Towards Sustainable Mining

Energy and Greenhouse Gas Emissions Management

Reference Guide

June 2014

The Mining Association of Canada

ADVOCACY STEWARDSHIP COLLABORATION

NOTE TO VERIFICATION SERVICE PROVIDERS:

This reference document is intended to be guidance for companies, and should not be interpreted as an additional layer of requirements under the TSM Initiative. This guide is not a ruling authority on interpretation of the protocol. TSM external verifications should assess conformance with the TSM protocol criteria only.

This reference document provides MAC member companies with detailed guidance on the criteria and elements of each indicator in the TSM energy use and GHG emissions management protocol.

More specifically, this guidance document:

- *Provides further description and discussion of management practices than what is provided in the protocol to support the consideration and implementation of practical, appropriate, and successful practices.*
- *Acts to bridge the gap between "what must be done" and "how to do it".*
- *Focuses on exploring different avenues to meet criteria, including discussion on the strengths and weaknesses of different approaches.*

Who Should Use this Guide?

This guidance document provides management guidance relevant to the following audiences:

- *Corporate and facility energy and GHG managers/leaders*
- *Operations managers*
- *Project managers*
- *Environmental management personnel*
- *Corporate strategy managers*
- *Environment/sustainability professionals*
- *Other members of the mining industry*
- *Interested stakeholders (including the federal and provincial governments)*

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1. Introduction

This reference guide provides Mining Association of Canada (MAC) member companies and other mining companies with an easy-to-use guide to energy use and greenhouse gas (GHG) emissions management. Part A of this guide is consistent with, and supports the implementation of, and the requirements set out in the Towards Sustainable Mining (TSM) Energy Use and Greenhouse Gas Emissions Management protocol. It also includes examples for ways in which a company can meet the requirements of the TSM protocol.

Part B of this guide provides guidance on technical steps that companies can take to become more energy efficient and reduce GHG emissions. The guidance in Part B is not based on the TSM requirements.

Verification Service Providers should refer to the TSM self-assessment protocol when conducting a TSM external verification. Suggestions in this guidance document are intended to help companies develop an energy use and GHG emissions management system and should not be interpreted as additional requirements under TSM.

1.1. MAC's TSM Assessment Protocol

Launched in 2004, TSM is an initiative created by MAC to enhance the industry's reputation by improving its performance. MAC members subscribe to TSM Guiding Principles, which are a set of commitments that address the industry's environmental and social performance. MAC and its member companies have developed assessment protocols for a number of key sustainability issues[1], including a protocol specific to energy use and GHG emissions management. The TSM Energy Use and GHG Emissions Management protocol is provided in **Appendix A**.

The assessment protocol is intended to provide a framework for evaluating company performance against three TSM indicators related to energy use and GHG emissions management performance. These indicators reflect the MAC membership's general expectations for energy use and GHG emission management.

[1] Assessment protocols have been developed for the following four areas: Crisis Management Planning, Energy use and Greenhouse Gas Emissions Management, Aboriginal and Community Outreach, Tailings Management, Biodiversity Conservation Managment, and Safety and Health.

Table 1 - Indicators in the TSM Protocol for Energy Use and GHG Emissions Management

Indicator	Purpose
1. Energy use and GHG emissions management systems	To confirm that systems are in place to manage energy use and greenhouse gas emissions. This indicator applies to facilities and/or business units for which energy use and GHG emissions are deemed to be material.
2. Energy use and GHG emissions reporting systems	To confirm that energy use and GHG emissions tracking and reporting systems are in place for internal use and for public reporting. This indicator applies to all facilities whether energy use and GHG emissions are deemed to be material or not.
3. Energy and GHG performance targets	To confirm that energy and GHG emissions performance targets have been established at each facility or business unit level. This indicator applies to facilities and/or business units for which energy use and GHG emissions are deemed to be material

For each of the above indicators, specific criteria are used to define five levels of performance. While customized criteria are presented for each indicator. **Table 2** provides an indication of what is generally required at each performance level.

Table 2 – TSM Performance Levels

Level	Criteria
AAA	Excellence and leadership.
AA	Integration into management decisions and business functions.
A	Comprehensive systems/processes are developed and implemented.
B	Basic systems/processes developed; comprehensive system planned and under development.
C	No systems in place; activities tend to be reactive; procedures may exist but they are not integrated into policies and management systems.

The goal is for MAC members to achieve, at a minimum, a consistent Level A rating for all three indicators and to continually improve their management and performance in this area.

For all Canadian operating facilities, companies self-assess against these indicators at the facility level and report their performance through MAC each year. Every three years, facility results are externally verified. TSM results are published in the annual *TSM Progress Report,* available at www.mining.ca.

1.1. TSM Performance Reporting To MAC

MAC member companies must report facility-level self-assessment performance results for the energy use and GHG emissions management protocol annually.[2] Each November, MAC issues a call letter to member companies that provides the reporting forms and instructions for their completion. Results are reported for the previous calendar year.

The *TSM Progress Report* presents aggregate and facility-level results. This public disclosure of results is fundamental to the credibility of the program.

Every three years, MAC member companies must have their self-assessment results externally verified. This is done on a rotational basis so that, in any given year, approximately one-third of reporting MAC member companies have their results externally verified. The verified results are distinguished from the self-assessment results within the *TSM Progress Report*. More information on TSM external verification is provided in **Section 5.**

In addition to reporting performance levels against the TSM assessment protocol to MAC, member companies report annual energy consumption and GHG emissions at the facility level. These data are included in the GHG and Energy Management Progress Report section of the annual *TSM Progress Report*. **Section 6.4** provides instructions for completing an energy and GHG emissions inventory.

[2] Upon joining MAC, a company has three years before it must publicly report its TSM results. This provides new members with time to understand and begin applying the protocols to each of their Canadian operating facilities.

1.2. Structure of This Guide

This document is broadly structured into three types of information:

Part A Provides detailed guidance on the criteria and elements of each indicator in the TSM Energy Use and GHG Emissions Management Protocol.

Part B Provides guidance on creating an energy use and GHG emissions inventory and on technical steps that companies can take to reduce energy use and GHG emissions, including energy efficiency measures. Part B also provides detailed instructions on completing the MAC GHG inventory template.

Appendices Provide more detailed background information on GHG reduction policies and programs, practical tools for assessing management practices and performance in this area, and references to other relevant sources of information.

Part A: Interpreting the TSM Protocol and Guidance on Management Practices

Part A of this guide provides detailed guidance on i) interpreting the criteria and elements of each indicator in the TSM Energy Use and GHG Emissions Management Protocol, and ii) guidance and examples of practices that would meet said criteria. The sub-sections of this section are aligned with each TSM indicator category: management systems, reporting systems, and performance targets. It also includes a section on verification, which is an element that appears at Performance Level AA of all indicators.

The TSM assessment protocol provides a framework for assessing whether an organization has the business framework that will enable and sustain management of energy use and GHG emissions. The three TSM indicators focus on the systems and elements required for embedding the practices that reduce or maximize the efficiency of energy use into the organization’s goals and culture, sustaining performance in these areas, and ensuring accountability for its performance in the eyes of stakeholders.

The goal is for MAC members to achieve, at a minimum, a consistent Level A rating for all three indicators and to continually improve their management and performance in this area (i.e. strive for Level AA and Level AAA Performance).

Readers are directed to the TSM Protocol for the definitive list of requirements for performance at Levels C, B, A, AA, and AAA for each of the three indicators.

2. Management Systems and Leadership Under TSM

Indicator 1 To confirm that systems are in place to manage energy use and GHG emissions. This indicator applies to facilities and/or business units for which energy use and GHG emissions are deemed to be material.

Indicator 1 of the TSM assessment protocol concerns the implementation of management systems that focus on energy and GHG emissions where they are material, both at the facility level (e.g. total site energy or GHG emissions), and at the source level (e.g. total energy or GHG emissions per fuel). This section also provides guidance on achieving performance in three categories that capture elements of effective management systems:

- Leadership and accountability
- Integration into business processes and systems
- Integration into broader sustainable business strategy

The management system elements described in this section are also summarized in the TSM energy use and GHG emissions management checklist included in **Appendix B**.

2.1. Materiality

Two types of materiality are identified and applied within the TSM Energy Use and GHG Emissions Management Protocol:

Facility Level Materiality

Recognizing that energy use and GHG emissions are not a material business risk for all companies and facilities, a materiality threshold has been incorporated into the energy use and GHG emissions management protocol. Facilities whose GHG emissions (as a sum of Scope 1 and Scope 2 emissions) are less than 25kt of CO_2e or whose on-site energy usage is less than 250,000 GJ, are not required to report on indicators 1 or 3 of this protocol.

Source Level Materiality

The energy and GHG emissions profile varies across the industry; what is a material fuel or emissions source at one operation may not be material at another. Designed to facilitate the targeting of efforts that produce the greatest results given one's resources, the TSM protocol enables a facility to develop a system to determine which energy consumption and GHG emissions sources account for material consumption/emissions or offer an opportunity for energy/GHG emissions performance improvement. The requirements of the protocol, in turn, are applicable only to those sources identified by the member company as material. As noted in the protocol FAQ, if an operation does not develop a documented process for determining materiality of fuel sources, all fuels will be considered material for the purposes of measuring against the TSM protocol.

Component of Level B

The TSM protocol requires facilities to establish processes to determine energy consumption sources and associated GHG emissions on a defined frequency for sources accounting for substantial consumption and/or offering considerable potential for energy performance improvement and with a level of disaggregation by major process activity (e.g., mill, mine, smelter, refinery, etc.)

Materiality may be driven by different metrics. Common metrics for assessing materiality include fuel or carbon costs ($), energy usage (e.g. GJ or kWh), and emissions (t CO_2e). Different companies are also likely to have differing thresholds for materiality; some may select a percentage of total costs (e.g. any fuel exceeding 25% of fuel costs), or they may choose an absolute cost (e.g. any fuel exceeding $1,000,000 in annual costs). Ultimately, it is for each company to establish its own process for defining these thresholds and to document its methodology.

2.2. Leadership and Accountability

This section presents elements that form the foundation of a successful management system to address energy use and GHG emissions: commitment from senior management, engagement of personnel throughout the company, and assignment of roles and responsibilities.

Demonstrated Commitment

Implementing management systems for energy use and GHG emissions typically involves senior management recognition of energy management as an important corporate or facility priority. Some examples of how senior management demonstrate their commitments are presented in **Table 3.**

Component of Level B

The TSM protocol requires demonstrated senior management commitment to manage energy use and GHG emissions at the facility level.

Table 3 - Examples of Demonstrated Senior Management Commitment to Energy Use and GHG Emissions Management

Senior Management Activities	Supporting Evidence
Approval of the facility or corporate sustainable development policy or Environmental Management System.	Energy efficiency/GHG emissions improvement specifically included as a component of the facility's or company's Sustainable Development Policy or Environmental Management System or any other comparable management stewardship vehicle.
Approval of energy and GHG emissions management policy.	Documented energy/GHG emissions management policy in place.
Assignment of operational accountabilities for energy efficiency and GHG emissions reduction.	Defined operational accountabilities for management of energy/GHG emissions touching on, for example, procurement, production process control and project requirements. Established procedures (including defined roles and responsibilities) for use by operations personnel in the day-to-day control of those activities which can materially affect energy use or GHG emissions.
Approval of facility's annual business plan.	Energy use and GHG emissions reflected in the facility's annual business plan (or equivalent), with annual and/or midterm improvement targets and action plans assigned.
Approval of capital expenditures.	Capital expenditures and allocation of resources to acquire the skills, equipment, controls, processes, and monitoring systems needed to achieve the energy use and GHG emissions goals.

Responsibility and Accountability

The TSM protocol requires clear accountability for energy use and GHG emissions management to be assigned to operational managers as well as facility level responsibility assigned to an individual or department (e.g. energy leader). A facility may decide to spread responsibilities for energy use and GHG emissions across several positions. Examples of assigned energy/GHG management roles and responsibilities are presented in **Table 4**.

Component of Level A

The TSM protocol requires that clear accountability for energy use and GHG emissions management be assigned to operational managers.

Table 4-Example of Assigned Energy/GHG Management Roles and Responsibilities

Possible Roles and Responsibilities	Examples of Supporting Evidence
Company-level Energy and GHG Leader(s)	
• Champions the management of energy and GHG emissions throughout the company • Reports energy performance to Top Management group • Provides input on energy/GHG performance for the Annual Financial Report and Sustainable Development Report • Implements energy/GHG management business processes at the company and facility levels	• Involvement in advancing the energy/GHG strategy or policy for the company • Spends a substantial portion of their time on energy/GHG matters • Is identified by others as the 'lead' • 'Go to' person for reporting information on energy/GHG • Is named as responsible in business planning or project documentation • Reflected in job description

Possible Roles and Responsibilities	Examples of Supporting Evidence
Facility-Level Energy/GHG Leader(s)	
• Develops energy awareness • Analyzes energy consumption • Locates energy cost reduction opportunities • Manages energy cost reduction projects • Implements energy management (EM) business processes within the facility • Manages the installation of EM technologies • Leads the development of EM and support skills required by the facility • Leads an Energy Committee • Ensures compliance with GHG reporting regulations • Analyzes emission patterns and reports on GHG performance trends • Identifies GHG emission reduction opportunities • Implements GHG business processes within the facility	• Spends a substantial portion of their time on energy/GHG matters • Is identified by others as the 'lead' • 'Go to' person for reporting information • Is named as responsible in business planning or project documentation • Documented responsibilities • Reports or correspondence generated by individuals in 'lead' role • Regulated compliance reports • GHG performance reports and analysis
Line management (for example, those supervising the production process as well as technical support supervision and process engineers, and the management staff to whom these individuals report)	
• Oversight or involvement in production process energy control, performance and cost • Reporting on energy costs vs. budget and operational energy performance metrics • Reports on energy improvement project cost and progress	• Operational control procedures • Operational energy reports and production reports • Minutes of planning/review meetings • Personal objectives and personal performance reviews • Capital project progress reports

While some companies may choose to create dedicated positions for energy use and GHG management, others may integrate these responsibilities into existing functions and systems where energy use and GHG emissions are additional variables in the determination of operational performance. Responsibility and accountability may be attributed in a number of different manners across companies, many of which are legitimate approaches to responsibility and accountability.

Companies that have identified GHG emissions and/or energy consumption as material issues may choose to enact more advanced accountability structures. This could include creating a management team to develop and implement an energy and GHG emissions management strategy. Some companies have also assigned oversight responsibility for these issues to a committee of the board of directors.

Education and Training

One of the most common barriers to implementing cost-effective energy use and GHG emissions reduction activities is a lack of awareness about opportunities on the part of those who make investment and operating decisions within a company. The TSM protocol requires that general energy and GHG awareness training is provided to relevant personnel and additional training for key personnel.

Component of Level A

General energy and GHG awareness must be provided to personnel with additional training for key personnel.

Table 5 identifies possible education and training programs for different types of personnel.

Table 5-Examples of Energy and GHG Emissions-related Training

Who	Training Topics
Relevant company personnel	• General awareness training as a one-time introductory initiative
Energy leaders	• Energy skills training, including consumption analysis, and remedial action cost/benefit analysis techniques
Operations management production levels	• Budgeting energy cost and consumption relative to production levels
Technical personnel	• How to support and maintain all energy consuming technologies • How to support energy controlling and data management technologies • How to identify auxiliary system and production process energy use reduction opportunities • Six sigma training
Operations personnel	• How to operate production processes in an energy efficient manner • How to analyze and control energy performance and cost

Materials to support the training described above might include:

- General awareness presentations or materials for company-wide dissemination such as:
    - Company newsletters with dedicated sections on energy and GHG emissions management
    - Energy efficiency or GHG emissions reduction components in all company publications
- Fundamental financial assessment training manuals and presentations
- Energy management handbooks and training manuals
- Equipment specific energy efficiency training manuals and specification sheets
- Operator training manuals

Canadian mining companies can draw on existing material to develop their own employee education program. Natural Resources Canada has developed a suite of training through its *Training and Awareness for Commercial and Institutional Organizations* program.

2.3. Integration into Business Processes and Systems

This section addresses processes and systems to measure and analyze data on energy use and GHG emissions that provide operators and managers with the information required to make decisions to improve performance.

Facility-Level Monitoring

Facility-level monitoring should support management activities such as the following:

- Energy consumption for material supply sources is quantified at the facility level and where appropriate, for production processes
- Annual historical data are archived
- Energy data are appropriately used as inputs by production process control systems

Component of Level B

The TSM protocol requires standard quantification and estimation methodologies for converting energy and GHG emission data (including process emissions data) into comparable units.

Evidence for reporting on facility-level monitoring activities may include:

- Utility invoices
- Monthly or weekly operational energy and production reports

Aggregation of Monitoring Data

Facility-level information on energy use and GHG emissions typically comes from aggregate monitoring data from major process activities.

