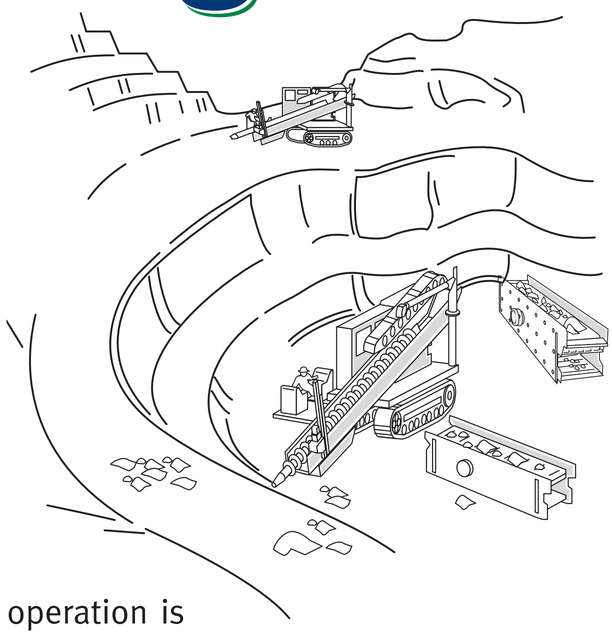
Reduce Energy Use at Quarries, Mineral Processing Plants & Gravel Crushing Facilities

- Compressed Air
- Cooling
- Pumping
- Motors
- Lighting

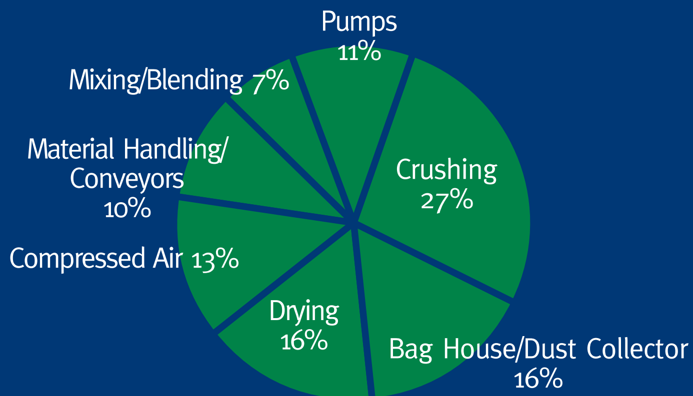


This publication will help you identify cost-saving opportunities whether your operation is involved in crushed stone, industrial marble processing or quarrying. Once you've identified the opportunities to improve your facility, Efficiency Vermont will work with you to implement energy-efficient upgrades.

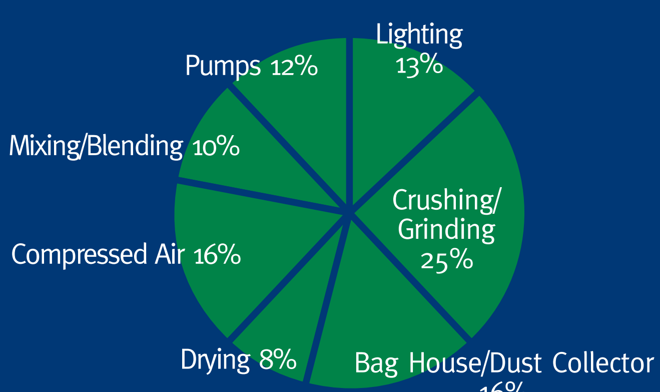
Mining and mineral processing facilities are important to Vermont's economy, providing an internationally recognized export. The high energy costs associated with this sector present both challenges and opportunities. One mining/crushing facility recently installed a customized crusher and process controls, reducing annual electricity costs by $28,300. The facility invested about $160,000 and Efficiency Vermont contributed about $40,000 to the project cost. The project yielded a 14% internal rate of return and has enabled the facility to increase throughput with lower energy use.

What equipment uses the most energy at different facilities?

Mining and Quarrying: Typical Electric Use for Gravel Crushing & Processing into Mix



Mining and Quarrying: Typical Electric Use for Industrial Calcium Carbonate Processing



Electricity Users

Although energy usage profiles vary from plant to plant, facilities of the same type usually use electric energy in similar ways. The three charts illustrate typical distributions of electric energy use in processes that occur after the rock has been drilled, blasted or otherwise separated from the formation.

The first pie chart at left shows a typical breakdown of electric energy use in a gravel-crushing operation that produces hot mix asphalt for road paving. Similar energy use profiles are found in other facilities with crushers, such as those that process landscape stone, roadway or railroad ballast, or concrete.

