed can be reduced by 10% even if five machines are running. When only some machines are in operation, a static pressure sensor installed in the main ductwork will further reduce motor speed. The average blower airflow is reduced to 73% of the initial value.

**Benefit:** Plant electric bills are reduced by $5,780 per year.

### Costs and Savings

| | |
|---|---|
| Annual electricity savings | 67,996 kWh |
| Electricity cost savings | $5,780 |
| Installation cost | $19,000 |
| Incentive from Efficiency Vermont | $4,750 |
| Net installation cost | $14,250 |
| Payback period | 2.5 years |

# Process Heat

### 1. Reduce heat loss from furnaces

In an induction furnace, only about 60% of the input energy goes to heating the charge. A significant portion of the input energy is lost in the form of heat transferred to the surroundings either directly (radiation, conduction) or indirectly (water cooling). Improving the insulation or lining material of the crucible, using crucibles with lids and minimizing the amount of time that the charge is kept in the molten state before casting can all reduce furnace energy use.

### 2. Provide makeup air control

Providing dedicated sources of makeup air for applications with large exhaust requirements such as furnaces can minimize problems with negative pressurization and infiltration in other parts of the building. In the winter, this will reduce space heating requirements for areas where supplemental heat is required, such as warehouses, assembly areas, etc. Summer electric savings will also result in facilities with air conditioning.

### 3. Take advantage of heat recovery

With forge and foundry equipment, a significant amount of waste heat can often be reclaimed for other uses, such as water heating, makeup air heating, space heating and process heating. Air-cooled air compressors offer a simple means of heat recovery. In the winter, you can duct compressor cooling air indoors to heat other areas of the plant. In the summer, manually reposition a damper to duct the waste heat outside.

# Motors

National Electrical Manufacturers Association (NEMA) Premium energy-efficient motors should be purchased when replacing or upgrading any continuous-duty motors in the facility. An improvement in energy efficiency from baseline to premium can result in an annual electrical savings. The range of savings will depend on motor size, runtime and type. Some examples of motor savings for Totally Enclosed Fan Cooled (TEFC) continuous duty motors are listed here:

| Efficiencies | | Motor Size | Annual Electricity Savings* | Incentives |
|---|---|---|---|---|
| Baseline | Premium | | | |
| 90% | 92% | 10 hp | $120 | $100 |
| 92% | 94% | 30 hp | $350 | $150 |
| 94.5% | 95.8% | 100 hp | $725 | $400 |

*$.1034 per kWh

REDUCE ENERGY USE

# Variable Speed Drives

With a variable speed drive (VSD), you can adjust motor speeds to match the actual workload of your process. Unlike constant-speed motor starters, which operate the motor at full speed at all times, a VSD operates at speeds selected and adjusted by an operator or through automatic controls. This speed control can result in improved operation in many applications.

Energy savings with a VSD can be surprisingly high, because energy use is often proportional to the cube of the motor speed. For example, in closed-circulation systems, using a VSD to reduce motor speed to 75% reduces the motor's energy use by more than half. In open systems that require a lot of pressure, energy use is more closely proportional to motor speed.

### SPECIFIC VSD APPLICATIONS INCLUDE:

**Dust Collectors/Bag Houses:** Centralized dust collectors that remove dust and fines from multiple pieces of machinery have blowers that are sized for the worst-case scenario of all machines running at the same time. This represents an opportunity for energy savings. Further, the dust collection equipment may be oversized compared with the actual maximum requirements for flow and static pressure, in which case operators can adjust the maximum allowable drive speed to achieve savings during all operating hours. When only some of the machines are running, you can use the VSDs to further reduce the blower speed while still maintaining sufficient airflow for dust removal. Automatic slide gates or dampers installed at each machine close when an individual machine is not in use.

**Fan Motors:** Ventilation and cooling fans are often designed for worst-case conditions, which may occur only a few hours per year. By installing a VSD, you can run the fan at all other times at slower speeds to reduce energy use while maintaining process conditions and physical comfort for the operators. If your facility uses fans to provide forced product-cooling air at a specific rate, VSDs can provide substantial savings compared with inlet or discharge dampers that are adjusted to achieve the desired flow. Cooling tower fans also can be good candidates for VSDs.

**Pumps** Pumps that circulate water for cooling induction furnace coils and their associated power supplies may benefit from VSDs, especially if you install water flow controls that adjust to coil and power supply temperature requirements. Pumps that serve multiple furnaces also save energy with VSDs if the furnaces served are not all operating concurrently. In the winter, when the cooling tower can make colder water, you can reduce the flow through the heat exchanger, while maintaining satisfactory conditions in the furnace.

# Develop Your Energy Action Plan

**1.** Review the measures described in this brochure with your operations staff and equipment vendors. Identify opportunities for savings, define the scope of your improvement project, obtain cost estimates and establish staffing and funding availability for your project.

**2.** If your plant hasn't instituted a leak detection and correction program for your compressed air system, sign up for Efficiency Vermont's leak detection training and the loan of a detector to help you get started with some low-cost energy savings.

**3.** Review your motors with your plant electrician. Identify any motors that have potential for a VSD installation. Contact your motor vendor for pricing information, then contact Efficiency Vermont for an estimate of energy savings and financial incentives before proceeding. We will do an independent analysis of the savings to ensure you have accurate information about the benefits of the project. We can also provide metering in areas where the savings potential is unclear.

**4.** Contact Efficiency Vermont for energy savings estimates, for technical assistance in identifying the most cost-effective equipment and for financial incentives before you begin installation.

**5.** We must have a written agreement in place with the customer prior to equipment installation in order for us to provide incentives. For more information, call Efficiency Vermont toll-free: 1-888-921-5990.

**6.** Contact Efficiency Vermont when:

- Plans and specifications are developed for an upgrade or addition to your facility;
- You have identified the contractors you plan to hire to implement the project(s);
- You are improving your current operations or making additions to the facility;
- You need help locating required equipment and identifying the leading energy-efficient processes in your business;
- You are commissioning a project after installation to ensure proper operation of the equipment;
- You are looking for qualified energy efficiency contractors and equipment vendors;
- You need energy-savings and cost analysis on projects under consideration for your next budget cycle.

Efficiency Vermont
your resource for energy savings
Toll-free: 1-888-921-5990 • www.efficiencyvermont.com

Printed on 100% recycled post-consumer waste content and process chlorine-free paper using soy-based inks.