The TSM protocol requires facilities to use standard quantification and estimation methodologies for converting energy data into comparable energy information, and fossil fuel use and process emissions data into comparable GHG emissions information. This does not preclude the development of site-specific emissions factors, provided that the bases of these site-specific factors are transparent and can withstand outside scrutiny. Site-specific emission factors may provide a greater degree of accuracy to GHG data.

The aggregate data typically captures the following:

- Energy costs and consumptions for material energy and GHG sources
- GHG emissions data from the factor conversion of fossil fuel use

Evidence to support the aggregation of data may include:

- Computerized energy/GHG emissions reports
- Summary operational energy/GHG emissions report and production reports

2.4. Integration with Operational Management System

The key energy management principle applied in this indicator is that floor level operators are managing energy consumption as a consumable of (or input to) the production process. This means that, energy use for processes that have material energy use or GHG emissions are subject to corresponding levels of control by technologies and/or operators that have the ability to intervene in the energy intensive process. The TSM protocol requires energy data to be reviewed regularly and integrated into operator actions for energy intensive processes. Examples include maintaining a temperature range and optimizing the speed of a variable speed pump.

Component of Level A

The TSM protocol requires energy data be reviewed regularly and integrated into operator actions for energy intensive processes.

Where GHG emissions are a direct result of energy use (e.g. GHG emissions from the consumption of natural gas in a direct fired boiler or emissions from the consumption of diesel by a fleet of mobile mining equipment), then the control of energy use can be used as a proxy for the control of GHG emissions. With the application of the appropriate conversion factors or quantification protocols, controlled energy performance can be expressed as GHG emissions performance. In these instances, information on GHG emissions does not need to be present on the operator's control interface, but can be inferred from the energy use information.

The TSM protocol requires that operator actions related to control of energy use and GHG emissions be included in the operator's job procedures. In addition to including such controls in the actions of operators, these controls on energy use and GHG emissions might instead be embedded into automated process control systems which may only involve monitoring to ensure the process is operating within expected parameters. In the situation where the GHG emissions are directly related to energy use, then energy related job procedures or process controls act as a proxy for GHG control procedures.

Company-Level Energy Use and GHG Emissions Data

To report total energy use and GHG emissions, companies with multiple facilities will need to gather and summarize data from these facilities. Manual and automated approaches to managing information can be used. The approach chosen to collect and report data will depend upon the information and communication infrastructure already in place. It will also depend on the amount of detail that corporate headquarters wishes to collect.

Typical examples of data collection and management tools include:

- Secure databases for direct data entry by facilities
- Spreadsheet templates filled out and emailed to a corporate or division office, where data are further processed and utilized

For internal reporting to the corporate level, it is recommended that standardized reporting formats be used to ensure that data received from different business units and facilities are comparable, and that internal reporting rules are observed.

Section 3 provides detailed guidance on energy use and GHG emissions reporting systems for internal and public reporting.

2.5. Integration into Broader Business Strategy

Level AAA companies will integrate energy use and GHG emissions into a broader business strategy and will likely look beyond the company for opportunities to reduce energy use and GHG emissions. This may include working with its supply chain to reduce energy consumption and/or GHG emissions, investing in R&D and technology demonstrations, or engaging its communities of interest in education and outreach initiatives or programs.

Component of Level AAA

Energy use and GHG management system is integrated into a broader sustainable business strategy that includes at least 2 of the following:

- procurement and supply chain management policies that incorporate energy efficiency and GHG reduction criteria
- voluntary corporate investments in research and development, feasibility studies and/or demonstration of technologies and/or new processes that target energy efficiency and reduced GHG emissions.
- corporate investments in renewable energy projects and/or energy recovery projects
- participation with communities of interest to improve energy efficiency and reduce GHG emissions (e.g., community events, environmental non-government organizations, government energy efficiency programs

Procurement and Supply Chain Management

Companies should consider energy sources and the magnitude of energy consumption and GHG emissions along the supply chain as part of managing the risk of exposure to increased prices for carbon-intensive energy. Upstream energy use and associated emissions will affect the cost of all inputs. Downstream energy use and emissions, such as those associated with transportation, will affect customer costs.

A range of actions can be taken to reduce the energy use and GHG emissions that are embedded in the products and services consumed by the company and that are ultimately part of the products that it passes on to its customers. These actions could include:

- Working with suppliers to implement actions that will reduce energy use and GHG emissions associated with the interaction between the two organizations
- Incorporating energy use and/or GHG emissions criteria into specifications for goods or services that entail significant energy consumption or GHG emissions (e.g. set energy performance standards for frequently used equipment, such as lights or motors)
- Favour suppliers that have developed action plans to reduce energy use and GHG emissions

Companies can also consider how best to manage the risks associated with market-based energy contracts. Companies that are actively managing their energy consumption and energy budgets may develop an energy risk management strategy. This strategy would likely be governed by corporate risk management (hedging) policy. As part of this risk management strategy, companies may apply financial instruments, such as fixed priced or indexed-based contracts to the purchase of energy from a commodities market. The volumes of energy supply and the duration of the supply are key variables to be considered and determined within the strategy.

R&D and Demonstration of Technologies

R&D can make an important contribution to the achievement of commitments over the long term through step changes in energy and GHG emissions performance.

Companies can make contributions to universities and research institutes, to internal research programs/initiatives, and/or to collaborative projects with other companies to research and develop technologies that will improve the energy efficiency and reduce the carbon intensity of key processes. Support is also typically provided for the testing and deployment of promising new technologies in core operations of the company.

Corporate Investments in Renewable Energy Projects

Companies can reduce their long-term energy costs, diversify their energy supply and achieve GHG targets through investments in renewable technology. Investments in renewable energy could include projects such as wind or solar farms and hydroelectricity. Companies may also choose to purchase carbon credits to offset GHG emissions made at another location.

Engaging Communities of Interest

Companies can extend their influence by working with external parties to promote improved energy efficiency and GHG emissions management. This can be done through engagement with one or more communities of interest including: community groups, non-government organizations, government energy efficiency programs, development of mandatory reduction programs, industry associations, and local school boards.

Companies can take steps such as supporting educational programs and GHG emissions reduction projects in communities where mines are operating, and advocating for government policies that support efforts by the mining industry to reduce GHG emissions. Engagement with communities of interest around this issue provides an opportunity to receive valuable support and feedback, and to develop proactive responses to help reduce energy use and GHG emissions. It also helps to demonstrate that responsibility for reducing GHG emissions is shared equitably among Canadians.

Case Study: Teck Resources Limited

Improving Haul Truck Productivity

Day and night, haul trucks travel back and forth across Teck's six steelmaking coal sites, hauling waste rock to the dumps and raw coal to the processing plant. This movement is a significant portion of Teck's site costs — approximately 40%. Finding ways to make trucks run faster and more efficiently, without sacrificing safety, is an opportunity to not only to save costs, but also reduce emissions and improve the company's overall sustainability performance.

In response to this challenge, Teck developed four ways to improve haul truck productivity:

- Reducing fixed time, which is the amount of time that a haul truck spends waiting to be loaded, being loaded and dumping its contents.
- Increasing operating hours by reducing as much unproductive time as possible. For example, fuelling trucks during lunch or during a shift change.
- Improving payload by switching to lightweight haul truck boxes allows Teck to move an additional 15 tonnes of material with each load. Lighter truck boxes also result in reduced fuel consumption on the return trip from the dump and the potential to load additional material every trip.
- Grouping trucks together based on speed so Teck's newer, faster trucks aren't being held up by older, slower ones.

These changes may seem small, but they add up to big results. For example, Teck reduced the amount of time that each haul truck waited to be loaded by one minute during 2013, thereby saving 40,000 truck hours and 450,000 litres of diesel. The diesel savings also reduced CO2 emissions by 1,200 tonnes and contributed 16 TJ towards Teck's energy reduction targets. Simply increasing truck productivity by 5% and sustaining it for one year can save an estimated 50,000 truck hours, reducing costs by $24 million and improving the efficient use of resources.

For more information, visit www.teck.com.

Case Study: Vale

Ventilation Management System

The following case study is a good example of how Vale's investments in energy efficiency technologies are helping the company achieve a requirement for Level AAA in the TSM energy use and GHG emissions management protocol.

Mine ventilation systems typically comprise 50% to 55% of the connected power load at a mine site, and are designed to operate on a continuous basis which can result in 70% of the mine's total energy consumption. The consumption of energy and the high capital cost to introduce additional air into a mine became the main drivers behind the development and application of a technology to manage the ventilation systems. A ventilation management system uses technology to adjust the ventilation fans, louvers and flows by responding to activities of mine personnel and air quality criteria.

In 2009, Vale joined a consortium consisting of a funding agency, industry representatives, suppliers, research organizations and a technology provider to realize the benefits from a broad base of expertise and funding. Vale piloted this project with the following objectives:

- Reduce the energy consumption of a mine ventilation system
- Understand the reliability, cost and maintenance of the technology
- Evaluate the application of VFD starters on auxiliary fans versus on/off option
- Maximize the efficiency of a ventilation system by being able to easily re-direct air volumes with changing mining activities and reduce the air volume into the mine when possible
- Ensure a safe underground working environment

The ventilation project was implemented at Coleman Mine and isolated within the 153 Orebody to assess the various control strategies, which each have a benefit and an associated cost. The full automated control strategy was installed so that the benefit could be determined between simple real-time control, scheduling, RFID tracking, environmental monitoring and combinations of the strategies. There are many factors (i.e. how the ventilation system is constructed, type and reliability of the communication system, mining methods, company goals, etc.) that determine the most suitable type of control strategy used and potential for energy savings.

In the business case that was developed to secure support for the research project, it was calculated that a ventilation management system capable of controlling air volumes by adjusting the fans and flows via responding to the activities of mine personnel and air quality criteria could produce a 30% savings in energy consumption. When the system was initially commissioned and allowed to operate for a one week period, the savings reached 39%. It is estimated that over a long period of time, considering operating and capital cost, that the energy savings alone for this application could sustain 35%. It was also determined that the ventilation management system could allow increased production opportunities from blast clearing and re-direction of available air.

For more information, visit www.vale.com/canada.

3. Reporting Under TSM

Indicator 2 To confirm that energy use and GHG emissions tracking and reporting systems are in place for internal use and for public reporting

The energy and GHG emissions management systems discussed in Section 2 provide the processes and structure that identify what information should be collected and what information should be used in decision making. Indicator 2 (energy use and GHG emissions reporting systems) of the TSM protocol focuses on whether tracking and reporting practices are in place to ensure that the facility provides the right energy and GHG performance information to the right people (both internally and externally) at the right frequency to allow the facility to make informed decisions around its energy consumption (as seen below in **Figure 1**).

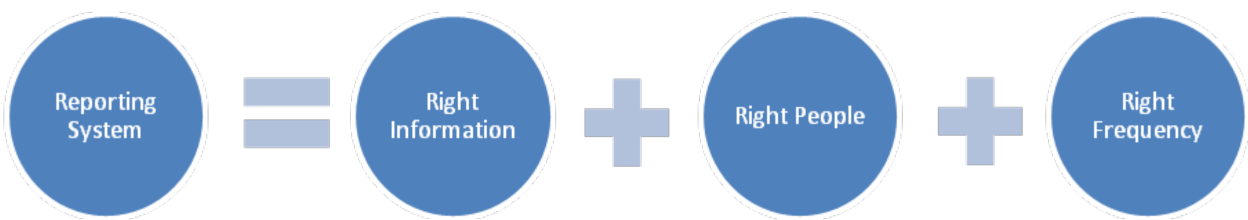


Figure 1-Reporting System

Section 3.1 focuses on internal reporting. **Section 3.2** describes how energy and GHG data and information can be publicly reported, and **Section 3.3** explains what performance information member companies are expected to report to MAC.

An energy use and GHG emissions reporting system is an important element of the energy use and GHG emissions management system. It should be designed to provide relevant information to key individuals and departments to enable improved energy performance.

To satisfy the requirements of Indicator 2, facilities must be able to demonstrate that a comprehensive energy use and GHG emissions reporting system has been established. At a minimum, the reporting system should ensure that:

- Energy use and GHG emissions performance data are reported internally on a regular basis

- Performance data are used to inform decision-making by management
- Data is reported publicly on an annual basis

3.1. Internal Reporting

To be confident in the accuracy, completeness and reliability of its energy consumption and GHG emissions data, a company should ensure that:

- There is clear responsibility for tracking and reporting energy use and GHG emissions performance data and that those responsible have the appropriate skills and training.
- There is a facility-level dataset of which disaggregated data by major process activities can be drawn from.
- Energy use and GHG emissions reporting practices are defined and specify how performance data are collected, which energy units and emissions factors are used, how data are to be validated and/or verified, and what is reported to whom, with what frequency.

A comprehensive reporting system will ensure that key energy performance and GHG emissions data and information are regularly provided to operators, managers, and senior management, and are used to support management decision-making processes. Facilities' individual management systems should define specific reporting frequencies and content to ensure that the right people can take timely action to respond to and, where necessary, correct actions that affect energy consumption and GHG emissions. **Table 6** provides examples of reporting frequencies for different audiences.

Table 6-Examples of Reporting Frequency for Energy Use and GHG Emissions Data

Data Reported to	Frequency	Why and How
Operators	Daily or weekly	Operators should receive information on energy consumption, process efficiency and associated GHG emissions on a regular basis. This information will enable early detection of anomalies and prompt corrective action. Many utility companies provide software for tracking energy use and GHG emissions.
Managers	Weekly or monthly	Managers should receive consumption and efficiency information that allows them to identify and analyze trends in a timely manner and demonstrate progress towards targets and objectives at the business unit level. Where possible, information should be collected and presented within established monitoring and reporting systems for production and financial data.
Senior Management and Employees	Quarterly	Senior Management should receive updates on energy consumption and GHG reductions relative to goals set out in an energy/GHG action plan. Analysis should identify positive and negative deviations from expected results, including explanatory information that can be used to inform decisions about further action. It is also important to communicate this information to all employees to encourage participation in, and support for, energy use and GHG reduction strategies.
Board Committee	Annually	For companies that have identified energy consumption and GHG emissions as material issues, the relevant Board Committee should receive progress reports on the status of implementation of the energy use and GHG emissions reduction action plan, and significant deviations from expected results.

A facility or business unit may want to incorporate tracking of energy use and GHG emissions into existing sustainability monitoring and reporting mechanisms and within the framework of the corporate EMS. This integrated approach allows management to evaluate energy use and GHG emissions alongside other significant issues under active management.

In addition to internal targets and goals, benchmarking reported information against peers may support decision-making and long-term strategy.

Performance Level A requires verification of the reporting system. The purpose of this type of verification is to assess whether a system has been developed and implemented and to determine whether it is being used in a way that is consistent with the design developed by the facility. Verification requirements are described in **Section 5** of this guide.

3.2. Public Reporting

There is a high level of interest and concern about GHG emissions within many communities of interest, including regulators, investors, non-governmental organizations, and the general public. MAC encourages its member companies to disclose publicly their energy use and GHG emissions. Absolute GHG emissions data for each MAC member company over multiple years is available on MAC's website (www.mining.ca).

Many MAC member companies also include energy use and GHG emissions data in their annual sustainability reports. Where these issues are determined to be material to a company, they are also included within their annual reports. Other examples of public reporting include the Carbon Disclosure Project, company websites, and publicly available regulatory reports. Reporting must be at the facility level to achieve a Level A.

Performance Level AA of the TSM assessment protocol requires annual public reporting of energy use and GHG emissions, and performance against energy use and GHG emissions targets. If a facility has not set targets, it cannot achieve a Level AA for the reporting system indicators.

Traits of good quality public reporting include:

- Identification of the boundaries (e.g. which operations and activities are included in the data and which are not)
- At least three years of data (many companies report an earlier year that they have chosen as their baseline year)
- A discussion and explanation of changes over time, including discussion of any significant events or changes that affect reported data (e.g. acquisitions, divestitures, closures, technology upgrades, changes of reporting boundaries or calculation methodologies applied)
- Performance against targets
- Future targets, and key elements of plans to achieve those targets
- A discussion of uncertainties in the data reported, and steps the company plans to take to reduce uncertainties

For companies that participate in the Global Reporting Initiative, these traits align with its guidance on reporting.

Confidential Business Information

In some instances, the public disclosure of both energy consumption and mineral production data at the facility level could compromise a company's position in relation to its competitors, particularly in instances where there are relatively few global competitors (e.g. iron ore). If a company chooses not to disclose energy intensity and GHG emissions intensity at the facility level for these reasons, this should not prevent the facility from achieving Level A performance, if all other requirements are met.

