CIPEC

BEST PRACTICE BENCHMARKING IN ENERGY EFFICIENCY:

CANADIAN AUTOMOTIVE PARTS INDUSTRY

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Leading Canadians to Energy Efficiency at Home, at Work and on the Road

The Office of Energy Efficiency of Natural Resources Canada
strengthens and expands Canada's commitment to energy efficiency
in order to help address the challenges of climate change.

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INTRODUCTION

The Automotive Parts Manufacturers' Association (APMA) is Canada's national association representing original equipment manufacturers of parts, equipment, tools, supplies and services for the worldwide automotive industry. The Association was founded in 1952 and has over 400 members accounting directly or indirectly for 95 percent of independent parts production in Canada. APMA's fundamental objective is to promote the automotive parts manufacturing industry both domestically and internationally.

APMA has been actively engaged in the Canadian Industry Program for Energy Conservation through its participation in the Transportation Manufacturing Task Force. This benchmarking survey, co-sponsored by Natural Resources Canada and APMA, assesses APMA member companies on several critical organizational, operational and technical practices that affect the energy efficiency of an organization and its capacity for effective energy management.

This report presents an overview of the sector's energy consumption and energy drivers, summarizes the responses to the benchmarking survey, and highlights energy-related best practices in this sector. Two self-evaluation tools that organizations can use to rate their energy management practices are also included (page 6 and 9).

1.1 AUTOMOTIVE PARTS INDUSTRY

In 2003, automotive parts sales were estimated at $34 billion, and the industry employed nearly 105 000 people. There are nearly 900 automotive parts manufacturing establishments across Canada, of which 64 percent are located in Ontario. On the whole, the sector has a relatively low energy intensity, representing 1 percent of manufacturing energy use or 25 467 TJ[a] and 6 percent of manufacturing GDP or $10 billion (in 1997 dollars) in 2002.

A Diverse Sector

Given the diversity of manufacturing processes in the automotive parts sector, member companies reported many processes as their major energy consumers. As Figure 1 (page 2) shows, assembly, plastics moulding, and surface coating and painting are the three most commonly identified major energy-consuming processes.

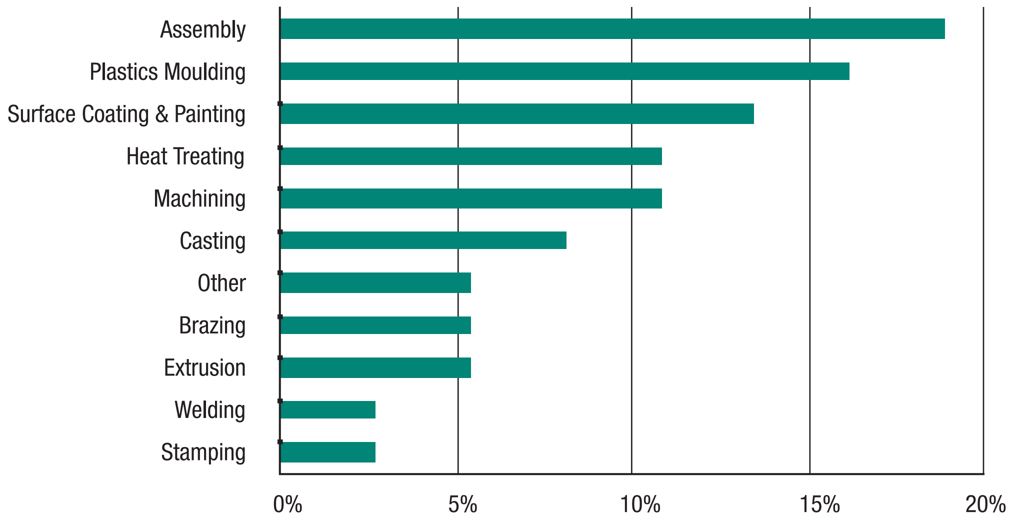
Energy Cost as a Percentage of Operating Costs

Energy cost is typically a relatively small component of total operating cost in this sector, representing on average 1.6 percent[b], with only a very small percentage of respondents reporting a cost share greater than 10 percent. However, many companies find that energy cost is more *manageable* – in terms of the potential reductions available – than other components that comprise a greater share.

[a] 2002 Industrial Consumption of Energy (ICE) Survey, Statistics Canada

[b] 2001 Annual Survey of Manufactures, Statistics Canada

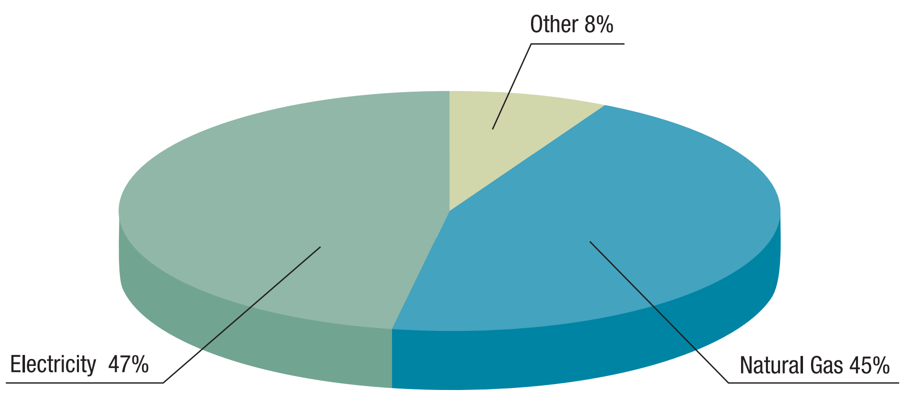
Figure 1 Frequency of Major Energy-Consuming Processes by Share of Respondents