In gravel-crushing operations, the crusher and the dust collector are the major users of electricity. Other significant electricity users include material handling such as conveyors, dryers and air compressors. Depending on the process, pumps may use significant amounts of energy.

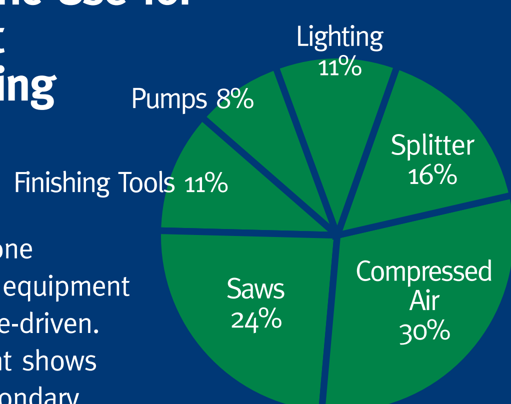
The second pie chart shows a typical breakdown of electric energy use in a calcium carbonate processing operation. Significant electric energy users include crushers, grinders, dust collection devices and mixers.

The third pie chart shows a typical breakdown of electric energy use in a monument stone finishing operation. Air compressors may be driven by electricity or by a diesel engine; in either case the compressor tends to be the largest energy user in dimensional stone facilities. Dimensional stone operations use compressed air for a variety of applications, including pneumatic tools such as drills, hammers and grinders. Other significant electric energy users are saws (wire or circular), splitters, polishers and pumps. In indoor facilities, ventilation and exhaust fans also use significant amounts of electricity.

Fuel Users

Major fuel users in this sector include engine-driven equipment such as air compressors and pumps. Quarries also may have diesel-powered generators, rolling stock and other heavy equipment. Additionally, some quarries use fuel oil-fired stonecutting jet torches; steam boilers may be used as a heat source for marble processing. Hot mix asphalt plants use fossil fuel such as natural gas or heating oil to heat the mix. It may be cost effective to use heat recovery from stationary engine-driven equipment, if there is a heating demand elsewhere in the plant.

Mining and Quarrying: Typical Electric Use for a Monument Stone Finishing Operation



In a dimensional stone quarry, much of the equipment is likely to be engine-driven. The pie chart at right shows a representative secondary processing facility for monument stone, where mill blocks or slabs are sawed, polished, and finished.

Compressed Air

This section addresses electric compressors. In some quarries, employees must move equipment frequently as different sections of the quarry are used, so the quarry uses engine-driven compressors instead of electric-driven ones. However, even if your facility uses engine-driven compressors, you still can benefit from the following suggestions because any measure that saves compressed air also lowers fuel use in an engine-driven compressor.

Typical mineral processing facilities use as much as 30% 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, typical compressed air improvements pay for themselves in less than two years and can 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 regular leak detection and repair programs, as much as 30% of the compressed air used in the plant can be attributed to leaks. A properly implemented leak detection and correction program with regular follow-up can reduce a facility's compressed air demand 5-10%. Flexible hoses and their associated couplings are particularly prone to leakage, and should be checked frequently. Efficiency Vermont can assist you with the initial leak detection and repair effort, which usually pays for itself in a matter of months with reduced energy bills. Once a leak correction program is in place, ongoing maintenance costs are low and well worth the effort. An additional benefit for facilities with high leakage rates is that by fixing existing leaks and reducing inappropriate uses of compressed air, managers can often eliminate the need for purchasing additional compressors, even when new production equipment is being installed. If you are planning to purchase a new compressor in the near future, it makes sense to institute a leak detection and correction program beforehand. The program will reduce the overall air demand on the new compressor and may save capital costs if a smaller compressor can meet your air requirements.

2. Eliminate inappropriate end uses

Making compressed air uses about four times as much energy as the work output of any compressed air end use. Eliminating inappropriate application of compressed air can 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 another possible retrofit for blowoff applications. An electric-driven vacuum or liquid pump uses only about 20% of the electrical input required by 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. Efficient part-load control is usually available on models 25 hp and larger and is a cost-effective upgrade from standard modulating inlet valve controls, especially when the demand for compressed air in the plant varies.

Three widely available methods of efficient part-load control are variable speed drive (VSD), variable displacement air-end (turn valve), and load/unload. For example, if the typical demand is 70% of the compressor's rated output, load/unload control with proper

An example of how a Vermont facility is **REDUCING COSTS FOR A BAG HOUSE SYSTEM**

Conditions: The plant operates a bag house with a 125 hp centrifugal fan. The system uses an inlet damper to control the static pressure in the ductwork. The fan runs at constant speed, at 80% of nameplate power.

Improvement: Install a VSD on the fan, along with new controls using the static pressure signal to vary the fan motor speed. The original control dampers are removed or locked in the 100% open position. The fan now runs at an average of 70% speed.