Case Study: Teck Resources Limited

Research Partnership on Energy Planning

Companies that achieve high levels of performance in the TSM energy use and GHG emissions management protocol recognize the value of collaborating with communities of interest in their energy efficiency initiatives. A good example of this type of collaboration is Teck's Highland Valley Copper operation, located in south central British Columbia, which has partnered with Thompson Rivers University (TRU) to improve the efficiency and reliability of its energy use reporting system. Highland Valley Copper and TRU have partnered on the research and development of an energy modelling tool that will accurately predict energy performance based on mine planning inputs. In doing so, a site will not only be able to forecast its energy profile based on future mine plans, but this information can also be used to help influence mine plans based on energy considerations.

The project, which aims to develop industry and site-specific Key Performance Indicators for Highland Valley Copper, will introduce a process that facilitates the selection of energy metrics that are able to appropriately reflect performance in a meaningful and manageable manner. The energy metrics used will differ from traditional approaches because they are derived through research using statistical and mathematical principles. The modelling tool's ability to incorporate mine plan inputs and generate future energy profiles will provide a tool that can be used during the planning phases of mining to influence decisions earlier and in a more meaningful way in terms of energy use.

This project will help all of Teck's operations to further fulfill its commitment to sustainability by improving the efficiency of its energy use and reducing GHG emissions and unnecessary energy consumption.

For more information, visit www.teck.com.

4. Planning and Setting Targets

Indicator 3 To confirm that energy and GHG emissions performance targets have been established at each facility or business unit level.

This indicator applies to facilities and/or business units for which energy use and GHG emissions are deemed to be material.

The setting of targets for revenue, sales and other core indicators, and the tracking of performance against those indicators is a practice undertaken by many successful businesses. Likewise, effective energy use and GHG emissions management involves setting specific targets. **Figure 2** illustrates a typical performance management model, including setting targets and working toward their achievement.

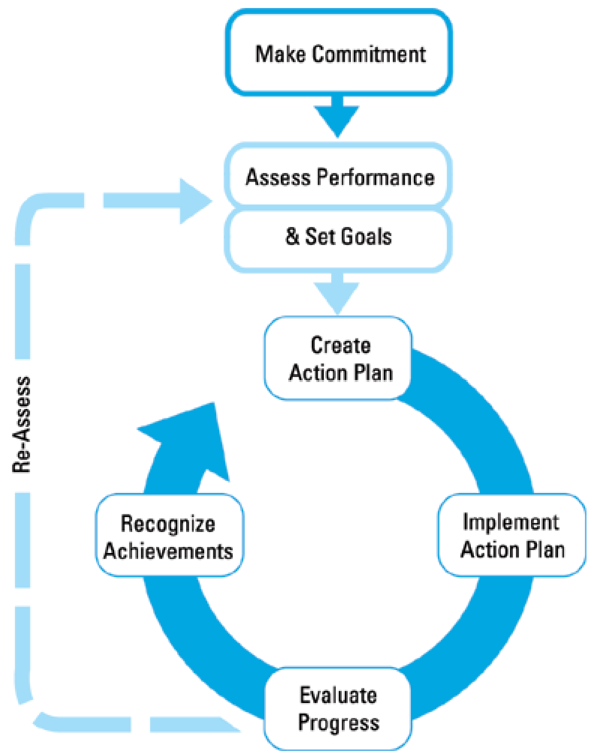
Energy use and GHG emissions reduction targets can be used to:[3]

- Achieve cost savings and stimulate innovation
- Prepare for future regulations
- Reduce and manage GHG risks
- Demonstrate leadership and corporate responsibility
- Participate in programs such as TSM

A facility or business unit may designate one or more (but are not limited to) of the following types of energy use or GHG emissions performance targets:

- Volume target: volume targets define a specified amount of carbon dioxide equivalent (CO_2 equivalent) or energy consumption that will be consumed or emitted by the facility.

Figure 2-Performance Management Model



[3] Adapted from World Resources Institute and WBCSD. The GHG Protocol. Chapter 11.

- Intensity targets: intensity targets define a specific amount of CO_2 equivalent or energy consumption against another variable to appropriately reflect efficiency. Examples of variables used are:
    - Energy per unit of production
    - Energy per unit of material moved (where material is inclusive of both "head tonnes" – tonnes of ore delivered to a processing area – and waste or other materials.)

Flexibility in selecting the variable that energy or CO_2e is normalized against is crucial in producing targets that are meaningful and manageable at many operations. For example, a target measuring kWh used in the mill per tonne of product might be a meaningful target for a mill operator, as they may have control over managing towards such a target, whereas energy per production unit includes elements (such as diesel for transportation) that are not within the mill operator's realm of control.

When selecting targets, consideration of the broad elements of a company's strategy to manage energy use and GHG emissions may present a fuller suite of options for targets, allowing a company to select a type and magnitude of target that is most appropriate. Elements might include increasing energy efficiency, purchasing or developing clean energy technologies, or offsetting GHG emissions on or off-site. Current or pending federal and provincial regulatory requirements may inform and, in some instances, drive target setting for a number of companies. Companies should consider whether their facility will be subject to caps on absolute GHG emissions or on GHG emissions-intensity. If so, consider what other targets your facility should set to meet these caps. If your facility's emissions are less than its caps, the resulting surplus credits could have value (either to sell or to put towards caps in future years).When setting targets, environmental, economic, and social issues

Examples of Targets

IAMGOLD, Esskane Mine

Three-year goal to reduce consumption of hydrocarbons by 2% to 5%.

Hudbay Minerals, Flin Flon

Reduce total CO_2-equivalent emissions by at least 1% per year.

Suncor Energy Canada

Improve energy efficiency by 10% by 2015.

ArcelorMittal Mines Canada

Reduce CO_2 emissions per tonne of steel produced by 8% by 2020.

should be taken into consideration. Below is a list of some of the items a facility or business unit may want to consider:

- Financial criteria and priorities
- Alternative energy sources
- Maintenance and infrastructure needs,
- Operational requirements and constraints
- Quality and appropriateness of energy resources
- Environmental impacts
- Safety and health issues
- Available human and technical resources
- Its energy management system including areas of significant use and drivers
- Life of mine

Useful targets are typically:

- Ambitious, so as to commit the organization to continual improvement
- Realistic, so that they can be achieved within specific time limits
- Specific and measurable

4.1. **Multiple Performance Targets**

Facilities with distinctly different production processes can set separate energy and/or GHG emissions performance targets for each process. It may be appropriate or even necessary, to have multiple targets representing a single facility where the dynamics of the production processes are such that one common production unit is not a representative consumption driver for each production process.

For example, a single performance intensity indicator may not be sufficient in the case of an open pit facility that is comprised of the pit and a concentrator. In this case, head tonnes could be used as the production driver (denominator) for milling/crushing consumption and emissions intensities, while pit material hauled could be used as the driver for diesel consumption and emissions intensities.

Similarly, it may be appropriate to have multiple targets when smelters are processing an increasing amount of recycled material. Typically, the processing of recycled feedstock consumes more energy per unit of output metal than normal concentrates. Therefore, in the case of a production process where the feedstock is predominantly recycled material, a facility could use the input tonnage as the consumption driver (denominator) when determining the intensity for that specific production process, but maintain separate intensities and targets for concentrate and recycle production processes.

4.2. Absolute Targets

Absolute reduction targets are a commitment to reduce total energy consumption or total GHG emissions against a baseline set by the facility or business unit, irrespective of changes in production levels. For example, a facility could set a GHG emissions reduction target to reduce total CO_2e emissions by x% below 2006 levels by 2020.

4.3. Intensity Performance Targets

While absolute measures refer to the total amount of energy consumed or GHG emissions produced, intensity-based measures refer to the energy consumed or GHG emissions per unit of economic output. Mining companies typically express intensity figures in terms of one of the following:

- Tonne of mill throughput
- Tonne of ore product
- Tonne of refined metal
- Tonne of contained metal
- Troy ounces of gold/silver

An intensity performance target is an established target for the performance of a facility or company that relates energy use or GHG emissions to units of production (e.g. 20 gigajoules/tonne of copper cathode production, or 20 tonnes of CO_2e/tonne of copper cathode production).

Level A requires that facilities not only establish performance targets, but that they meet them for the current year. For example, a facility might set a five-year target to reduce its GHG emissions per unit of production by 5% by 2015 over a 2009 base year. The facility can then set annual targets that, collectively, will enable it to achieve the 2015 target. Annual targets will reflect the operational context, and specific actions planned and budgeted for each year. For example, this facility might set annual targets as shown below in **Table 7**.

Table 7-Reduction in GHG Emissions Intensity by Year

Year	% Reduction in GHG Emissions Intensity
2010	0.5
2011	0.5
2012	2
2013	1
2014	1

To achieve a Level AA performance or higher for indicator 3, the facility must show a consistent performance history by having met its energy use and GHG emissions performance targets for three of the past four years. Level AA also requires internal or external verification of performance (see Section 5 for more detailed information on verification requirements).

4.4. Multi-Year Target

A multi-year target is an energy or GHG emissions target that specifies a certain performance over a defined number of years. For example, a 20% reduction over a three year period is a multi-year target. In such a case, it is difficult to determine if a facility is meeting expectations toward the target if progress is not linear. The target may make sense for a facility or business unit in a case where they are implementing a multi-year capital plan or infrastructure upgrade that will result in emissions reductions and/or energy savings only when the final plan is complete. In such a case, an action plan outlining the specific steps that will be implemented each year until the plan is complete should be used to assess progress. Such actions may include, but are not limited to, new operating procedures to be implemented, new equipment to be purchased and installed, or new processes to be commissioned. Actions in the plan should be specific and measurable and should clearly contribute to achieving the reduction specified in the multi-year plan. For a facility or business unit to achieve a Level A under indicator 3, it must be able to demonstrate that previously declared annual milestones for the current year of a multi-year target have been achieved in the reporting year. For the purposes of indicator 3, energy efficiency plans can extend to a cycle of no more than three years.

The intent of the TSM indicators is to reflect the performance of the total facility. Therefore, if a facility has defined multiple energy and GHG emissions targets, all of the targets must be met in a given year in order to achieve a Level A performance rating for indicator 3. Similarly, all of the targets must have been met for three of the past four years in order to achieve a Level AA rating or higher.

4.5. Additionality

A facility or business unit assessed at a Level AAA for indicator 3 will be able to demonstrate that one or more of its performance strategies or projects meet an additionality test. This test would confirm whether a project goes beyond business-as-usual. The Pacific Carbon Trust's *Guide to Determining Additionality* offers comprehensive guidance on conducting additionality tests for carbon offsets.

Common tests to determine offset additionality include:

- Legal additionality test: Was the project implemented to satisfy a regulatory requirement? If yes, it is likely not additional.
- Technology test: Does the project involve a technology that is not likely to be used for a purpose other than reducing GHG emissions? If yes, the project is likely additional.
- Investment test: Was the return on investment a decisive factor? If yes, the project is likely not additional.
- Barrier test: Was there any non-financial barriers that the project needed to overcome? If these barriers would not have been faced by a business as usual approach, it is likely additional.
- Common practice test: Did GHG emissions reductions come from a common practice? If yes, it is likely not additional.[4]

[4] Adapted from World Resources Institute and WBCSD. The GHG Protocol. Chapter 3 (http://www.ghgprotocol.org/files/ghgp/ghg_project_protocol.pdf)

Case Study: Rio Tinto

Diavik Wind Farm

Investment in renewable energy projects that lead to meaningful energy reductions is one way to achieve a Level AAA for indicator 3 of the TSM energy use and GHG emissions management protocol. The Diavik Diamond Mine, located 300 kilometres northeast of Yellowknife, invested $31 million in the development of the first large-scale wind farm in the Northwest Territories. The project was fully funded by the mine's joint venture partners, Rio Tinto and Dominion Diamond Corporation, and the payback is estimated at eight years.

Prior to commissioning (the wind farm began delivering power at the remote off-grid mine in September 2012), Diavik completed a three-year wind data study and an extensive feasibility study. The Diavik wind farm consists of four 2.3 megawatt turbines, which are integrated into Diavik's existing diesel-powered system and will offset the amount of diesel consumed. The extreme location of the mine meant a highly innovative design was needed for the turbines to maximize their output in the harsh subarctic climate. With temperatures in the winter as low as -40°C, the blades are fitted with de-icing technology, and represent a new benchmark for wind power in low temperatures.

Annually, the wind farm reduces Diavik's seasonal winter road fuel haul by up to 100 loads. In first half 2014, the wind farm reduced Diavik's diesel fuel consumption by 2.5 million litres, reduced the mine's carbon footprint by 6,908 CO_2e, and provided 10.3 per cent of its power needs. During feasibility, Diavik estimated that this renewable energy facility would, per year, deliver approximately 10 per cent of the mine's power needs, reduce CO_2e by approximately 12,000 tonnes, and reduce fuel consumption by approximately five million litres. At mid-year, the wind farm was on track to meet these targets.

Diavik is optimistic that the experience and knowledge gained through the planning, development, construction, and operation of its wind farm will be able to be shared so that other projects can be developed in the future.

For more information, visit www.diavik.ca.

5. TSM External Verification Framework

TSM's primary objectives are to drive performance improvement and, through demonstration of this improvement, to build trust with communities of interest. This means that communities need to understand TSM and trust the performance results reported by MAC members. To build this trust, the program includes a number of checks and balances to ensure that reported results present an accurate picture of each facility's management systems and performance. **Figure 3** identifies the different layers of assurance embedded in TSM.

Self-Assessment – Annually, companies self-assess their performance against each of the program's 23 indicators across six protocols. For each indicator they assign a letter grade that reflects their performance ranging from Level C to Level AAA. These grades are made public for each facility. New members have three years to start publicly reporting to provide an opportunity to train employees for full implementation.

External Verification – Every three years, MAC member companies must have their TSM self-assessment results externally verified to confirm the accuracy of reported TSM performance. The individuals who are qualified to conduct TSM external verifications are know as Verification Service Providers (VSP).The Terms of Reference outline VSP requirements and the process to be followed in completing the verification. The Terms of Reference are available in the TSM section of the MAC website: www.mining.ca.

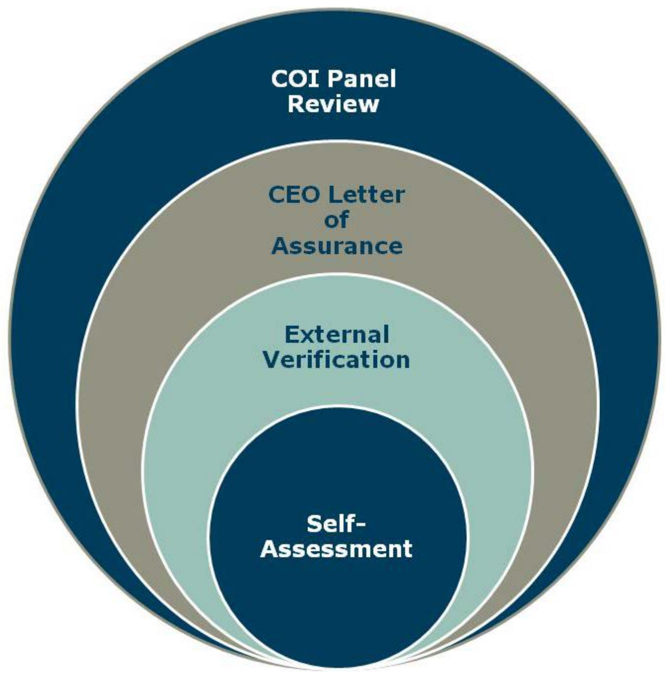


Figure 3-TSM's Assurance Framework

The VSP is required to verify the self-assessment results. This means the VSP will determine if there is adequate evidence to support the self-assessment performance rating for each indicator. The VSP conducts a detailed document and record review, and may interview facility and corporate personnel. Based on this review, they determine if all criteria for performance levels up to and including the self-assessed performance level have been met. That is, if a facility has assessed itself as performing at a Level AA for indicator 1, the VSP would confirm that all criteria for Levels C, B, A and AA have been met.

The VSP provides the company with the verified TSM performance results and notes any changes that were made to the self-assessment. Only the verified results are reported to MAC for inclusion in the annual *TSM Progress Report.*

Preparing for TSM External Verification

To prepare for verification, it is essential that you maintain good records:

- Record how your facility's management system, reporting system, and energy/GHG performance meets each of the criteria for all Levels up to and including your self-assessed performance
- Be sure that all criteria are met up to and including the Level at which you have self-assessed; if one criterion (e.g. bullet point in the rating table for the indicator) is not met, the VSP will have to lower the performance level
- Collect electronic or paper copies of all substantiating documentation (evidence) and have them ready to supply to the VSP

When keeping records of any audits or verifications that have been performed, be sure to write down:

- What verification has been completed
- Whether the verification was internal or external
- Who completed the verification
- The year in which the verification took place
- The year(s) of data that were verified
- The scope of verification
- The verification findings
- The verification's conclusion(s)

The amount of preparation put into the self-assessment will directly affect the length of time required for the VSP to verify the reported results and the cost of verification. If you are able to provide the VSP with the evidence that supports your self-assessment ratings at the outset, verification will go very quickly. If you have not collected the supporting evidence, the VSP will require much more time to collect supporting documents and records, and to ask associated questions. They may also require a visit to review evidence on-site. Thorough preparation also means you will be more confident in your self-assessment results.