Fuel Mix

Overall, the automotive parts industry uses primarily electricity and natural gas, with other energy sources accounting for only 8 percent of the total. Although some of the technical improvements recommended for energy efficiency are energy source specific, many of the best practices identified in the benchmarking survey apply to all energy types. As well, savings in energy costs may be found by exploring alternate energy sources.

Figure 2 2002 Canadian Automotive Parts Industry Fuel Mix (Source: ICE Survey)



1.2 METHODOLOGY

Forty-three APMA member sites were surveyed. Due to the diversity of industries in the automotive parts manufacturing sector, the survey focused on the use of good organizational, operational and technical practices, and not on quantitative measures of energy consumption. The belief supporting this approach is that the implementation of good practices leads inevitably to improved energy efficiency.

Based on their responses to the survey, respondents were rated at Level 1, 2 or 3 – Level 1 being the most energy efficient and Level 3 being the least energy efficient. Performance benchmarks were then established based on the energy practices that the Level 1 performers have as their normal way of doing business.

The objective of this report is to help companies identify steps they can take to optimize the energy efficiency of their plants. Organizations at lower performance levels have opportunities to implement the practices associated with Levels 1 or 2; those at Level 1 may wish to consider other best practices, as described in the reference boxes included in this report.

2

BENCHMARKING SURVEY FINDINGS

Effective energy management depends on the organizational, operational and technical capacities of an organization. The findings of the benchmarking survey are grouped according to these three capacities:

Section 1 – **Organizational Capacity** refers to the position of energy management and decision making in a company's organizational structure, including *energy policy, organizational structure, skills and knowledge, information systems, marketing and communications and investment.*

Section 2 – **Operational Capacity** refers to the operating practices that contribute to the energy efficiency of all energy-consuming systems, including *operating procedures, employee awareness and training, and energy measurement and data analysis (instrumentation)*.

Section 3 – **Technical Capacity** focuses on measures to improve a system's energy efficiency, including *energy-efficient technologies and energy-efficient practices.*

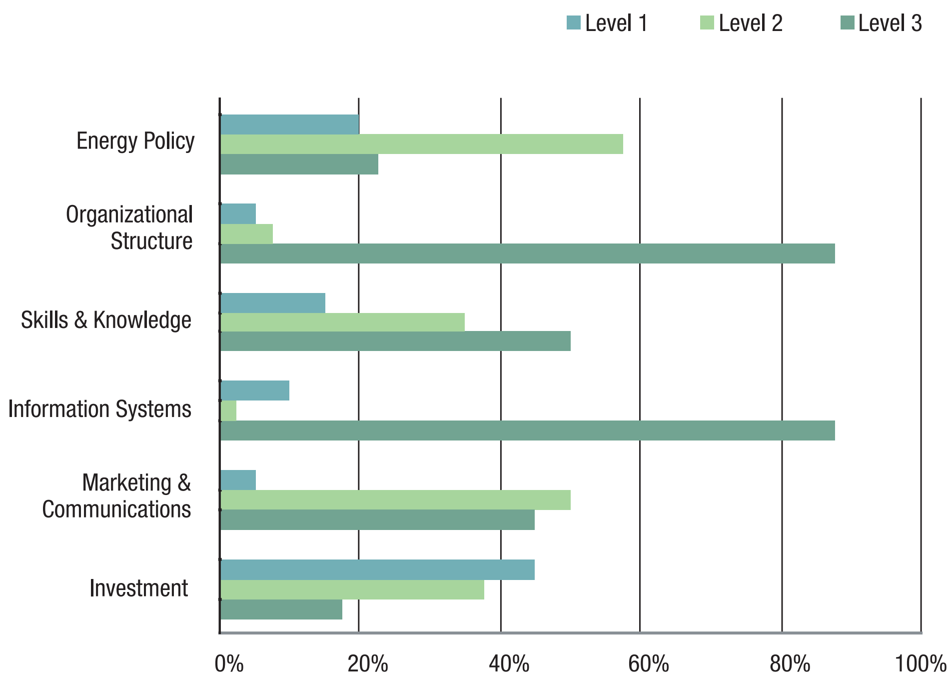
2.1 ORGANIZATIONAL CAPACITY

A company's organizational capacity for managing its energy use is the degree to which its practices include formulating an energy policy, positioning energy management in the organizational structure, improving employee skills and knowledge in the area of energy efficiency, managing energy information, producing internal and external communications about energy management, and investing in efficiency measures.