Benefit: Plant electric bills are reduced by $10,509 per year.

Costs and Savings

Annual electricity savings	123,638 kWh
Electricity cost savings	$10,509
Installation cost	$39,100
Incentive from Efficiency Vermont	$9,775
Net installation cost	$29,325
Payback period	2.8 years

storage capacity can reduce energy use by 10% compared to modulating control; 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, especially when the compressed air demand in the plant varies. These controls automatically operate the most efficient combination of compressors to meet a given load while maintaining the plant's pressure requirements.

4. Increase air storage

Additional storage capacity can help reduce the inadvertent running of a trim compressor to satisfy momentary surges in demand. Properly sized air storage capacity also is essential for efficient part-load control and reduces 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.

Motors

When replacing or upgrading any continuous-duty motors in the facility, you should purchase National Electrical Manufacturers Association (NEMA) premium energy-efficient motors. An improvement in energy efficiency from baseline to premium can result in significant annual electrical savings. The range of savings is dependent on motor size, runtime, and type.

An example of how a Vermont facility is REDUCING COSTS FOR A GRAVEL-WASHING OPERATION

Conditions: A gravel-crushing operation uses a 100 hp wash pump. The wash pump is oversized for the typical flow requirement and pumps over a pressure relief valve. The average flow requirement is 60% of the pump's capacity.

Improvement: Add a VSD to the pump, and control the pump to maintain the required pressure at the washer. The pump now handles the actual required flow, and runs at reduced speed, saving pump energy and reducing excess runoff.

Benefit: Electric bills are reduced by $7,316 per year.

Costs and Savings

Annual electricity savings	86,076 kWh
Electricity cost savings	$7,316
Installation cost	$31,600
Incentive from Efficiency Vermont	$7,900
Net installation cost	$23,700
Payback period	3.2 years

Some examples of motor savings for Totally Enclosed Fan Cooled (TEFC) continuous-duty motors are listed here:

Efficiencies Baseline	Efficiencies Premium	Motor Size	Annual Electricity Savings*	Incentives
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 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 pump speed to 75% reduces the motor's energy use by more than half. In open systems that require high pressure, energy use is more closely proportional to motor speed.

SPECIFIC VSD APPLICATIONS INCLUDE:

Dust Collectors/Bag Houses: Centralized dust collectors that remove dust from multiple pieces of machinery have blowers that are sized for the worst-case scenario of all machines running at the same time. Reducing flow when possible will save energy. Also, the dust collection equipment may be oversized compared with the actual maximum requirements for flow and static pressure; if this is the 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 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.

Pumps: Circulating pumps are used in many mineral processing applications, including washing of crushed stone, "sink/float" separation processes, high-pressure water jet cutting, and cooling and lubricating of other cutting and polishing operations. Some of these pumps may benefit from VSDs, especially those that serve applications with variable flow requirements at relatively low pressures.

Lighting

Mineral processing operations occur both outdoors and indoors, with significantly different lighting requirements. Outdoor lighting at a quarry can range from 0.5 to 2 footcandles (fc) for nighttime security lighting or to higher levels (5 fc for general lighting with higher levels for specific tasks) if the plant ordinarily operates at night. For outdoor lighting, facilities typically use high-intensity discharge (HID) lamps, which include metal halide and high- or low-pressure sodium. The specific type of lighting used depends on the application.

Recommended light levels for indoor processing vary between 20 fc and 200 fc, depending on the activity. Product inspection and quality control areas usually require the highest light levels, and warehouse areas and other processing areas operate with lower levels.

Manufacturing facilities are often lit to provide an even light level throughout. This approach wastes energy in overlit spaces and may result in underlighting of critical task areas, possibly reducing productivity and affecting quality assurance. Upgrades to the lighting system can reduce overall lighting usage to less than 1.0 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 reduces 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.

An example of how a Vermont facility is REDUCING MIXER OPERATING COSTS

Conditions: A hot mix asphalt (HMA) plant uses a mixer to combine the aggregate and asphalt cement before delivery to the work area. The mixer has a 100 hp drum motor, which runs at a constant speed for 2,500 hours per year. Some of the HMA formulations that the plant makes do not require the peak speed of the mixer.

Improvement: Install a VSD to modulate drum speed. The mixer speed is tailored to the size and formulation of each batch, and runs at an average speed of 70%.

Benefit: Plant electric bills are reduced by $6,936 per year. Other benefits include the potential for improved mix quality due to automatic control of mixing rate.

Costs and Savings

Annual electricity savings	81,595 kWh
Electricity cost savings	$6,936
Installation cost	$31,600
Incentive from Efficiency Vermont	$7,900
Net installation cost	$23,700
Payback period	3.4 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

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.

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