CEO Letter of Assurance – In the year of external verification, the company's CEO or most senior executive in Canada, submits a letter to MAC that confirms the external verification has been conducted in accordance with the Terms of Reference for VSPs. The letter is then posted on the MAC website (www.mining.ca).

COI Panel Post-Verification Review – Each year, MAC's independent COI Advisory Panel selects two companies to appear before the Panel to present and discuss their TSM results. Through these discussions, the Panel tests to see whether and how facility systems are leading to performance improvement.

5.1. Energy Use and GHG Emissions Management and Third Party Verification

Within the TSM Energy Use and GHG Emissions Management Protocol:

- Indicator 1, Level AA requires energy use and GHG emissions management systems to be subject to internal or external verification.
- Indicator 2, Level AA requires the energy use and GHG emissions reporting system to be subject to internal verification.
- Indicator 2, Level AAA requires energy use and GHG emissions (scope 1 and 2) to be subject to external verification.
- Indicator 3, Level AA requires energy and GHG emissions performance targets to be subject to internal or external verification.

The verification requirements of Level AA and AAA of the energy and GHG emissions management protocol differ from TSM external verification, which is a validation of self-assessed TSM results. To achieve high levels of performance within the energy use and GHG emissions management protocol, a facility must conduct an independent assessment of its management system, reporting system and performance targets.

Internal verification

Internal verification is completed by company personnel and is intended to validate the robustness of a facility's processes, systems and performance. Many organizations use risk-based internal review processes as part of an operational management system like ISO 14001.

External verification

External verification is completed by a third party, and the verification is conducted using the third party's policies and procedures.

While the scope of work for verification should be developed on a site-by-site basis, the verification should confirm at a minimum whether:

- The management system, reporting system and performance targets meet the protocol criteria
- The management system has been implemented according to its design
- The reporting system has been implemented and energy and GHG emissions data are reliable and accurate

For how long are internal and external verifications valid?

An internal or external verification that was completed within the last three years meets the requirements for an internal verification or an external verification as required by Performance Levels AA and AAA in all indicators of the Energy Use and GHG Emissions Management Assessment Protocol.

5.2. External Verifications or Audits By Regulatory Agencies

As different jurisdictions introduce regulations related to GHG emissions, MAC member companies may be required to undertake external verifications, or more detailed audits, of their energy use and GHG emissions reporting systems to demonstrate that they meet applicable regulatory requirements. This is the case in Alberta under the *Specified Gas Emitters Regulation*.

An external audit or verification completed by a regulatory agency can fulfill the requirements for Level AA, provided that:

- Scope of the verification includes assessing the implementation of the protocol requirements
- Audit/verification report has been provided to the facility

MAC member companies might want to consider the role of external verifications/audits completed by regulatory agencies as part of their risk-based audit plans and assurance strategies.

5.3. Streamlining Verification Mechanisms

Substantial time and resources are required to prepare for and to undergo verification and/or audit. Streamlining verification mechanisms to reduce duplication and overlap can save time and money, and ensure that verification adds value to the organization. **Table 8** identifies potential ways to streamline the required verifications related to energy use and GHG emissions.

Table 8-Ways to Streamline Verifications

Internal Verification	• Ensure energy use and GHG emissions management audits are integrated into your corporate risk-based internal audit plan. • Consider the timing of external verifications (e.g. TSM verification, regulatory agency audits) when setting the schedule for internal audits in the corporate audit plan. Ideally, the internal audit would be conducted one year prior to an external audit. • Use the internal audit process to help you collect the evidence that will be required to support an external audit. • Ensure audit criteria for the internal audit include those criteria from the TSM protocol. Share this section of the guidance document with the internal audit team so that they understand MAC guidance in this area.
External Verification	• Consider whether your facility will be subject to regulatory audits of GHG emissions reporting systems and data, under current or emerging legislation. If so, the regulatory audit could be used as the company's external verification. Note that some companies prefer to engage a third party to conduct an external audit prior to undergoing a regulatory audit, to ensure they detect any weaknesses in the system beforehand.
TSM External Verification	• Consider integrating the TSM external verification as part of other management system audits (e.g. ISO 14001 audits). However, if you choose to integrate it as part of another audit, be sure the audit team has adequate energy and GHG expertise and includes an approved TSM verification provider (the list of approved VSPs is provided on MAC's website: www.mining.ca). • When determining the year in which to undertake external TSM verification, consider the timing of other verifications as well.

PART B – Measuring and Reducing Energy Use and GHG Emissions

Part B provides specific guidance on technical steps that companies can take to reduce energy use and GHG emissions.

Section 6 provides a step-by-step guide to preparing an energy use and GHG emissions inventory.

Section 7 introduces the energy management action process, and identifies a number of specific actions facilities can consider to reduce their energy consumption and GHG emissions.

The guidance provided in Part B is to be adapted to match the circumstances of each company. Unlike Part A, this guidance is not based on the TSM requirements, and is not considered to be within the scope of a TSM verification.

6. Doing a Basic Inventory of Your GHG Emissions

This section describes the process for completing an inventory of your GHG emissions, and provides direction on completing the MAC GHG inventory template worksheet. This inventory is understood to include the six greenhouse gases covered by the Kyoto Protocol – Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbon (HFCs), Perfluorocarbon (PFCs), and Sulphur Hexafluoride (SF_6). The guidance provided here is modelled on that provided in the WRI/WBCSD's *Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard* (hereafter called the *GHG Protocol*). Following this widely internationally accepted standard provides the advantage of saving costs by being able to meet different internal and external information requirements in the same format.

6.1. Your Carbon Footprint and Setting Boundaries

The first step in preparing a GHG emissions inventory is to determine the inventory boundaries (that is, what sources are included and excluded from the inventory). The 'carbon footprint' concept is helpful when considering appropriate boundaries for your inventory.

Carbon Footprint

The term ecological footprint was first coined in 1992 by William Rees, a Canadian ecologist and professor at the University of British Columbia. Derivatives of this term that focus on carbon and climate change include: carbon footprint, climate footprint and GHG emissions footprint. Though commonly used, these terms are poorly defined. Though these terms and their corresponding methods vary, standard tools for measuring footprint are being developed and applied in various industries, including the primary metals sector.

The GHG Protocol uses the term emissions footprint to convey the idea that GHG inventories should extend to parts of the value chain that may normally be considered outside corporate boundaries and beyond traditional GHG inventories. Leading companies are expanding the boundaries of their emissions footprint to recognize that their activities influence the GHG emissions both upstream and downstream of their operations. This wider lens lets companies consider a broader range of potential actions affecting their overall footprint, including partnerships or active engagement across the value chain.

Carbon footprints are often examined and estimated using lifecycle studies based on a product cycle and/or value chain approach. Lifecycle studies are conducted for a variety of reasons, including the improvement of the production process or entire lifecycle of a product, selecting the preferred recovery/waste options, or comparing alternative products.

These approaches are useful for understanding the full range of business activities that affect energy use and produce GHGs, and for setting the boundaries of the business entity and activities being analyzed, monitored and reported on. Since carbon emissions and impacts do not discriminate between corporate, regional, or national boundaries, the carbon footprint concept is important in developing comprehensive and innovative strategies to address climate change.

Boundaries

The first step in preparing an inventory is to define boundaries for the purpose of accounting and reporting GHG emissions. Two types of boundaries are defined: organizational boundaries and operational boundaries. Together, these two sets of boundaries constitute a company's GHG inventory boundary.

Organizational Boundaries

Business operations vary in their legal and organizational structures. Organizational boundaries are set first. In setting organizational boundaries, the company should select an approach for consolidating energy use information and GHG emissions and consistently apply this approach to define those business units and operations that constitute the company for this purpose. Where an operation is shared between two parties (such as a joint venture), the two parties are encouraged to discuss which party will complete the assessment, and whether it should be undertaken jointly or divided so that the results reflect the appropriate activities of each company.

Examples for setting organizational boundaries include: the **equity share** approach and the **control approach**. Under the equity share approach, a company accounts for GHG emissions from operations according to its share of equity in the operation. Under the control approach, a company accounts for all of the GHG emissions from operations that it controls, regardless of its level of financial interest. Clearly, if a company wholly owns its operations, both approaches will result in the same organizational boundary.

Defining organizational boundaries consistently between companies becomes important when consolidating GHG emissions as part of an industry-wide, regional, or national inventory. This also helps avoid double-accounting between companies.

Operational Boundaries

Once the organizational boundaries are set, a company will decide on its operational boundaries. Operational boundaries define the scope of direct and indirect emissions that fall within the company's organizational boundary. Direct emissions (*Scope 1* emissions) are from sources that the company owns or controls, such as mining equipment and heating plants. Indirect emissions (*Scope 2* emissions) are the result of company activities, such as electricity consumption for lighting and machinery, but occur at sources not controlled or owned by the company, such as a power plant controlled by the provincial utility. *Scope 3* emissions are those resulting from other indirect emissions, such as those associated with fuel extraction or the production of purchased goods.

Scope 1: Direct GHG Emissions

- Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, and other sources, as well as emissions from chemical production in owned or controlled process equipment
- Direct CO_2 emissions from the combustion of biomass shall not be included in Scope 1 but reported separately
- GHG emissions not covered by the Kyoto Protocol, e.g. CFCs, NOx, etc. shall not be included in Scope 1 but may be reported separately

Scope 2: Electricity Indirect GHG Emissions

- Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company
- Scope 2 emissions physically occur at the facility where electricity is generated

Scope 3: Other Indirect GHG Emissions

- Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions
- Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company
- Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services

Source: World Resources Institute and World Business Council for Sustainable Development, 'Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard – Revised Edition'

Operational boundaries should reflect a company's business goals and its understanding of the risks related to GHG emissions that exist along the value chain. Effective and innovative GHG management involves setting operational boundaries that include Scope 2 and Scope 3 emissions. In some cases, addressing indirect emissions may in fact be more cost effective than Scope 1 reductions. Exploring the full range of emissions allows companies to identify the reduction options that achieve maximize GHG reduction at the minimum cost with the greatest return on investment.

6.2. Identify GHG Emissions Sources

The first step in identifying and quantifying Scope 1 GHG emissions is to categorize sources within the agreed organizational and operational boundaries. The following are examples of categories:

- Stationary combustion
- Stationary combustion – cogeneration
- Mobile mining equipment
- Other mobile emissions

- Industrial process emissions
- Fugitive emissions
- Reagents
- Venting
- Flaring
- Electricity purchased
- Self-generated electricity (non fossil fuel)

Table 9 provides an overview of common direct and indirect GHG emissions sources for selected mining subsectors.

Table 9 - Common Sources of Direct and Indirect GHG Emissions in Selected Mining Subsectors

Sector	Scope 1 Emission Sources	Scope 2 Emission Sources	Scope 3 Emission Sources
Coal Mining	• Stationary combustion (methane flaring and use, use of explosives, mine fires) • Mobile combustion (mining equipment, transportation of coal) • Fugitive emissions (CH4 emissions from coal mines and coal piles)	• Stationary combustion (consumption of purchased electricity, heat and/or steam)	• Stationary combustion (product use as fuel) • Mobile combustion (transportation of coal/waste, employee business travel, employee commuting) • Process emissions (gasification)
Underground Mines/ Concentrators	• Stationary combustion (mine air heating, surface building heating, boilers, diesel generation of electricity, use of explosives) • Mobile combustion (ore haulers)	• Stationary combustion (consumption of purchased electricity)	• Mobile combustion (transportation services, business travel, employee commuting)
Smelters/ Refineries	• Stationary combustion (Building heating, boilers,) • Process emissions (coke, natural gas, Light Fuel Oil) • Mobile combustion (on-site transportation)	• Stationary combustion (consumption of purchased electricity)	• Stationary combustion (mining equipment, production of purchased materials) • Mobile combustion (transportation of raw materials/ products/ waste and intermediate products, recycle materials) • Mobile combustion (transportation services, business travel, employee commuting)

Sector	Scope 1 Emission Sources	Scope 2 Emission Sources	Scope 3 Emission Sources
Open Pit Mines/ Concentrators	• Stationary combustion (diesel generation of electricity, surface building heating, boilers, use of explosives) • Mobile combustion (ore haulers)	• Stationary combustion (consumption of purchased electricity)	• Mobile combustion (transportation services, business travel, employee commuting)

For activities in each of the emission categories identified above, companies should identify Scope 1 emissions and Scope 2 emissions. Some companies may also take the optional step of identifying Scope 3 emissions by examining other indirect emissions from its upstream and downstream activities as well as emissions associated with outsourced/contract services not included in scope 1 or Scope 2.

6.3. Collect Activity Data and Choose Emission Factors

The most common approach for calculating GHG emissions is to apply emissions factors (EFs). These factors are used to convert a unit of process activity data (e.g. tonnes of fuel consumed or tonnes of product produced) into an estimate of the resulting GHG emissions. This includes collecting activity data for scope 1, 2, and 3 emission sources and selecting the most appropriate emissions factors for each source.

Data pitfalls to avoid:

- Be sure to avoid discrepancies between volume purchased and volume used
- Be sure to use cost data to calculate volume or mass
- Be sure to differentiate between different uses of the same fuels
- Be sure to use current emission factors and global warming potentials (GWPs)

For most medium-sized companies and for many larger companies, scope 1 GHG emissions will be calculated based on the purchased quantities of commercial fuels (such as natural gas and diesel) using published emission factors. Scope 2 GHG emissions will primarily be calculated from metered electricity consumption and supplier-specific, local grid, or other published emissions factors. Scope 3 GHG emissions will primarily be calculated from activity data such as fuel use and published or third-party emission factors.

Typical information sources that would support this activity include:

- Fuel bills (although data should be based on fuel consumed, not purchased)
- Utility invoices
- Monthly operational energy and production reports

6.4. Completing the MAC GHG Inventory Template

MAC has developed an *Energy Use and Greenhouse Gas Inventory Worksheet* for member companies to use to document and quantify their GHG emissions. A representation of this worksheet is provided in **Appendix C** of this guidance document. The functional Excel version of the worksheet is sent to member companies each year.

The MAC reporting form has been aligned with the Government of Canada's Section 71 reporting form and is organized into the following categories:

- Stationary combustion
- Stationary combustion – cogeneration
- Mobile mining equipment
- Other mobile emissions
- Industrial process emissions
- Fugitive emissions
- Reagents
- Venting
- Flaring
- Electricity purchased
- Self-generated electricity (non-fossil fuel)

The worksheet is for Scope 1 and Scope 2 emissions only.

One worksheet is to be completed for each facility, providing annual emissions for the previous calendar year. MAC sends out a call letter requesting companies to voluntarily report this information each year in early winter. Each facility's data is published on the MAC website, which can be used to satisfy the protocol's requirement for public reporting.

Member companies can complete this worksheet in one of two ways:

- **Option 1: Using this worksheet to prepare your facility's inventory**

Your facility can use the worksheet to compile and calculate its energy use data and determine its GHG emissions. In this instance, the facility would complete all cells in the worksheet (Form A). Recognized emissions factors that reflect a range of fuels and regional conditions are embedded in the worksheet and do not need to be entered by the user. The emissions factors are obtained from Environment Canada and are updated every year. The formulae embedded in the worksheet will automatically calculate the GHG emissions associated with each type of fuel consumption or process activity.

In cases where facilities have process or equipment-specific emissions factors, these can be entered in the indicated columns of the worksheet to override the standard emissions factors. This change should be recorded in the notes section. Companies should use the most accurate calculation approach available to them that is appropriate for their reporting context, while maintaining consistent approaches for similar processes and sources between facilities. Detailed completion instructions are provided within the worksheet.

- **Option 2: Completing the summary portion of the worksheet from your existing inventory**

Facilities that have their own energy and GHG emissions database can simply complete the summary portion presented in Form B of the worksheet. Care should be taken when transcribing the data to ensure that the categories provided in the MAC worksheet coincide with the categories used within your facility’s inventory.

6.5. Documentation and Quality Control

In addition to the use of standard worksheets and electronic data collection, several simple quality control steps can be taken to ensure that inventories are correctly reported to MAC. These steps include:

- Comparing your current inventory to previous years' data to catch order of magnitude errors or other anomalies
- Where inventories are developed using company-specific forms or tools, check consistency between these reports and data provided in the MAC worksheet, and note any discrepancies on the notes section in the MAC worksheet
- Ensure that the inventory and related procedures are kept in a logical location in the company's electronic and/or paper filing system and integrated into reporting systems to ensure that knowledge and data to maintain the inventory is known within the organization and across relevant personnel
- Maintain documentation to provide background information related to the development and use of process or facility-specific emission factors

The GHG Protocol provides additional guidance on developing an inventory quality management system (see: www.ghgprotocol.org for more information).