Survey respondents were rated on these issues using the energy management matrix (Table 1 on page 7). The implementation of sound energy practices follows a logical sequence. Ensuring the awareness of the importance of energy management is an important first step.

As can be seen in Figure 3 (page 6), the survey results indicate that upgrading energy measurement and information management systems and positioning energy management as a clearly designated function in a company's organizational structure are two measures that many companies would do well to consider to improve their organizational capacity for energy management. For example, although 58 percent of respondents have a person or team that is responsible for energy at their site, only 25 percent currently have or are developing a written energy policy.

Figure 3 Organizational Capacity Rating



Did you know?

Energy management does not happen in isolation from other organizational factors. Three key initiatives that support the integration of energy management into "business as usual" are ISO 14000 certification, reported by the majority of respondents; corporate energy reduction targets, found in about one third of the companies; and long-term energy management plans, again in the minority of respondents. A positive indicator is the number of companies that have the latter two initiatives in development.

Rate Your Own Organizational Capacity

Using the Organizational Energy Management Matrix (Table 1), companies can rate their organizational capacity based on the elements of good energy management. The *organizational profile* is the line joining the boxes that describe the current status of the company in each of the six columns.

The experience of energy-managing organizations suggests that good "next steps" are actions that companies can take *to move lower scores up one or two levels* in order to achieve both a *balanced profile* and *a higher overall score*.

Table 1 Organizational Energy Management Matrix

	Energy Policy	Organizational Structure	Skills & Knowledge	Information Systems	Marketing & Communications	Investment
1	Energy policy and action plan are reviewed annually and have the commitment of top management as part of a business and environmental strategy.	An energy committee, team or energy manager reports to executive or senior manager.	Key energy users receive regular and specific training. Brief awareness training is provided to all energy users.	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking for key departments and areas.	There is a program to build staff awareness, supported by regular publicity campaigns.	Same payback criteria employed as for all other investments.
2	An un-adopted energy policy with a set of unwritten, but generally accepted, guidelines.	An energy committee, team or part-time energy manager reports to mid-level manager or supervisor.	All energy users receive informal on-the-job training on energy efficiency.	Regular reporting of consumption based on utility meter data or utility to key energy users or departments.	Some ad hoc staff awareness training.	Investment using short-term payback criteria only.
3	No explicit policy.	No energy management or any formal delegation of responsibility for energy use.	Energy users rely on their existing knowledge.	No accounting for energy consumption.	No promotion of energy efficiency.	No investment in energy efficiency and/or only low-cost measures taken.

Best Practices for Organizational Capacity – Beyond the Survey

- ❒ Energy management is fully integrated into the management structure, and there is clear delegation of responsibility for energy consumption.
- ❒ All energy users receive specific energy training integrated into other development activities. Workshops are also held to facilitate the sharing of knowledge.
- ❒ The value of energy efficiency and what is being done in the area of energy management are communicated within and outside the organization.
- ❒ There is positive discrimination in favour of green schemes, with detailed appraisals of all new-build and refurbishment opportunities.

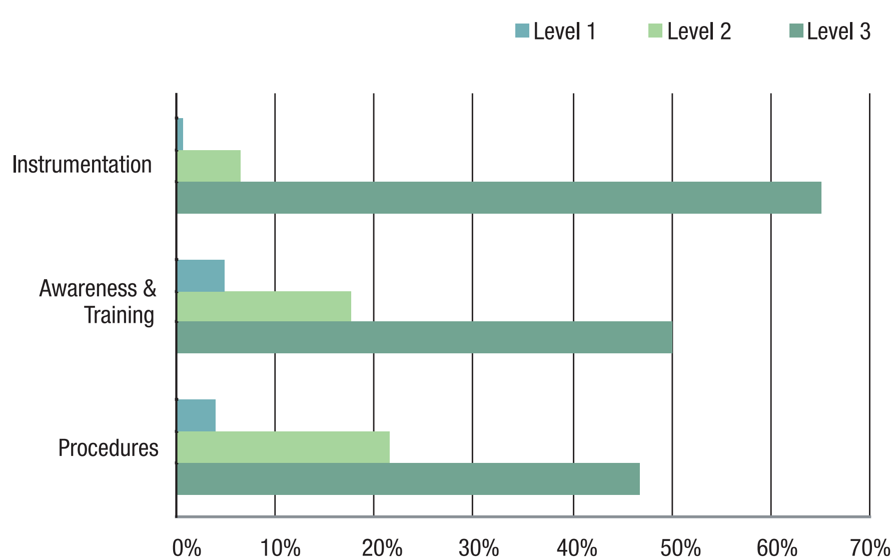
2.2 OPERATIONAL CAPACITY

A company's operational capacity for good energy management is the degree to which it provides its employees with operating procedures and training that will help them to keep energy efficiency in mind during production. Although most operating procedures are written for specific energy-consuming systems, many have common elements that can be implemented plant-wide. For that reason, Figure 4 presents the aggregate operational capacity results for energy management across the energy-consuming systems presented in Section 2.3 (pp. 10–18).