Companies are encouraged to identify the current and potential use of their GHG inventory and to manage documentation and quality control accordingly. GHG inventories and the data and documentation that support them may be required for a range of purposes, including:

- Internal reporting to management
- Internal reporting to the Board
- Regulatory reporting
- Industry association reporting (e.g. MAC's annual *TSM Progress Report*)
- Public reporting (e.g. within an annual report or corporate sustainability report) and
- Other communications with communities of interest

Each of these purposes will have its own requirements regarding format, accuracy, and verification of the GHG inventory and the data collection and management process. Companies should ensure that data collection and management processes meet the requirements of the most stringent audience.

Verifiable Data

Performance Level AA of all indicators in the TSM protocol requires internal or external verification of energy use/GHG management systems, reporting systems, or performance. In preparing for TSM verification or other verifications (e.g. by regulatory agencies or corporate head office), it will be important to demonstrate that:

- Management and reporting systems are well-organized, documented, understood by those involved, and consistently implemented; and
- Performance data are accurate, complete, and replicable.

Be sure to maintain detailed and well-organized records and procedures related to the preparation of the energy use and GHG emissions inventory to facilitate the verification process.

The verification requirements of Level AA of the energy and GHG emissions management protocol differ from TSM external verification, which is a validation of self-assessed TSM results. To achieve high levels of performance within the energy use and GHG emissions management protocol, a facility must conduct an independent assessment of its management system, reporting system and performance targets.

7. Energy and GHG Emissions Management

By applying energy management principles and best practices, a mining facility can reduce energy consumption and demand, reducing the total spent on energy supply. Over 95% of the GHG emissions generated directly by the mining industry are a result of fossil fuel use. Therefore, controlling energy use will result in GHG emissions reduction, which for some companies can reduce the cost of compliance with climate change regulations and bottom line energy costs.

However, reducing energy and compliance costs is only one positive economic outcome of controlling energy use. By controlling energy along with other production process parameters, facilities can:

- Reduce the need for equipment repairs resulting from excessive energy demand (e.g. fan motor damage resulting from blocked inlet filters), which reduces maintenance costs and allows for higher equipment utilization. This can mean higher production rates.
- Operate production processes more efficiently, resulting in more cost-effective production and potentially increased output. In the case where the production process has extra capacity, any saved energy can be immediately turned into more units for the marketplace. The control of energy has become an operating tool to improve profit margins.

This section provides a framework to identify and implement measures to reduce energy costs and associated GHG emissions.

7.1. How to Reduce Energy Costs and GHG Emissions

It is important to quantify and sustain improvements to energy performance to:

- Build a business case and track record to support and further improvements.
- Take advantage of incentives for reductions, such as energy efficiency programs provided by governments, utilities or other organizations. Examples of such incentives could include the use of offsets.

As explained in Part A – Management Guidance – the TSM Energy/GHG Indicators stimulate the integration of energy as a production process input into operations management systems to create an environment that sustains improvements in the control of energy use and reductions of GHG emissions.

Typically, reductions in energy use per unit of product occur as a result of:

- Minimized variability in energy use during a production cycle
- Improved facility operation and maintenance
- Facility infra-structure/production process technology improvements

Figure 4 shows, conceptually, how each of these measures can contribute to energy use reduction over time.

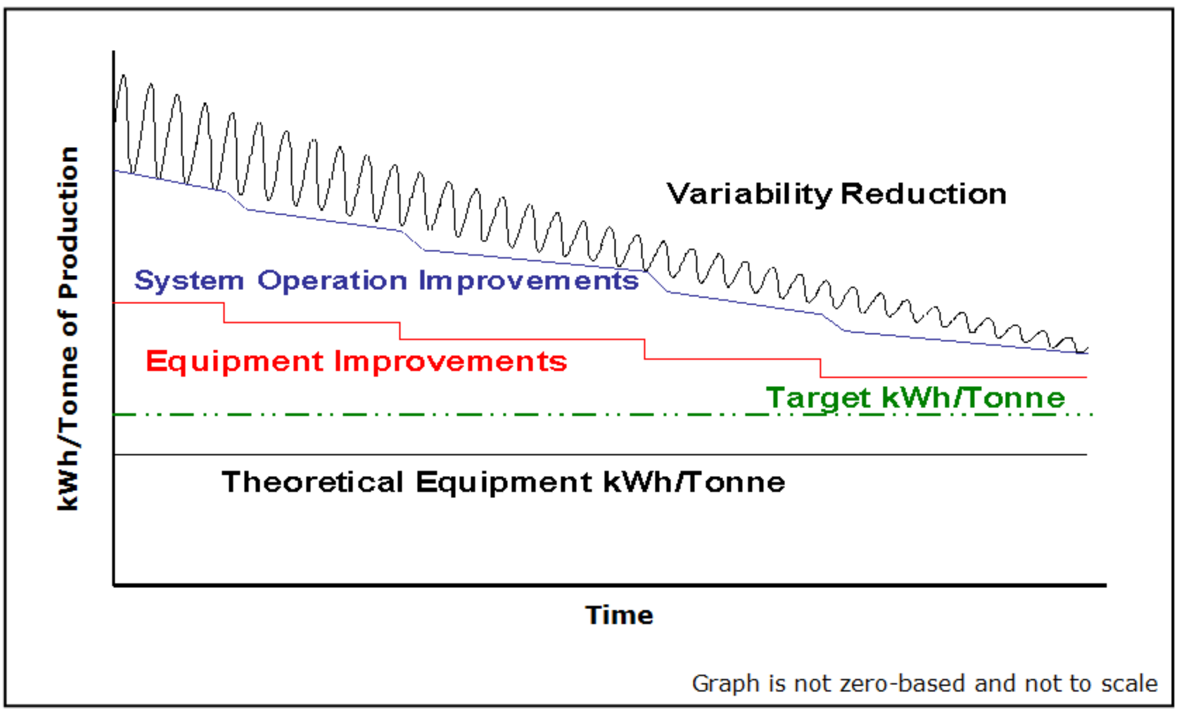


Figure 4 - Reducing Energy Use per Unit of Production

Source: TdSDixon Inc., http://www.knowenergy.com

Decreasing the variability of energy use and improving operating and maintenance practices can reduce energy costs by 5% to 10% and in most cases do not require a capital expenditure. On the other hand, significant technology improvements are made up of production process technology modifications and major equipment upgrades. Both must satisfy the requirements of the in-house capital approval process. Energy efficiency incentive programs are available to industry at both the federal and provincial levels that may provide sources of additional funding for energy projects. **Appendix J** provides information on the types of incentive programs available and where to find more information.

To facilitate the identification of potential reductions in energy use and GHG emissions, this section introduces the widely-used energy management action process, followed by a table of possible technological solutions.

Energy management action process

The action process for minimizing energy cost, optimizing energy use and minimizing GHG emissions consists of the following five steps:

1. Understand your energy costs
2. Understand how energy is used
3. Eliminate energy waste
4. Use energy efficiently
5. Improve system and process technologies

The energy management principles used in this process are the basis for NRCan's *Dollars to $ense* workshop series, accessible through the NRCAN website at http://www.nrcan.gc.ca

1. Understand your energy costs

Energy costs are a function of five elements: consumption, demand, time of use (in the case of electricity), commodity market volatility, and the cost of carbon associated with the fuel.

a) **Consumption** – Consumption is defined as ***how much*** energy is used in total and is measured in kilowatt-hours (electricity), gigajoules (natural gas), litres (petroleum products), or tonnes (coal/coke and biofuels). Consumption results in a volume payment.

b) **Demand** – Demand is defined as ***how fast*** energy is used in a specific period and is measured in kilowatts (electricity), peak gigajoules (natural gas), or peak delivered volumes of liquid and solid fuels. The demand cost is determined by the transportation capacity required to match the period of peak use. For example, in the case of electricity the demand level (kilowatts) is typically averaged over 15 minute periods by the supplying utility and a fixed cost per kilowatt is applied to the maximum average level per 15 minute interval in the month and is added to the transmission (wires) portion of your bill.

c) **Time-of-Use** – In certain regions of Canada (e.g. Ontario and Alberta), the period of electricity consumption and peak demand during the day determines its cost because of the variable cost of electricity generation.

d) **Commodity Market Volatility** – When energy is purchased in a commodities market, the volatility of the market price has a bearing on what is paid for energy supply.

e) **Cost of Carbon** – With emerging GHG regulations, both at the federal and provincial level, the actual and impending cost of carbon associated with the energy source will become an additional expense that must be considered.

2. Understand how your energy is used

The purpose of this step is to create an accurate picture of all aspects of energy use within a facility. It is the critical analysis phase that will provide evidence to support actions taken in each of the other four action process steps.

Understanding how energy is used includes:

- Examining energy demand profiles at the facility level and then at the production process level;
- Inventorying energy loads (equipment and systems) related to the facility infrastructure and production processes; and
- Linking energy demand/consumption with production schedule hours and time-of-use energy prices.

This step should result in the development of performance models that relate and synchronize energy use to drivers (e.g. production units, temperature), and enable the creation of facility and production process energy use baselines and ongoing performance trends.

3. Eliminate energy waste

Taking direct actions to reduce energy consumption/demand and GHG emissions begin with this step. Eliminating energy waste involves matching real energy needs. This is done in the following ways:

- Matching infrastructure system operating times with workforce and production schedules;
- Matching production process equipment operating time with production schedules;
- Matching the sizing of infrastructure and production process equipment to the work required;
- Matching production schedules with time-of-use electricity rates
- Turning down energy demand to match the real requirement (e.g. heating/cooling); and
- Automating systems and equipment so that the variability in their energy demand is minimized.

4. Use energy efficiently

The purpose of this step is to eliminate energy losses in all equipment and systems by carrying out the following actions:

- Ensure operators use equipment and systems in an energy efficient manner;
- Ensure effective maintenance is carried out;
- Insulate pipes and ducts;
- Improve power factor;
- Install energy efficient equipment;
- Implement technical energy audit recommendations; and
- Carryout energy balance or pinch analysis.

5. Improve system and production process technology

This step can be considered an extension of steps 3 and 4 because the end result is the elimination of both energy waste and losses attributed to antiquated equipment or systems. It involves conducting more extensive technical audits; reviewing advances in system and equipment technologies and benchmarking evolving production process technologies. Cost/benefit analyses can assit in determining the feasibility of application. Existing production processes can often be rationalized so that production capacity can be more efficiently utilized.

Appendix E provides a more detailed checklist of actions that can be taken to address each of the five steps of the *action process*.

Technical Solutions for Energy Consumption And GHG Emissions Reductions

Since many different types of equipment use energy, one of the simplest ways to improve energy efficiency is to ensure that only the most efficient equipment is installed. In other words, energy should be a key factor in deciding which equipment to use. Companies should make it a priority to adopt the best available technology that is readily available and competitive in the marketplace. This equipment includes lights, electric motors, building shells, vehicles, heaters, boilers, compressors and pumps, conveyers, transformers, and ventilation equipment.

A number of steps can be taken to help ensure equipment is used efficiently, including: employee education and training, energy audits, improved maintenance programs, and regular monitoring and reporting of energy use.

Appendix F provides a list of some of the broad technical solutions that can be considered to enhance a facility's capability to reduce energy consumption and GHG emissions. The cost of implementing a particular solution is situation-specific and needs to be estimated based on detailed engineering or analysis. After this analysis, each solution can be rated (low, medium, high) in terms of its potential impact on energy savings for different aspects of a mining company's operation and then be used to inform improvement plans. In addition, **Appendix G** provides a list of energy efficiency/energy management websites where theoretical reference material, technical information, case studies and software tools can be found.

Energy Efficient Design – New Buildings

Although it is beyond the scope of this guide to address the application of energy efficient design to new projects, it is important to note some key principles and approaches involved in doing so. Key principles include:

- Using the most advanced and energy efficient equipment, systems, and production process technology, as well as control automation, and computerization.
- Benchmarking new technologies is critical to a successful design to ensure that they have been applied successfully.
- Building on internal experience while brainstorming on design concepts.
- Applying the first four steps of the *action process* to the detailed design and commissioning phases in order to ensure that energy efficient and cost effective operation is in place.

Additionally, standards such as the LEED™ standard (www.cagbc.org/leed) provide guidelines for the construction of energy efficient buildings, and tools such as RETScreen (www.retscreen.net) can be used to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of renewable-energy and energy-efficient technologies (RETs).

Energy Supply Choices

Many mining operations are in remote locations and their energy choices have been limited to one or two resources. Traditionally in the case of electricity, for example, companies were either forced to use grid power provided by a local electric utility, generate their own power onsite for off-grid applications using diesel fuel or, in some cases, hydroelectricity. In recent years, technology advancements have begun to increase the choices of electricity production modes.

The opportunities for fuel switching that exist today involve electricity, natural gas and renewable energy sources. Remote northern mine sites that depend on diesel powered electricity generation are candidates for a conversion to electricity from the regional grid if the grid is expanded to service the mine site.

In one case, where expanding the electricity grid is not possible, the mining operation is investigating whether a nearby natural gas field can be tapped in order to supply power with natural gas fired generation.

Renewable Energy

Practical applications of renewable energy in the Canadian mining sector are currently limited, but technology in this area continues to develop rapidly. Renewable energy involves generating electricity through means other than burning fossil fuels. These alternative energy sources have a greatly reduced carbon footprint, and can be an important component of a company's strategy to reduce GHG emissions. As described above, RETScreen (www.retscreen.net) can be used to evaluate the costs and benefits for various types of renewable-energy technologies.

The Canadian mining industry has been evaluating a number of renewable sources of energy over the last decade, including wind, geothermal, and solar power. Some companies have several decades of experience successfully implementing water-powered electricity generation.

Appendix A – TSM Assessment Protocol – A Tool for Assessing Energy and GHG Emissions Management Performance

TSM Assessment Protocol

A Tool for Assessing Energy Use and Greenhouse Gas Emissions Management Performance

Introduction

Launched in 2004, Towards Sustainable Mining (TSM) is an initiative of The Mining Association of Canada designed to enhance the industry's reputation by improving its performance. MAC members subscribe to TSM guiding principles, a set of commitments that addresses all areas of our industry's performance.

These guiding principles are backed by specific performance indicators, which member companies began reporting against in 2004. These indicators are designed to identify the industry's current performance in key performance areas, and point to actions that could be taken to improve it. Areas for which performance indicators have been developed include tailings management, energy use and greenhouse gas emissions management, Aboriginal and community outreach, crisis management planning, biodiversity conservation management and safety and health.

This document provides a tool to assist companies in the assessment of the standard of energy use and greenhouse gas emissions management currently being implemented by their facilities, in conformance with the TSM energy use and greenhouse gas emissions management performance indicators. It enables key performance indicators to be segregated and performance improvements for each indicator tracked year to year. The use of this protocol also enhances the consistency of assessments conducted across companies. In addition, this tool has been designed to enable external verification of company performance, consistent with the TSM verification system and the initiative's commitment to transparency and accountability.

In 2009 the Mining Association of Canada endorsed the International Council on Mining and Metals' (ICMM) policy on climate change, recognizing that comprehensive and sustained global action is required to reduce the scale of human-induced climate change and to adapt to its impact. The energy use and greenhouse gas emissions management protocol is an important tool to assist mining companies to demonstrate that they are implementing policy commitments such as those in ICMM's policy on climate change. Through the development of comprehensive management systems, members of the Mining Association of Canada are establishing systems to monitor and reduce their energy consumption and greenhouse gas emissions.

Assessing Energy Use and GHG Emissions Management Implementation

The purpose of the assessment protocol is to provide guidance to the member companies in completing their evaluation of energy use and GHG emissions management against TSM indicators. The assessment protocol sets out the general expectations of MAC for energy use and greenhouse gas emissions management by its member companies in support of the TSM initiative. Assessment should also:

- Assist member companies to develop capacity to monitor and improve performance; and
- Provide a basis for company assurance

What are energy use and greenhouse gas (GHG) emissions?

Energy use refers to the consumption of fossil fuels, electric power, solar energy, steam etc.

Greenhouse gases (GHGs) generally refer to the following:

- *Carbon Dioxide (CO_2)*
- *Methane (CH_4)*
- *Nitrous Oxide (N_2O)*
- *Hydrofluorocarbons (HFCs)*
- *Perfluorocarbons (PFCs)*
- *Sulphur Hexafluoride (SF_6)*

As with any assessment of a management system, professional judgment is required in assessing the degree of implementation of a system indicator and the quality of management processes and intervention. Application of this protocol will therefore require a level of expertise in auditing and systems assessment and some knowledge of and experience in the practice of energy use and greenhouse gas emissions management. This assessment protocol provides an indicator of the level of implementation of energy use and greenhouse gas emissions management systems in support of the TSM initiative and is not, of itself, a guarantee of the effectiveness of energy use and greenhouse gas emissions management activities.

Performance Indicators

Three performance indicators have been established.

1. Energy use and greenhouse gas emissions management systems
2. Energy use and greenhouse gas emissions reporting systems
3. Energy and greenhouse gas emissions performance targets

Five levels of performance are identified for each indicator. Criteria further define performance at each level, as illustrated below.

Energy Use and Greenhouse Gas Emissions Management Assessment Criteria	
Level	**Criteria**
C	No systems in place; activities tend to be reactive; procedures may exist but they are not integrated into policies and management systems
B	Basic systems/processes developed; comprehensive system planned and under development
A	Comprehensive systems/processes are developed and implemented
AA	Integration into management decisions and business functions
AAA	Excellence and leadership

Specific criteria for each performance indicator are provided in subsequent tables to enable the assessor to determine an appropriate level of performance (Levels C-AAA).

The assessor is required to select the level that most clearly represents the status of the operation. Only one level can be selected for each indicator, and it can be chosen only if all criteria for that level and all preceding levels have been met.

Where a performance element or indicator is not relevant, then an assessment of N/A should be assigned.

The goal of each MAC member is to achieve, at a minimum, a consistent "A" ranking on the TSM Energy Use and Greenhouse Gas Emissions Management assessment and to work towards continuous improvement.

Facility-level Assessments

Respondents are expected to provide facility-level assessments for each specified indicator.

By “facility-level assessments”, it is intended that companies will complete an assessment and report on energy use and greenhouse gas emissions for each distinct operating unit, or facility, of the company. It is recognized that companies may categorize their facilities in different ways.

Facility-level reporting has been found to be the most reliable, informative and useful approach for performance evaluation. The TSM on-line performance reporting database has been designed to facilitate assessment on a facility by facility basis.

Assessment Process

It is recommended that the assessment be completed using a process of interview, discussion and document review, including representative site management, operations and environmental personnel. A level of expertise in auditing and systems assessment and some knowledge of and experience in the practice of energy use management, energy conservation, greenhouse gas emissions calculations, etc., is required.

Only one level can be selected for each indicator, and it can be chosen only if all criteria for that level and all preceding levels have been met. No partial levels of performance (e.g. B+) can be reported. Where a performance element or indicator is not relevant, then an assessment of N/A should be assigned.

Where an operation is shared between two parties, e.g. a joint venture, the two parties are encouraged to discuss amongst themselves who should complete the assessment, whether it should be undertaken jointly or divided so that the results reflect the appropriate activities of each company.

Structure of the Assessment Protocol

For each indicator, the protocol provides:

- A statement of purpose that expresses the spirit and intent of the indicator
- Assessment criteria for each level of performance
- Supporting guidelines to help the assessor to understand the general scope of each indicator and to act as a framework for reviewing documentation and conducting interviews necessary for the assessment of the company’s (or facility’s) performance
- Frequently Asked Questions (FAQs) that provide further information, such as definitions for key terms and answers to common questions that arise.

1. ENERGY USE AND GREENHOUSE GAS EMISSIONS MANAGEMENT SYSTEMS

Purpose:

To confirm that systems are in place to manage energy use and greenhouse gas emissions. This indicator applies to facilities and/or business units for which energy use and GHG emissions are deemed to be material (see FAQs).

Energy Use and Greenhouse Gas Emissions Management Systems **ASSESSMENT CRITERIA**	
Level	Criteria
C	No formal management system in place.
B	Basic energy use and greenhouse gas emissions management system established that includes: • demonstrated senior management commitment to manage energy use and GHG emissions at the facility level • facility-level responsibility for energy use and GHG emissions assigned to department or individual (e.g., Energy Leader) • established processes to determine energy consumption sources and associated GHG emissions on a defined frequency for sources accounting for substantial consumption and/or offering considerable potential for energy performance improvement and with a level of disaggregation by major process activity (e.g., mill, mine, smelter, refinery, etc.) • identification and estimation of significant sources of non-energy GHG emissions • standard quantification and estimation methodologies used to convert energy and GHG emission data into comparable units, including process emissions data • records of facility level data are maintained

Energy Use and Greenhouse Gas Emissions Management Systems **ASSESSMENT CRITERIA (continued)**	
A	Comprehensive energy use and GHG emissions management system established that includes these additional elements: • facility or business unit have identified and annually reviewed what energy and emissions sources are material according to their established criteria • clear accountability for energy use and GHG emissions management assigned to operational managers • energy data is reviewed regularly and integrated into operator actions for energy intensive processes • actions and process controls related to energy use and GHG emissions are included in management systems for material sources • general energy and GHG awareness training is provided to personnel with additional training for key personnel
AA	Energy use and GHG emissions are considered in business planning at the facility and/or business unit level. Energy use and GHG management system has been subject to internal or external verification.
AAA	Energy use and GHG management system is integrated into a broader sustainable business strategy that includes at least 2 of the following: • procurement and supply chain management policies that incorporate energy efficiency and GHG reduction criteria • voluntary corporate investments in research and development, feasibility studies and/or demonstration of technologies and/or new processes that target energy efficiency and reduced GHG emissions. • corporate investments in renewable energy projects and/or energy recovery projects • participation with communities of interest to improve energy efficiency and reduce GHG emissions (e.g., community events, environmental non-government organizations, government energy efficiency programs

2. ENERGY USE AND GREENHOUSE GAS EMISSIONS REPORTING SYSTEMS

Purpose:

To confirm that energy use and GHG emissions tracking and reporting systems are in place for internal use and for public reporting. This indicator applies to all facilities whether energy use and GHG emissions are deemed to be material or not (see FAQs).

Energy Use and Greenhouse Gas Reporting Systems **<u>ASSESSMENT CRITERIA</u>**	
Level	Criteria
C	No energy use or GHG emissions reporting system in place.
B	Basic energy use and GHG emissions reporting system established that includes: • a facility-level reporting system for energy use and GHG emissions • energy use and GHG emissions performance results are reported annually at a facility level to management.
A	Comprehensive energy use and GHG emissions reporting system established that includes: • energy use and GHG emissions performance results are reported regularly at a facility level to management to inform decision making • annual public reporting of energy[5]use and GHG emissions • where offsets are used by the facility or business unit to meet commitments, public reporting includes: • the amount of offsets as a percentage of total emissions generated at the facility and/or at the business unit level, and • the source and nature of the accreditation of offsets
Energy Use and Greenhouse Gas Emissions Reporting Systems	

[5]The combination of energy consumption and mineral production data can significantly compromise a company's position vis-à-vis its competition, particularly in instances where there are relatively few global competitors (e.g. iron ore). This may affect a company's ability to disclose certain types of information on energy use and GHG emissions. Necessary limits on public reporting for competitive reasons should not prevent a facility from satisfying level A criteria. Where information is not disclosed, reporting should include a list of information omitted and a reason for the omission.

ASSESSMENT CRITERIA (continued)	
AA	Energy use and GHG emissions reporting system is internally verified Annual public reporting of performance[1] (against target) Overview of corporate energy and GHG emissions management strategy is publicly available
AAA	Energy use and scope 1 and 2 GHG emissions reporting systems are externally verified. Some scope 3 GHG emissions are included in reporting.

3. ENERGY AND GREENHOUSE GAS EMISSIONS PERFORMANCE TARGETS

Purpose:

To confirm that energy and GHG emissions performance targets have been established at each facility or business unit level[6].

This indicator applies to facilities and/or business units for which energy use and GHG emissions are deemed to be material (see FAQs).

Energy and GHG Emissions Performance Targets **ASSESSMENT CRITERIA**	
Level	**Criteria**
C	No energy or GHG emissions performance targets have been set for the facility and/or business unit.
B	Energy and GHG emissions performance targets have been set for the facility and/or the business unit, and performance strategies have been developed that are consistent with energy policy and/or commitments to improve performance.
A	• Energy and GHG emissions performance targets for the facility and/or business unit are met in the reporting year. • In establishing objectives and targets, the facility or business unit has considered significant energy uses identified in their energy management system as well as its financial, operational and business conditions, legal requirements, technological options, the views of potentially affected parties and opportunities to improve energy performance.
AA	• Facility and/or business unit has met its energy and GHG emissions performance targets for 3 of the past 4 years. • Energy and GHG emissions performance have been internally or externally verified.
Energy and GHG Emissions Performance Targets	

[6] Recognizing that climate change is a global issue and that the geographic location/source of GHG emissions doesn't matter, companies are encouraged to set performance targets that achieve the greatest reductions at the lowest cost, regardless of location.

ASSESSMENT CRITERIA (continued)	
AAA	• Some performance strategies or projects meet an additionality test (See FAQ). 2 of the following: • set ROI threshold to determine criteria for implementing energy efficiency or GHG reduction projects and demonstrate implementation • set continuous improvement targets that demonstrate reductions based on historical trends • investments in new technologies and/or new processes have resulted in meaningful reductions

APPENDIX 1: FREQUENTLY ASKED QUESTIONS

PROTOCOL-SPECIFIC GUIDANCE

1. Can corporate documentation be used to demonstrate facility-level commitment?

Written senior management commitment at the corporate level (e.g. a corporate policy) can be accepted as evidence during a facility-level self-assessment or TSM verification if it is accompanied by evidence that the corporate commitment is being applied and adhered to at the facility level. There must be evidence of a link between the corporate documentation and facility-level practices. If this linkage is established, then the corporate documentation can be accepted as evidence of facility-level commitment.

2. What are standard quantification and estimation methodologies?

Standard quantification and estimation methodologies are conversion factors, process equations or process simulations that have been accepted by the federal/provincial/territorial harmonized reporting process for energy use and GHG emissions.

3. What is a major process activity?

This can be defined as a significant component of the production process that can be easily bounded and whose consumption of energy and GHG emissions can be accurately measured.

4. What is meant by "energy data is reviewed regularly and integrated into operator actions for energy intensive processes"?

The key energy management principle applied in this indicator is that floor level operators are managing energy consumption as a consumable of (or input to) the production process. This means that, energy use for energy intensive process must be metered and controlled by technologies and operators that operate the energy intensive process. Therefore, information about energy use must be available to the operator on a frequency that enables the operator to optimize energy consumption. Examples include maintaining a temperature range and optimizing the speed of a variable speed pump.

5. What is meant by "actions and process controls related to energy use and GHG emissions are included in management systems for material sources"?

Operator actions related to energy use and GHG emissions must be included in the operator's job procedures. In the situation where the GHG emissions are directly related to energy use, then energy related job procedures act as a proxy for GHG control procedures. Examples include procedure to identify and repair compressed air leaks as part of the operation manual for air compressors and energy saving steps as part of the start-up procedures of a large piece of equipment.

Where GHG emissions are a direct result of energy use (e.g. GHG emissions from the consumption of natural gas in a direct fired boiler or emissions from the consumption of diesel by a fleet of mobile mining equipment), then the control of energy use can be used as a proxy for the control of GHG emissions. With the application of the appropriate conversion factors or quantification protocols, controlled energy performance can be expressed as GHG emission performance. In these instances, information on GHG emissions does not need to be present on the operator's control interface, but can be inferred from the energy use information.

6. Can a facility with distinctly different production processes have separate Energy/GHG Emissions Performance targets i.e. one for each production process?

Yes, particularly when a facility uses intensity based targets. It has been pointed out that a single indicator may not be sufficient in the case of an open pit facility that is comprised of the pit and a concentrator, or where smelters are processing an increasing amount of recycled material. It may be necessary to have multiple targets representing a single facility where the dynamics of the production processes are so different that one common target is not adequate representative consumption driver for each production process.

7. If a facility uses multiple targets, does the site have to meet all targets before it achieves a Level A rating?

Yes. The intent of the TSM Indicators is that they reflect the performance of the total facility. Therefore, all targets must be met in order to achieve a Level A rating.

8. In some instances, underground mines are developing new production zones at much greater depth and the energy intensity becomes greater because of the extra energy required for ventilation, pumping, cooling, hoisting and sustaining the infrastructure at depth. What methodology can be used to create a practical target in these cases?

A zero based energy budget can be used to determine the new intensity level as well as the performance indicator and target. The zero based energy budget is established by estimating baseline consumptions for each mining activity (e.g. ventilation, pumping, lighting, hoisting) at depth for a convenient period of time, and then determining the expected total monthly and annual consumptions relative to forecasted production levels. Typically, operations monitor total monthly consumption versus the estimated consumption budget. However, the total estimated monthly consumption can be divided by the forecasted production to determine monthly intensity targets. Actual performance can then be tracked throughout the year versus these target intensities.

9. What dictates whether energy use and/or GHG emissions are material to a facility or business unit?

Energy use and/or GHG emissions are to be considered material for a facility and/or business unit if:

- Exceeds 25kt (GHG) system and target and or uses more than 250,000GJ
- Elects to define energy use and/or GHG emissions as material.

10. What is considered a material fuel source?

For the purpose of this protocol, companies must define the criteria to determine whether a fuel source is material in their management system. One such example of a material threshold for fuel sources is anything above 10% of the total fuel consumption is to be considered material. This 10% threshold would apply to miscellaneous energy use at the mine site, which does not have a direct or indirect impact on its ability to create, preserve or erode economic, environmental and social value for itself and its stakeholders.

If an operation so chooses or fails to define materiality, all fuel sources will be assumed to be deemed material.

11. What is the threshold for significant sources of non-energy GHG emissions?

Facilities or business units must identify and estimate significant sources of non-GHG emissions over 100 tonnes.

12. What constitutes an energy use or GHG emissions performance target?

A facility or business unit may designate one or more of the following types of energy use or GHG emissions performance targets:

Volume target: volume targets define a specified amount carbon dioxide equivalent (CO2 equivalent) or energy consumption that will be consumed or emitted by the facility. Such targets are independent of the amount of product produced by the facility and/or business unit, and are calculated relative to current or historical data.

Intensity targets: intensity targets define a specific amount of CO2 equivalent or energy consumption *per unit of production*, where production for a mine/mill is “head tonnes” and for smelters/refineries is “refined metal or metal in matte”. “Head tonnes” is the term used for tonnes of ore delivered to a concentrator. It is the denominator that is commonly used to determine intensity. Head tonne volume is the most appropriate driver of energy consumption and GHG emission production in production processes and is independent of changing ore grades.

13. What should be considered during the process of selecting targets?

When selecting targets environmental, economic, and social issues should be taken into consideration. Below is a list of some of the things a facility or business unit may want to consider:

- Financial criteria and priorities,
- Alternative energy sources,
- Maintenance and infrastructure needs,
- Operational requirements and constraints,
- Quality and appropriateness of energy resources,
- Environmental impacts,
- Safety and health issues,
- Available human and technical resources,
- Its energy management system including areas of significant use and drivers, and
- Life of mine

Targets should be:

- Ambitious, so as to commit the organization to continual improvement;
- Realistic, so that they can be achieved within specific time limits;
- Specific and measurable.

14. Can offsets be used to meet performance targets?

Yes, performance targets can be met by a combination of on-site reductions and offsets (including performance credits). However, if offsets have been used to meet targets, the percentage and source of offsets used must be clearly documented and the use of offsets should not exceed any regulatory caps on the use that may be in place for a facility or business unit.

15. Do targets have to apply to the entire facility or business unit?

No. Some targets may apply to equipment (e.g. specific piece of equipment), while others may address the energy consumption of departments, training or energy awareness or additional measuring and monitoring.

16. How can a facility or business unit express energy reduction targets?

Energy use and GHG emissions reduction targets can be expressed either as absolute energy savings attributable to a given initiative or through a performance improvement metrics.

17. If a business unit target is achieved by realizing reductions at a single facility do all facilities in that business unit get credit for the reduction?

Yes, if an energy use and GHG emissions management system designates a business unit level target that calls for a defined emission reduction and the specified reduction target for the entire business unit is achieved by reducing emissions at one facility then all facilities listed in that business unit are to receive credit for achieving the target. The climate makes no distinction as to where a tonne of GHGs come from and as such, this protocol encourages the most cost effective reduction, rather than reductions across all facilities. This principle is consistent with the principles underlying carbon pricing policies such as cap-and-trade, in that the intent is to establish a price on carbon that should encourage companies to implement the lowest cost opportunities.