As Figure 4 shows, most companies were rated at Level 3 because, although many of them address energy efficiency in operating procedures, training and measurement for a few systems, few of them consistently implement all measures across all systems.

For example, 65 percent of the respondents provide training on energy-efficient operating practices to employees for at least one energy-consuming system. However, only 27 percent of the respondents provide such training for three or more systems. Similarly, although 14 percent of the respondents have written operating procedures that address energy efficiency for one system, none have detailed documentation for all systems.

Figure 4 Aggregate Operational Capacity Rating



Rate Your Own Operational Capacity

Using the Operational Energy Management Matrix below (Table 2), companies can rate their operational capacity for good energy management. The *operational profile* is the line joining the boxes that describe the current status of the company in each of the three columns.

The experience of energy-managing organizations suggests that good "next steps" are actions that companies can take *to move up one or two levels* in order to achieve both a *balanced profile* and a *higher overall score*.

Table 2 Operational Energy Management Matrix

	Procedures	Awareness & Training	Instrumentation
1	Operating procedures that specifically address energy-efficient operation are documented, reviewed and updated on a regular basis.	Training on energy-efficient operating practices is given to operators and maintainers through either formal training sessions or informal, on-the-job instruction.	Energy metering is installed in such a way that system consumption can be measured directly; data are correlated with production and are used to minimize consumption.
2	Operating procedures addressing energy efficiency are unwritten but well understood by operators and maintainers.	Training on energy-efficient operating practices is given to operators or maintainers through either formal training sessions or informal, on-the-job instruction.	System consumption can be calculated directly or indirectly; data are correlated with production or used to minimize consumption.
3	Operating procedures addressing energy efficiency do not exist.	There is minimal or no training on energy-efficient operational practices.	Energy metering does not exist.

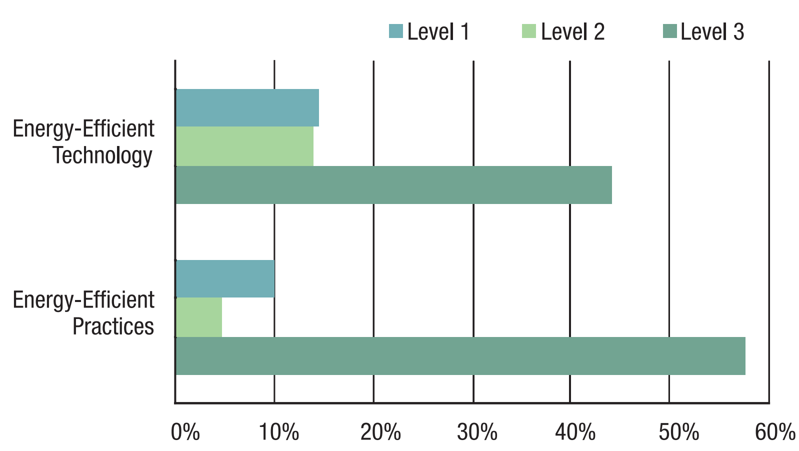
2.3 TECHNICAL CAPACITY

Although operational capacity relates to providing employees with resources to improve energy efficiency in operations, a company's technical capacity for good energy management is the degree to which it incorporates energy efficiency into its acquisition and operation of individual energy-consuming systems. This capacity is split into two categories: energy-efficient technology and energy-efficient practices. The best practices used at the sites achieving Level 1 status are:

ENERGY-EFFICIENT TECHNOLOGY	Energy efficiency is a criterion for all equipment acquisitions. Plant systems are designed and fitted with appropriate controls and other components that optimize their end-use energy efficiency.
ENERGY-EFFICIENT PRACTICES	Energy-consuming systems are regularly monitored, cleaned, adjusted, maintained and operated to ensure they make the most efficient use of energy. Employees are aware of and implement system-specific operating and maintenance measures.

Figure 5 presents the aggregate survey results for technical capacity across all energy-consuming systems. Over 50 percent of the respondents were rated at Level 3 in both energy-efficient technology and practices, which indicates there is considerable potential for improvement. For details on which energy-consuming systems present the most opportunity for efficiency improvements, see sub-sections 2.3.1 through 2.3.7.

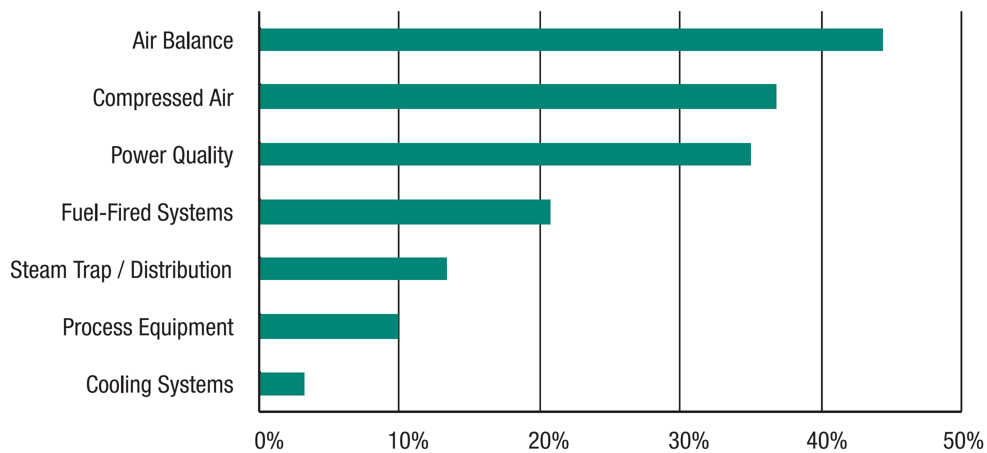
Figure 5 Aggregate Technical Capacity Rating



Finding and Understanding Opportunities

Good practice for the operation of energy-consuming systems includes periodic auditing of their operating efficiency to identify operational or technological measures that can improve efficiency. The survey respondents have audited some systems more than others, as can be seen in Figure 6. Opportunities exist to audit all systems more frequently as part of the ongoing energy management strategy.

Figure 6 Percentage of Respondents Who Have Audited Energy-Consuming Systems – By Type of Audit



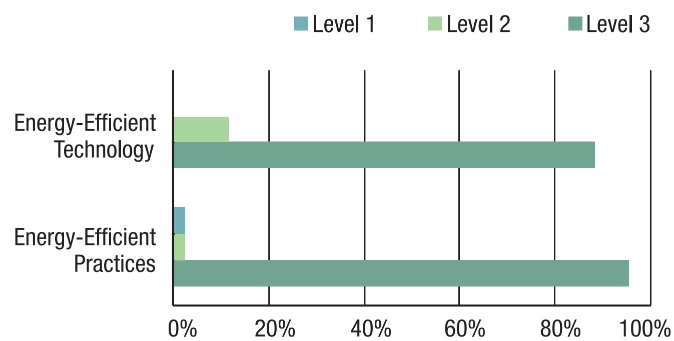
2.3.1 Compressed Air Systems

Compressed air is often referred to as the fourth utility, after electricity, natural gas and water. Compressed air systems include unitary or central equipment used to compress, treat and distribute compressed air up to and including end-use appliances. Leaks in the system are the most common and major cause of system inefficiency.

Survey Findings

- The surveyed respondents have implemented, on average, two end-use management practices for compressed air systems, with the most popular being shut-off valves and engineered nozzles.
- 59 percent of the respondents reported having a procedure in force for identifying and reporting air leaks.
- 71 percent of the respondents shut down compressors during non-production periods.

Figure 7 Technical Capacity Rating for Compressed Air Systems



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
End-use management technologies, including shut-off valves, are used to eliminate compressed-air waste and match delivery pressure to the requirement. Care is taken to match system sizing and output control to the requirement.

Energy-Efficient Practices
All employees are aware of the importance of leaks in the compressed air system and follow leak-reporting procedures. Procedures exist to repair air leaks within one hour of being reported, to shut down compressors during non-production periods, and to draw inlet air from outside. High quality air is delivered in a segregated system, and receiver sizing and placement are optimized for system requirements.

Did you know?

Compressed-air system improvements, identified in the U.S. Industrial Assessment Centers' energy audits of small- and medium-sized industrial sites, had on average projected compressed-air savings of 15 percent with simple paybacks of less than two years. In some plants, as much as 50 percent of the compressed air is consumed by leaks. Ultrasonic leak detectors make quick work of locating leaks and cost around $300 to $500. In many cases, this cost was paid back in the first hour of use.

For more information:

- M27-01-1330E **Throwing Money Into the Air** (Video)
- **Compressing Air Cost** (GPG126): www.oit.doe.gov/bestpractices/compressed_air

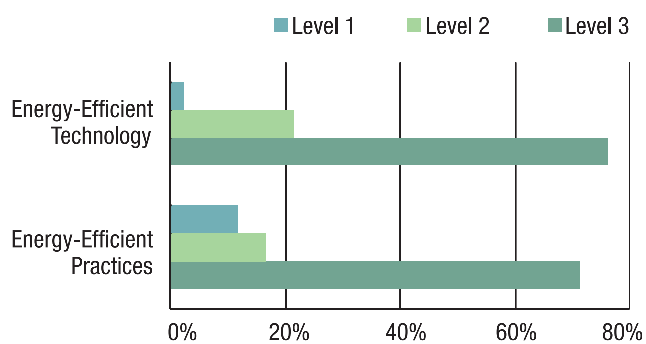
2.3.2 Exhaust and Make-Up Air Systems

Exhaust systems remove gases and particulates generated in the process and plant areas. Make-up systems bring air into these areas. These systems typically involve the use of fans, filters and ductwork, as well as heaters during the heating season.

Survey Findings

- 20 percent of the respondents check and adjust combustion controls on make-up air heaters at least once a year.
- 24 percent of the respondents filter and re-circulate air.
- Although 39 percent of the respondents have undertaken an air-balance or similar study, only 6 percent of such studies have been within the last 10 years.

Figure 8 Technical Capacity Rating for Exhaust and Air Make-Up Systems



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
Air is filtered and re-circulated, and flow controls are used.