18. How is progress against a multi-year emissions target and energy efficiency plan to be assessed?

A multi-year target is an energy or GHG emissions target that specifies a certain performance over a defined number of years, for example a 20% reduction over a 3 year period. In such a case it is difficult to determine if a facility is meeting expectations toward the target if progress is not linear. The target may make sense for a facility or business unit in a case where they are implementing a multi-year capital plan or infrastructure upgrade that will result in emissions reductions and/or energy savings only when the final plan is complete. In such a case, an action plan outlining the specific steps that will be implemented each year until the plan is complete should be used to assess progress. Such actions may include, but are not limited to, new operating procedures to be implemented, new equipment to be purchased and installed, or new processes to be commissioned. Actions in the plan should be specific and measurable and should clearly contribute to achieving the reduction specified in the multi-year plan. For a facility or business unit to achieve a level A under indicator 3, it must be able to demonstrate that previously declared annual milestones for the current year of a multi-year target have been achieved in the reporting year. Energy efficiency plans must be made on a cycle of no more than 3 years.

19. Can investments in renewable energy that provide benefits of offsets for regulatory compliance fulfill the requirements of corporate investments under indicator 1 Level AA?

Yes.

20. Can a facility or business unit develop a single plan incorporating both energy and GHG emissions management?

Yes, the vast majority of GHG emissions produced as a result of mining are associated with burning fossil fuels and consuming energy. Based on this fact, many facilities will manage GHG emissions by managing their energy consumption first and as such, it is very appropriate for facilities or business units to develop a single plan to address both energy and GHG emissions. It is also appropriate for facilities or business units to establish a single reporting mechanism for both energy and GHG emissions as well as reduction targets focused only on energy reductions where those reductions lead directly to GHG emissions reductions. Regardless of whether a company creates a single plan or separate plan, non-combustion emissions should be included, where appropriate.

21. What are Scope 1, Scope 2 and Scope 3 emissions?

Scope 1 emissions: the total global direct emissions from sources owned or controlled by the reporting facility or business unity:

- Stationary combustion;
- Mobile combustion;
- Process emissions; and
- Fugitive emissions.

Scope 2 emissions: indirect GHG emissions that the facility or business unit has caused through its consumption of energy in the form of electricity, heat, cooling or steam.

Scope 3 emissions: indirect emissions that arise as a consequence of a facility or business unit's activities from sources that are owned or controlled by others. (Carbon Disclosure Project)

VERIFICATION

22. What is verification?

Verification is the systematic, independent and documented process for the evaluation of an energy or GHG assertion (for example, related to management systems, reporting systems, or performance) against agreed verification criteria. (Adapted from ISO 14064: 2006.)

DEFINITION OF KEY TERMS

23. What does "formal" mean?

The term "formal" is used frequently in the assessment, and usually in conjunction with "system" or "process". Formalized processes or activities are usually given status through clear and precise requirements, usually documented as a written procedure. This means that the business can clearly and easily demonstrate that the process or system is in place. It would also typically require documented processes or an 'audit trail'.

24. What is a "system"?

A system, or "management system" represents processes that collectively provide a systematic framework for ensuring that tasks are performed correctly, consistently and effectively to achieve a specified outcome and to drive continual improvement in performance. A systems approach to management requires an assessment of what needs to be done, planning to achieve the objective, implementation of the plan and review of performance in meeting the set objective. A management system also considers necessary personnel, resources and documentation requirements. Other definitions associated with systems are:

Policy: The formal expression of management's commitment to a particular issue area that presents the stance of the company to interested external parties.

Practice: Informal, undocumented approaches to carrying out a task.

Procedure: A formalized, documented description of how a task is to be carried out.

25. What does "accountability" mean?

Accountability: The energy use and GHG emissions management system must identify the party who is ultimately answerable for energy use and GHG emissions management performance and the development and implementation of the energy use and GHG emissions management system at the facility. This accountability cannot be delegated. Resources are available to the accountable party to ensure proper systems (training, equipment, communications, etc) are in place to effectively meet their energy use and GHG emissions management goals.

26. What does "responsibility" mean?

Responsibility: Within the energy use and GHG emissions management system, specific energy use and GHG emissions management related requirements and tasks are identified and assigned to specific positions within the facility. It is important that responsibilities are clearly communicated so that each position understands what is expected of them.

27. What does "business unit" mean?

Business Unit: The energy use and GHG emissions management system allows a company to set targets at both facility and business unit levels. For the purpose of this protocol, a business unit is defined as a logical element or segment of a company representing a specific business function or a definite place on the organizational chart, under the domain of a manager, or a functional geographic area. This may include but is not limited to a series of mines located in a defined physical area, a series of mines producing the specific product, or the combination of a mine and smelter. For the purpose of this protocol a business unit is defined by the company but requires a documented rational for why two or more facilities has been grouped together in the business unit.

28. What does “offset” mean?

Offset: a unit of carbon dioxide-equivalent (CO2e) that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere, in this case at a mine or smelter. Offsets work in a financial system where, instead of reducing its own carbon use, a company can comply with emissions caps by purchasing an offset from an independent organization that completed and certified an emissions reduction, avoidance or sequestration project. For the purpose of TSM an offset must be independently verified by an accredited body, fungible, and passed a credible additionality test.

29. What does “defined frequency” mean?

Defined frequency: As defined for each material fuel source in the energy and GHG management system.

30. What does “established criteria” mean?

Established criteria: As defined in the energy and GHG management system.

31. What does “additionality” mean?

The Emission Offset Regulation defines additionality in terms of the baseline emissions against which a project's emission reductions are estimated:

"…the baseline scenario will result in a conservative estimate of the greenhouse gas reduction to be achieved by the project considering… existing or proposed regulatory requirements, provincial or federal incentives…including tax incentives or grants…the financial implications…of…action referred to in the baseline…any other factor…to justify the claim that the baseline scenario is likely to occur if the project is not carried out" (*Guide to Determining Project Additionality*, Pacific Carbon Trust)

APPENDIX 2: TSM SELF ASSESSMENT CHECKLIST

Energy Use and Greenhouse Gas Emissions Management

Facility name:		**Company name:**	
Assessed by:		**Date submitted:**	

Supporting Documentation / Evidence:	
Name of Document	Location

Interviewees:			
Name	Position	Name	Position

	Question	Y	N	NA	Description & Evidence
INDICATOR 1: ENERGY USE AND GREENHOUSE GAS EMISSIONS MANAGEMENT SYSTEMS					
Indicator 1 Level B	Has a basic energy use management system established that includes: • demonstrated senior management commitment to manage energy use and GHG emissions at the facility level?				
	• facility-level responsibility for energy use and GHG emissions assigned to department or individual (e.g.., Energy Leader)?				
	• established processes to determine energy consumption sources and associated GHG emissions on a defined frequency for sources accounting for substantial consumption and/or offering considerable potential for energy performance improvement and with a level of disaggregation by major process activity (e.g., mill, mine, smelter, refinery, etc.)?				
	• identification and estimation of significant sources of non-energy GHG emissions?				
	• standard quantification and estimation methodologies used to convert energy and GHG emission data into comparable units, including process emissions data?				
	• records of facility level data are maintained?				

<table>
<tr><th></th><th>Question</th><th>Y</th><th>N</th><th>NA</th><th>Description & Evidence</th></tr>
<tr><td></td><td colspan="5">If you have answered “Yes” to all of the Level B questions, continue to the Level A questions. If you have not answered “Yes” to all of the Level B questions, assess the facility as a Level C.</td></tr>
<tr><td rowspan="6">Indicator 1 Level A</td><td>Has a comprehensive energy use and GHG emissions management system established that includes these additional elements
facility or business unit have identified and annually reviewed what energy and emissions sources are material according to their established criteria?</td><td></td><td></td><td></td><td></td></tr>
<tr><td>clear accountability for energy use and GHG emissions management assigned to operational managers?</td><td></td><td></td><td></td><td></td></tr>
<tr><td>energy data is reviewed regularly and integrated into operator actions for energy intensive processes?</td><td></td><td></td><td></td><td></td></tr>
<tr><td>actions and process controls related to energy use and GHG emissions are included in management systems for material sources?</td><td></td><td></td><td></td><td></td></tr>
<tr><td>general energy and GHG awareness training is provided to personnel with additional training for key personnel?</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">If you have answered “Yes” to all of the Level A questions, continue to the Level AA questions. If you have not answered “Yes” to all of the Level A questions, assess the facility as a Level B.</td></tr>
</table>

	Question	Y	N	NA	Description & Evidence
Indicator 1 Level AA	Can the facility and/or business unit demonstrate that energy use and GHG emissions are considered in business planning?				
	Has the energy use and GHG management system has been subject to internal or external verification?				
	If you have answered "Yes" to all of the Level AA questions, continue to the Level AAA questions. If you have not answered "Yes" to all of the Level AA questions, assess the facility as a Level A.				
Indicator 1 Level AAA	Is the energy use and GHG management system integrated into a broader sustainable business strategy that includes at least 2 of the following: • procurement and supply chain management policies that incorporate energy efficiency and GHG reduction criteria?				
	• voluntary corporate investments in research and development, feasibility studies and/or demonstration of technologies and/or new processes that target energy efficiency and reduced GHG emissions?				
	• corporate investments in renewable energy projects and/or energy recovery projects?				

	Question	Y	N	NA	Description & Evidence
	• participation with communities of interest to improve energy efficiency and reduce GHG emissions (e.g., community events, environmental non-government organizations, government energy efficiency programs?				
	If you have answered "Yes" to all of the Level AAA questions, assess the facility as a Level AAA. If you have not answered "Yes" to all of the Level AAA questions, assess the facility as a Level AA.				
	ASSESSED LEVEL OF PERFORMANCE FOR INDICATOR 1				**Level: _____________**

	Question	Y	N	NA	Description & Evidence
INDICATOR 2: ENERGY USE AND GREENHOUSE GAS EMISSIONS REPORTING SYSTEMS					
Indicator 2 Level B	Has a basic energy use and GHG emissions reporting system established that includes: • a facility-level reporting system for energy use and GHG emissions?				
	• energy use and GHG emissions performance results are reported annually at a facility level to management?				
	If you have answered "Yes" to all of the Level B questions, continue to the Level A questions. If you have not answered "Yes" to all of the Level B questions, assess the facility as a Level C.				

	Question	Y	N	NA	Description & Evidence
Indicator 2 Level A	Has a comprehensive energy use reporting system established that includes: • Energy use and GHG emissions performance results are reported regularly at a facility level to management to inform decision making?				
	• annual public reporting of energy use and GHG emissions?				
	Where offsets are used by the facility or business unit to meet commitments, does public reporting include: • the amount of offsets as a percentage of total emissions generated at the facility and/or at the business unit level, and • the source and nature of the accreditation of offsets?				
	If you have answered “Yes” to all of the Level A questions, continue to the Level AA questions. If you have not answered “Yes” to all of the Level A questions, assess the facility as a Level B.				
Indicator 2 Level AA	• Is the energy use and GHG emissions reporting system internally verified?				
	• Annual public reporting of performance (against target)?				

	Question	Y	N	NA	Description & Evidence
	• Is the overview of corporate energy and GHG emissions management strategy publicly available?				
	If you have answered "Yes" to all of the Level AA questions, continue to the Level AAA questions. If you have not answered "Yes" to all of the Level AA questions, assess the facility as a Level A.				
Indicator 2 Level AAA	• Are the energy use and scope 1 and 2 GHG emissions reporting systems externally verified?				
	• Are some scope 3 GHG emissions included in reporting?				
	If you have answered "Yes" to all of the Level AAA questions, assess the facility as a Level AAA. If you have not answered "Yes" to all of the Level AAA questions, assess the facility as a Level AA.				
	ASSESSED LEVEL OF PERFORMANCE FOR INDICATOR 2				**Level: _____________**

	Question	Y	N	NA	Description & Evidence
INDICATOR 3: ENERGY AND GREENHOUSE GAS EMISSIONS PERFORMANCE TARGETS					
Indicator 3Level B	Have energy and GHG emissions performance targets have been set for the facility and/or the business unit, and performance strategies been developed that are consistent with energy policy and/or commitments to improve performance?				
	If you have answered "Yes" to all of the Level B questions, continue to the Level A questions. If you have not answered "Yes" to all of the Level B questions, assess the facility as a Level C.				
Indicator 3Level A	• Have the energy and GHG emissions performance targets for the facility and/or business unit been met in the reporting year				
	• In establishing objectives and targets, has the facility or business unit considered significant energy uses identified in their energy management system as well as its financial, operational and business conditions, legal requirements, technological options, the views of potentially affected parties and opportunities to improve energy performance?				
	If you have answered "Yes" to all of the Level A questions, continue to the Level AA questions. If you have not answered "Yes" to all of the Level A questions, assess the facility as a Level B.				

	Question	Y	N	NA	Description & Evidence
Indicator 3Level AA	• Has the facility and/or business unit met its energy and GHG emissions performance targets for 3 of the past 4 years?				
	• Have the energy and GHG emissions performance been internally or externally verified?				
	If you have answered “Yes” to all of the Level AA questions, continue to the Level AAA questions. If you have not answered “Yes” to all of the Level AA questions, assess the facility as a Level A.				
Indicator 3Level AAA	• Do some performance strategies or projects meet an additionality test?				
	• 2 of the following: o Has an ROI threshold been set to determine criteria for implementing energy efficiency or GHG reduction projects and demonstrate implementation?				
	o Have continuous improvement targets been set that demonstrate reductions based on historical trends?				

	Question	Y	N	NA	Description & Evidence
	o Have investments in new technologies and/or new processes resulted in meaningful reductions?				
	If you have answered “Yes” to all of the Level AAA questions, assess the facility as a Level AAA. If you have not answered “Yes” to all of the Level AAA questions, assess the facility as a Level AA.				
	ASSESSED LEVEL OF PERFORMANCE **FOR INDICATOR 3**				**Level: _____________**

Appendix B - TSM Energy Use and GHG Emissions Management Checklist

The checklists below provide examples of how the requirements of the protocol can be met. In many cases, the checklist elements are based on actions taken by MAC member companies. The checklist elements shown in italics are additional or secondary means of achieving the requirement. Following the checklist for each protocol requirement is a list of documents that may be used to demonstrate that certain management system elements are in place.

Level B

Demonstrated senior management commitment to manage energy use and GHG emissions at the facility level

Energy Efficiency/GHG emissions improvement is a component of the facility’s sustainable development policy or Environmental Management System	☐

OR

Formal energy/GHG management policy that defines operational accountabilities as well as procurement, production process and project requirements	☐

OR

Energy use and GHG emissions are considered key production parameters in the facility's annual business plan. Have annual and midterm improvement targets and action plans assigned to operations managers	☐

Potential supporting documents:

- Sustainable Development Policy
- Annual Sustainability Report
- EMS energy performance improvement action plans or results reports
- Documented energy management accountabilities for operations management (in Energy Plan or Organizational Chart)
- Annual business plan

Facility-level responsibility for energy use and GHG emissions assigned to department or individual (e.g. Energy Leader)

Developing energy awareness	☐
Analyzing energy consumption	☐
Seeking energy and GHG emissions reduction opportunities	☐
Managing energy cost reduction projects	☐
Implementing energy management business processes within the facility	☐
Managing the installation of energy management technologies	☐
Ensuring compliance with GHG reporting regulations	☐

Potential Documents:

- Documented responsibilities for energy use and GHG emissions management
- Analysis of energy/GHG performance
- Regulated compliance reports

Established processes to determine energy consumption sources and associated GHG emissions on a defined frequency for sources accounting for substantial consumption and/or offering considerable potential for energy performance improvement and with a level of disaggregation by major process activity.