Energy-Efficient Practices
Combustion controls on make-up air heaters are checked and adjusted at least quarterly. Systems are operated only when needed to optimize system efficiency.

Did you know?

Heat recovery may be achieved using relatively low-tech applications. De-stratifying hot air in a boiler room to preheat combustion air is a simple form of waste heat recovery. Boiler efficiency can be increased by 1 percent for each 22°C (40°F) of preheating provided – that's $5,000 per year on a gas bill of $500,000 per year.

For more information:

- M91-6-010E **Heating, Ventilation and Air Conditioning**
- CADDET Result R228 **Solar Collector Heats Ventilation Air**

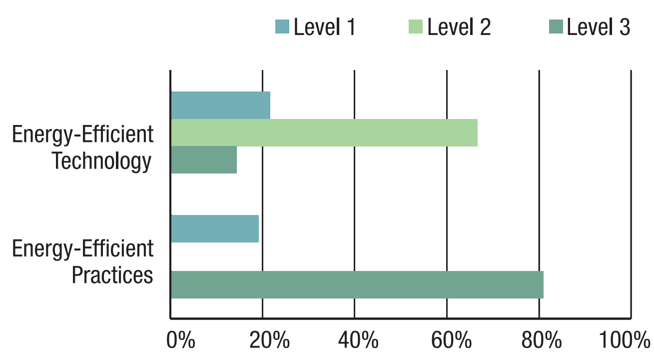
2.3.3 Lighting Systems

Lighting systems present opportunities to reduce electrical costs. Lighting systems include all the equipment required for the provision of plant, office, warehouse and outdoor lighting, including fixtures and luminaries for light distribution, the light sources and associated controls.

Survey Findings

- 20 percent of the respondents indicated that they use motion sensors at their sites.
- 20 percent of the respondents reported using a group re-lamping strategy.

Figure 9 Technical Capacity Rating for Lighting Systems



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
Non-incandescent or mercury vapour lighting technologies appropriate to the requirement are applied throughout the facility, along with automated on/off controls such as occupancy sensors and photocells.

Energy-Efficient Practices
Lighting fixtures are cleaned regularly, and a group re-lamping strategy is used. Adequate area switching is provided to allow appropriate manual control of lighting.

Did you know?

Turning off 100 four-foot fluorescent lamps for 100 hours during non-production time can save you at least $300 per year.

For more information:

- M92-242-2002-7E **Lighting Control**
- M92-242-2002-4E **Lighting Options for Gymnasiums**
- M92-242-2002-9E **Fluorescent Lamp and Ballast Options**

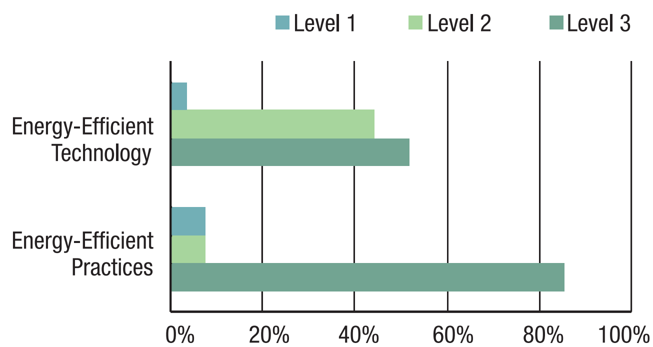
2.3.4 Fuel-Fired Equipment

Fuel-fired equipment includes fuel combustion systems, re-circulation and exhaust equipment, enclosures, loading and unloading systems, and any associated control systems.

Survey Findings

- Although 30 percent of the respondents reported that combustion efficiency was measured by staff or a contractor at least once a year, only 15 percent of the respondents indicated that their combustion controls are checked and adjusted annually.
- 50 percent of the respondents reported using either an oxygen trim control or electronic combustion controls (no oxygen trim) with their fuel-fired equipment.

Figure 10 Technical Capacity Rating for Fuel-Fired Equipment



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
The combustion efficiency of fuel-fired equipment is controlled by means of oxygen trim controls.

Energy-Efficient Practices
The combustion efficiency of burners is measured at least weekly by plant staff or a service contractor, and combustion controls are checked and adjusted at least quarterly. Insulation is maintained in good condition and equipment doors are maintained to close properly.

Did you know?

An electronic flue gas analyzer or a combustion efficiency analyzer can be purchased for as little as $1,500. If using an analyzer improves the overall annual efficiency by 2 percent, the cost of the unit could be paid back within one year, assuming an annual fuel bill of $100,000.

For more information:

- CADDET Result R107 **Natural gas-fired rapid heater for metals**, 1992
- M91-6-007E **Process Furnaces, Dryers and Kilns**
- www.oit.doe.gov/bestpractices/process_heat

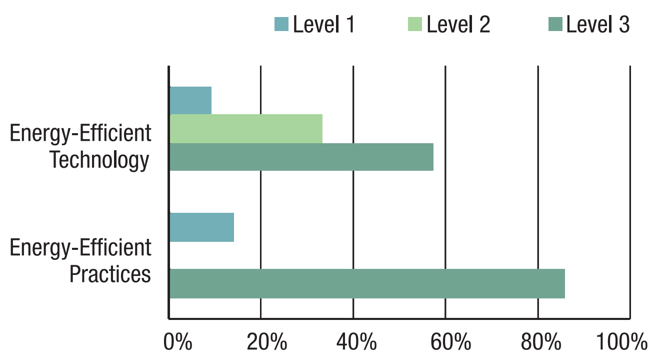
2.3.5 Boiler Plant Systems

Boiler plant systems include unitary or central equipment that generates and distributes hot water or steam for both process and space heating purposes. This encompasses the boiler, combustion systems, boiler auxiliaries, steam distribution equipment (including steam traps and condensate returns), heat exchangers and hot-water circulation systems (including pumping systems).

Survey Findings

- 25 percent of the respondents reported having operators that calculate, track and maintain boiler efficiency.
- 45 percent of the respondents reported determining the combustion efficiency of their boilers by means of an oxygen trim control, electronic combustion controls (no oxygen trim) or mechanical combustion controls (no oxygen trim).

Figure 11 Technical Capacity Rating for Boiler Plant Systems



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
The combustion efficiency of boilers is controlled by means of oxygen trim controls.

Energy-Efficient Practices
The combustion efficiency of boilers is measured quarterly; boilers are shut down for water-side and fire-side cleaning semi-annually; and all boilers and distribution system components are properly insulated, with insulation maintained in good condition.

Did you know?

A 20°C reduction in flue gas temperature will produce a 1 percent improvement in boiler efficiency. This equates to $2,500 on a natural gas bill of $250,000 per year.

For more information:

- M91-6-006E **Boiler Plant Systems**
- M92-229-2001E **Boilers and Heaters: Improving Energy Efficiency**
- www.oit.doe.gov/bestpractices/steam

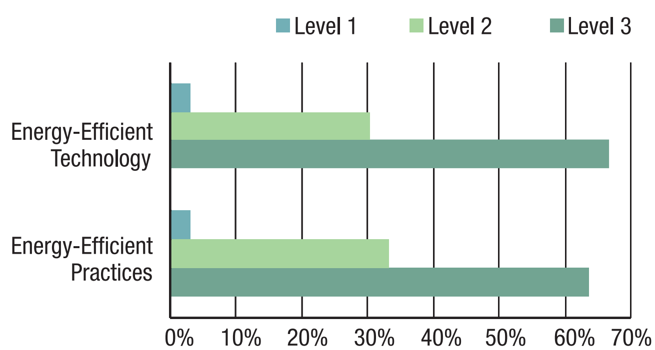
2.3.6 Cooling Systems

Cooling systems may be unitary or central and include all equipment required to generate and distribute a cooling medium for processes or space cooling. This typically encompasses some form of water chiller, including a compressor, evaporator, condenser, cooling towers and, typically, a chilled medium (water) circulation system.

Survey Findings

- 63 percent of the respondents surveyed have insulated chilled-water distribution lines.
- 25 percent of the respondents shut down chiller compressors in the winter to take advantage of the "free" cooling of water with outside air.
- 38 percent of the respondents have either variable-speed chillers or chilled-water temperature reset controls in place to control capacity.

Figure 12 Technical Capacity Rating for Cooling Systems



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
Chilled water is treated to control surface fouling, and control technologies are used to match chilled water volume and temperature to the plant requirement.

Energy-Efficient Practices
Cooling system heat exchangers are cleaned semi-annually; chilled-water lines are properly insulated; and opportunities for free cooling during the winter months are used.

Did you know?

Setting chilled water temperatures warmer by 1°C can reduce chiller energy consumption by 2 to 4 percent. For a 100-ton chiller, this could equate to cost savings of $1,000 per year.

For more information:

- M91-6-011E **Refrigeration and Heat Pumps**
- **Running Refrigeration Plant Efficiently – A Cost Saving Guide for Owners** (GPG279), www.actionenergy.org.uk

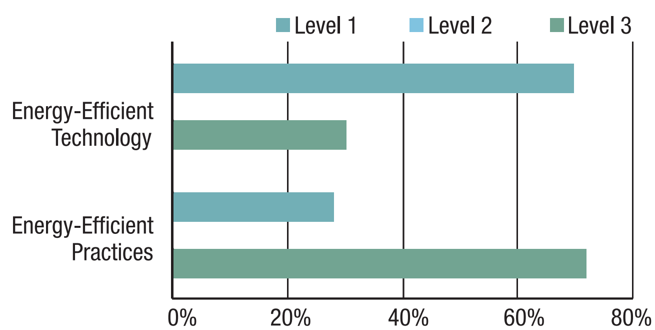
2.3.7 Process Equipment

Process equipment can be wide-ranging, depending on the processes unique to each manufacturing segment. Examples include coating processes, energy-intensive processes such as electric furnaces, metal-forming processes such as stamping, and plastics-forming processes such as extrusion or injection moulding.

Survey Findings

- 30 percent of the respondents reported that their maintenance practices for process equipment address energy consumption.
- 75 percent of the respondents indicate they consider energy efficiency when acquiring new process equipment.

Figure 13 Technical Capacity Rating for Process Equipment



Level 1 Best Practices

The best practices used at sites achieving Level 1 status are:

Energy-Efficient Technology
Energy efficiency is a consideration in the procurement of new process equipment.

Energy-Efficient Practices
Maintenance practices specifically address optimizing the energy efficiency of process equipment.

Did you know?

Speed control offers an excellent opportunity to save energy by matching the speed of the equipment to the actual process requirements. In fan, pump and compressor systems, power requirements can vary with the cube of the flow. Flow varies directly with speed, so a 20 percent reduction in speed will result in approximately 50 percent savings in energy. In contrast, reducing flow 20 percent by using a throttling valve for fluid or dampers for air will reduce energy consumption by less than 10 percent. Using a variable speed drive to control flow can be paid back in one year and provide improved process control.

For more information:

- M91-6-001E **Process Insulation**
- M92-165-1999E **Energy-Efficient Motors Systems Assessment Guide**
- **Monitoring and Targeting in Large Companies** (GPG112), www.actionenergy.org.uk
- **EnerGuide for Industry** oee.nrcan.gc.ca/egi/english/index.cfm

BEST PRACTICES CHECK LIST

– 50 WAYS TO REDUCE YOUR LOSSES!

Survey respondents identified their best energy efficiency actions, system by system. These are listed here, along with other "world class" best practices. Using the check list below, companies can easily identify measures that can be implemented at their sites to improve the energy efficiency of specific energy-consuming systems:

Compressed Air Systems

❒ Make leak reduction part of standard operating procedures.
❒ Isolate equipment and lines when not in use.
❒ Stop inappropriate end-use.
❒ Use engineered nozzles.
❒ Maintain filters and dryers.
❒ Minimize system pressures and provide adequate receivers to demand.
❒ Manage demand, and sequence multiple compressors to follow demand.
❒ Use a ring main for distribution.
❒ Use variable speed compressors.
❒ Heat plant with heat from compressors.

Exhaust and Make-Up Air Systems

❒ Operate systems to match requirement in air volume and time – ideally with automatic controls.
❒ Ensure standard operating procedures include start-up and shutdown of exhaust and make-up air systems.
❒ Eliminate negative pressures – exhaust and make-up air are balanced.
❒ Use systems that re-circulate and filter air where doing so is appropriate and not hazardous to health.
❒ Use heat recovery between make-up air and exhaust.
❒ Use a solar wall to preheat make-up air.

Lighting Systems

❒ Arrange switching to allow shut-off of individual areas.
❒ Ensure operating procedures specify shutdown of lighting.
❒ Make maximum use of outside light with windows, skylights and controls.
❒ Use metal halide or high-pressure sodium lamps in the plant, warehouse and yard.
❒ Use automatic lighting controls, including timers, photocells, occupancy sensors and integration into plant automation.
❒ Provide illumination at only necessary levels, particularly in storage areas.

Fuel-Fired Equipment

- ❒ Check and adjust combustion efficiency monthly.
- ❒ Use high-efficiency and high turndown ratio burners.
- ❒ Optimize exhaust rates on direct-fired ovens for energy efficiency.
- ❒ Use electronic burner controls, ideally with on-line flue gas measurement (O_2).
- ❒ Heat fuel oil to proper temperature for good atomization.

Boiler Plant Systems

- ❒ Eliminate steam and hot water leaks.
- ❒ Keep steam pressures and hot water temperatures at a minimum.
- ❒ Monitor and maintain steam traps regularly as part of operating procedures.
- ❒ Insulate all hot surfaces, including valves and fittings.
- ❒ Maximize condensate return.
- ❒ Maintain combustion efficiency with oxygen trim control.
- ❒ Recover heat from blow-down and boiler flue gas.
- ❒ Burn waste or biomass when possible.
- ❒ Warm incoming combustion air.
- ❒ Size boilers properly – use several.

Cooling Systems

- ❒ Optimize chilled water temperatures.
- ❒ Insulate all chiller lines.
- ❒ Take advantage of free cooling in the colder seasons.
- ❒ Dedicate chillers to specific processes.
- ❒ Increase condenser and cooling tower sizing and/or floating head pressures.
- ❒ Ensure chiller plant has load-following controls and capacity to be turned down with multiple, reciprocating or variable speed compressors.
- ❒ Use variable speed pumping of chilled water.
- ❒ Recover and re-use cooling water.
- ❒ Replace retired chillers with high efficiency models.

Process Equipment

- ❒ Ensure energy efficiency is a key consideration in new equipment design and installation.
- ❒ Use energy-efficient motors.
- ❒ Use variable speed drives on fans and pumps.
- ❒ Provide proper maintenance.

For more information:

- oee.nrcan.gc.ca/ici/english/publications.cfm
- www.oit.doe.gov/bestpractices
- www.actionenergy.org.uk/Action+Energy/AE+Resources/Default.htm
- M92-239-2001E **CIPEC Energy Efficiency Planning and Management Guide**
- **EnerGuide for Industry**
  oee.nrcan.gc.ca/egi/english/index.cfm