Energy consumption for all material supply sources is monitored at the facility level	☐
Energy consumption for all material supply sources is monitored at the appropriate level for production processes	☐
Annual historical data is archived	☐
Energy data and reports are accessible	☐

Potential Documents:

- Utility invoices

- Operational energy report and production report
- Energy reports

Identification and estimation of significant sources of non-energy GHG emissions

Non-energy GHG emissions for material sources are identified	☐
Non-energy GHG emissions are estimated using established methodology	☐

Potential Documents:

- GHG performance reports

Facility-level data is maintained

A paper archive or computerized database that contains annual historical energy costs and consumptions for all energy sources at each company facility	☐
A paper archive or computerized database that contains annual historical GHG emission data from the conversion of fossil fuel use with approved factors for each company facility	☐
An electronic database of monthly energy use for all sources complete with the automated conversion of fossil fuel data to GHG emissions data for each company/facility	☐

Potential Documents:

- Annual energy and GHG emission compliance reports (e.g. NPRI or Environment Canada)
- Computerized real time energy/GHG emissions reports
- Annual Sustainability and Financial Reports

Level A

Facility or business unit has identified and annually reviewed what energy and emissions sources are material according to its established criteria

A method for determining material energy and emissions sources has been developed	☐
Material energy and emissions sources are reviewed annually	☐
Energy and emissions data is reviewed annually	☐

Potential Documents:

- Energy and GHG emissions materiality procedure
- Energy and GHG emissions analysis

Clear accountability for energy use and GHG emissions is assigned to operational managers

Operational managers have specific accountability for production process energy performance and cost	☐
Operational managers report to the facility GM monthly on energy costs vs. budget and energy performance metrics	☐
Production process managers have energy performance as a component of their annual performance appraisal	☐
Production process managers report to the facility GM monthly on energy improvement project cost and progress	☐

NOTE: **Operational Managers** include 1st, 2nd and 3rd Line supervision of the production process as well as technical support supervision and process engineers

Potential Documents:

- Budget reports
- Operational energy report and production report
- Personal Performance Assessment reviews
- Capital project progress reports

Energy data is reviewed regularly and integrated into operator actions for energy intensive processes

Monthly energy consumption/costs based on production levels are budgeted at the production process level	☐
Energy and GHG performance are a focus of continuous improvement in environmental management systems	☐
Energy performance metrics appear in monthly facility performance reporting	☐
Operations managers and engineers develop daily control limits for energy use and GHG emissions	☐
Energy and GHG performance metrics are controlled to target levels by production process operators	☐
Standard Operating Procedures contain energy / GHG controlling actions	☐

Potential Documents:

- Monthly budget reports
- Monthly operational energy report and production report
- Continuous Improvement Management System progress reports
- Standard Operating Procedures

Actions and process controls related to energy use and GHG emissions are included in management systems for material sources

Procedures exist to ensure that operators are provided with energy data.	☐
Actions related to energy management are included in operators' job procedures.	☐

Potential Documents:

- Operator job description

- Energy management procedures
- Operational energy report and production report

General energy and GHG awareness training is provided to personnel with additional training for key personnel

General energy awareness training is given to all company personnel as a one-time initiative	☐
Energy Leaders receive energy skills training which includes consumption analysis, and remedial action cost/ benefit analysis techniques	☐
Operations management is trained to budget energy cost and consumption relative to production levels	☐
Technical personnel are trained to support and maintain all energy consuming technologies	☐
Technical personnel are trained to support energy controlling and data management technologies	☐
Operations personnel are trained to operate production processes in an energy efficient manner	☐
Technical personnel are trained to identify auxiliary system and production process energy use reduction opportunities	☐
Operations personnel are trained to analyze and control energy performance and cost	☐

Potential Documents:

- General awareness presentations
- Fundamental financial assessment training manuals and presentations
- Energy management handbooks and training manuals
- Equipment specific energy efficiency training manuals and specification sheets
- Operator training manuals

Level AA

Energy use and GHG emissions are considered in business planning at the facility and / or business unit level

Energy use and GHG emissions are considered key production parameters in the facility's annual business plan and have annual and midterm improvement targets and action plans assigned to operations managers	☐
Energy and GHG emissions have KPIs matching business plan objectives monitored on facility and corporate level dashboards vs. targeted performance	☐
Progress on energy savings projects is reported monthly	☐

Potential Documents:

- Sustainable Development Policy
- Annual Sustainability Report
- EMS energy performance improvement action plans or results reports
- Annual business plan
- Monthly budget reports
- Monthly operational energy report and production report
- Capital project progress reports

Energy use / GHG Emissions management system has been subject to internal or external verification

Internal/external audits of the energy/GHG management function are formalized in an environmental management system or other internal auditing protocol where energy performance improvement actions, energy management systems, reports and databases are checked	☐
External auditing is deployed to check database accuracy and verify measurement system accuracy	☐

Potential Documents:

- Audit report containing energy management assessment

Level AAA

Procurement and supply chain management policies that incorporate energy efficiency criteria

Procurement standards are established for frequently used equipment (such as lights, motors)	☐
Energy procurement practices include a review and optimization of utility and energy supply contracts	☐
Production process material and equipment is purchased from certified energy/GHG managing suppliers	☐
Energy procurement practices include the risk management of market based contracts	☐

Potential Documents:

- Procurement standards
- Energy risk management policy
- Energy supply contracts
- Utility invoices, and energy supplier invoices

Voluntary corporate investments

Investments in research and development that target energy efficiency or reduce GHG emissions	☐
Feasibility studies for energy reduction opportunities	☐
Reduced energy consumption/GHG emissions as a result of implementation of technology or processes	☐
Investments in renewable energy projects or energy recovery projects	☐

Potential Documents:

- Annual business plan
- Capital project reports
- Feasibility study reports

Participation with communities of interest to improve energy efficiency and reduce GHG emissions

Financial or in-kind support for energy awareness programs in the community	☐
Collaboration with environmental non-governmental organizations on energy efficiency projects	☐

Appendix C– MAC Energy Use and GHG Emissions Reporting Form

Form A

Members can use this reporting worksheet to calculate their GHG emissions if they do not have another mechanism in place to do so.

FORM A - DETAILED DATA

Reporting Year:		Company:			
ENERGY CONSUMPTION					
Fuel	**Use**	**Volume/Mass**	**Unit**	**Energy Consumed**	**Greenhouse Gas Emissions in CO2e tonnes**
STATIONARY FUEL COMBUSTION					
Heavy (Residual) Fuel Oil	Utility Boiler	0	in m3	0 GJ	0 tonnes
Heavy (Residual) Fuel Oil	Industrial Boiler	0	in m3	0 GJ	0 tonnes
Heavy (Residual) Fuel Oil	Commercial Boiler	0	in m3	0 GJ	0 tonnes
Light (Distillate) Fuel Oil	Utility Boiler	0	in m3	0 GJ	0 tonnes
Light (Distillate) Fuel Oil	Industrial Boiler	0	in m3	0 GJ	0 tonnes
Light (Distillate) Fuel Oil	Commercial Boiler	0	in m3	0 GJ	0 tonnes
Propane	Heater	0	in m3	0 GJ	0 tonnes
Butane	Heater	0	in m3	0 GJ	0 tonnes
Natural Gas	Utility Boiler	0	m3	0 GJ	0 tonnes
Natural Gas	Industrial Boiler	0	m3	0 GJ	0 tonnes
Natural Gas	Commercial Boiler	0	m3	0 GJ	0 tonnes
Natural Gas	Other	0	m3	0 GJ	0 tonnes
Coal	Utility Boiler	0	tonnes	0 GJ	0 tonnes
Coal	Fluidized Bed	0	tonnes	0 GJ	0 tonnes
Coal	Industrial Boiler	0	tonnes	0 GJ	0 tonnes
Coal	Commercial Boiler	0	tonnes	0 GJ	0 tonnes
Coke		0	tonnes	0 GJ	0 tonnes
TOTAL STATIONARY FUEL COMBUSTION:				**0 GJ**	**0 tonnes**
STATIONARY FUEL COMBUSTION - COGENERATION					
Heavy (Residual) Fuel Oil	Utility Boiler	0	in m3	0 GJ	0 tonnes
Heavy (Residual) Fuel Oil	Industrial Boiler	0	in m3	0 GJ	0 tonnes
Heavy (Residual) Fuel Oil	Commercial Boiler	0	in m3	0 GJ	0 tonnes
Light (Distillate) Fuel Oil	Utility Boiler	0	in m3	0 GJ	0 tonnes
Light (Distillate) Fuel Oil	Industrial Boiler	0	in m3	0 GJ	0 tonnes
Light (Distillate) Fuel Oil	Commercial Boiler	0	in m3	0 GJ	0 tonnes
Diesel	Stationary Prime Mover	0	in m3	0 GJ	0 tonnes
Natural Gas	Utility Boiler	0	m3	0 GJ	0 tonnes
Natural Gas	Industrial Boiler	0	m3	0 GJ	0 tonnes
Natural Gas	Commercial Boiler	0	m3	0 GJ	0 tonnes
Coal	Utility Boiler	0	tonnes	0 GJ	0 tonnes
Coal	Industrial Boiler	0	tonnes	0 GJ	0 tonnes
Coal	Commercial Boiler	0	tonnes	0 GJ	0 tonnes
TOTAL STATIONARY FUEL COMBUSTION - COGENERATION:				**0 GJ**	**0 tonnes**
MOBILE MINING EQUIPMENT					
Diesel	Heavy Duty Vehicle	0	in m3	0 GJ	0 tonnes
Gasoline	Heavy Duty Vehicle	0	in m3	0 GJ	0 tonnes
TOTAL MOBILE MINING EQUIPMENT:				**0 GJ**	**0 tonnes**
OTHER MOBILE EMISSIONS					
Light (Distillate) Fuel Oil	Jet/Turbo Aviation	0	in m3	0 GJ	0 tonnes
Diesel	Car	0	in m3	0 GJ	0 tonnes
Diesel	Light Truck	0	in m3	0 GJ	0 tonnes
Gasoline	Car	0	in m3	0 GJ	0 tonnes
Gasoline	Light Truck	0	in m3	0 GJ	0 tonnes
Gasoline	Off-Road Vehicles	0	in m3	0 GJ	0 tonnes
Gasoline	Aviation	0	in m3	0 GJ	0 tonnes
Propane/Heater	Propane Vehicle	0	in m3	0 GJ	0 tonnes
Natural Gas	Natural Gas Vehicles	0	m3	0 GJ	0 tonnes
TOTAL OTHER MOBILE EMISSIONS:				**0 GJ**	**0 tonnes**
Sub Total Fuel Energy Use and Associated Direct Emissions				**0 GJ**	**0 tonnes**

OTHER SOURCES	Quantity of Emissions (Specify Units)			CO2e	
	Quantity	Units		tonnes	
INDUSTRIAL PROCESSES					
Limestone use	0			0	tonnes
Explosives (in tonnes)	0	tonnes		0	tonnes
Pyrometallurgy (specify fuel)	0			0	tonnes
SF6 in magnesium production	0	tonnes		0	tonnes
Naptha	0	m3		0	tonnes
TOTAL INDUSTRIAL PROCESSES:				**0**	tonnes
FUGITIVE EMISSIONS					
Fugitive emissions	0			0	tonnes
Refrigerants (e.g. HCFC)	0			0	tonnes
TOTAL FUGITIVE EMISSIONS:				**0**	tonnes
REAGENTS					
Carbonate reagents	0			0	tonnes
TOTAL REAGENTS:				**0**	tonnes
VENTING					
Venting	0			0	tonnes
TOTAL VENTING:				**0**	tonnes
FLARING					
Flaring	0		0 GJ	0	tonnes
TOTAL FLARING:				**0**	tonnes
OTHER					
Other (specify)	0			0	tonnes
Other (specify)	0			0	tonnes
Other (specify)	0			0	tonnes
TOTAL OTHER:				**0**	tonnes
Sub Total Direct Emissions from Other Sources				**0**	tonnes

ELECTRICITY **ELECTRICITY (PURCHASED FROM UTILITY GRID)**	**Energy Consumed**		**SECTION D. Greenhouse Gas Emissions**
	kWh	**GJ**	**in CO2e tonnes**
BC	0 kWh	0 GJ	**0 tonnes**
Alberta	0 kWh	0 GJ	**0 tonnes**
Saskatchewan	0 kWh	0 GJ	**0 tonnes**
Manitoba	0 kWh	0 GJ	**0 tonnes**
Ontario	0 kWh	0 GJ	**0 tonnes**
Quebec	0 kWh	0 GJ	**0 tonnes**
New Brunswick	0 kWh	0 GJ	**0 tonnes**
Nova Scotia	0 kWh	0 GJ	**0 tonnes**
Prince Edward Island	0 kWh	0 GJ	**0 tonnes**
Newfoundland/Labrador	0 kWh	0 GJ	**0 tonnes**
Yukon	0 kWh	0 GJ	**0 tonnes**
NWT	0 kWh	0 GJ	**0 tonnes**
Nunavut	0 kWh	0 GJ	**0 tonnes**
Other Purchased Electricity	0 kWh	0 GJ	**0 tonnes**
Steam Generated Offsite	0 kWh	0 GJ	**0 tonnes**
Sub Total Electricity Purchased and Associated Indirect Emissions	**0 kWh**	**0 GJ**	**0 tonnes**
Self Generated Electricity (non-fossil fuel)	0 kWh	0 GJ	**0 tonnes**
Electricity or Other Energy Sold	0 kWh	0 GJ	**tonnes**
Other Indirect Emissions (specify)			**0 tonnes**

Form B

For those members who have already calculated their GHG emissions, they may use the following form to input their totals.

NOTE: All members must complete Form B – Summary Table. Form A is optional and can be used at the company's discretion.

Energy Consumption Totals:		
TOTAL Energy Use	0	GJ
TOTAL Fuel Energy	0	GJ
TOTAL Electricity	0	GJ

GHG Emission Totals:	CO_2	CH_4		N20		HCFC		PFC		SF_6		CO_2e
	tonnes	tonnes	CO_2e tonnes	tonnes	CO_2e tonnes	tonnes	CO_2e tonnes	tonnes	CO_2e tonnes	tonnes	CO_2e tonnes	tonnes
Stationary Fuel Combustion	0	0	0	0	0							0
Stationary Fuel Combustion - Cogeneration	0	0	0	0	0							0
Mobile Mining Equipment	0	0	0	0	0							0
Other Mobile Emissions	0	0	0	0	0							0
Industrial Processes	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Emissions	0	0	0	0	0	0	0	0	0	0	0	0
Reagents	0	0	0	0	0	0	0	0	0	0	0	0
Venting	0	0	0	0	0	0	0	0	0	0	0	0
Flaring	0	0	0	0	0							0
Electricity Purchased	0	0	0	0	0							0
Self-Generated Electricity (non-fossil fuel)	0	0	0	0	0							0
TOTAL Emissions	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL Direct Emissions	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL Indirect Emissions	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D – Conversion Tables, Emissions Factors, and Global Warming Potentials

Common Units of Measure:

Metric Prefixes		
Abbreviation	**Prefix**	**Multiple**
K	kilo-	10^{3}
M	mega-	10^{6}
G	giga-	10^{9}
T	tera-	10^{12}
P	peta-	10^{15}

Mass	
1 tonne =	1000 kg = 1 000 000 g
	1.1023 tons
	2204.6 lbs***

Volume	
1 cubic metre (m3) =	1000 litres
	264.2 US gallons
	6.29 barrels
	35.315 cubic feet
	1.308 cubic yards

Energy		
Measurement	**Equivalent**	**Units**
1 gigajoule (GJ)	947817.00	BTU
1 GJ	0.947817	Mmbtu***
1 GJ	277.8	kWh (kilowatt hour)
1 megawatt hour = 1 MWhr	3.6	GJ**
1 million Btu/hr	293.07	kW**
1 kWh electricity = 3.6 MJ = 0.0036 GJ		
1 m3 heavy fuel oil	41.73	GJ
1 m3 light fuel oil	38.68	GJ
1 m3 light crude oil	38.51	GJ
1 m3 heavy crude oil	40.9	GJ
Energy		

Measurement	**Equivalent**	**Units**
1 m3 diesel	38.68	GJ
1 m3 motor gasoline	34.66	GJ
1 m3 aviation gasoline	33.62	GJ
1 m3 aviation turbo	35.93	GJ
1 m3 propane	25.53	GJ
1 m3 butane	28.62	GJ
1 m3 natural gas	0.03723	GJ
1 m3 naphtha	35.17	GJ***
1 tonne coal (anthracite)	27.7	GJ***
1 tonne Canadian bituminous coal***		
NF, PEI. and NS	28.96	GJ
NB	26.8	GJ
QC.	28.9	GJ
MB		
ON, SK, AB	25.43	GJ
BC	26.02	GJ
Yukon, N.W.T.	25.43	GJ
1 tonne imported bituminous coal	29.82	GJ
1 tonne coal coke	28.83	GJ
1 tonne wood	18	GJ

Emissions Factors for Common Transportation Fuels:*

Fuel	Use	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
		g/l fuel	g/l fuel	g/l fuel	t/m3 fuel	t/m3 fuel	t/m3 fuel
Heavy (Residual) Oil	Utility Boiler	3124	0.034	0.064	3.12400000	0.00003400	0.00006400
	Industrial Boiler	3124	0.12	0.064	3.12400000	0.00012000	0.00006400
	Commercial/ Other Boiler	3124	0.057	0.064	3.12400000	0.00005700	0.00006400
	Ships	3124	0.28	0.079	3.12400000	0.00028000	0.00007900
Light (Distillate) Oil	Utility Boiler	2725	0.18	0.031	2.72500000	0.00018000	0.00003100
	Industrial Boiler	2725	0.006	0.031	2.72500000	0.00000600	0.00003100
	Commercial/ Other Boiler	2725	0.026	0.031	2.72500000	0.00002600	0.00003100
	Jet/Turbo Aviation	2535	0.028	0.071	2.53500000	0.00002800	0.00007100
	Ships	2725	0.26	0.073	2.72500000	0.00026000	0.00007300
Diesel	Stationary Prime Mover	2663	0.133	0.4	2.66300000	0.00013300	0.00040000
	Car	2663	0.051	0.22	2.66300000	0.00005100	0.00022000
	Light Truck	2663	0.068	0.22	2.66300000	0.00006800	0.00022000

Fuel	Use	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	Heavy Duty Vehicle	2663	0.14	0.082	2.66300000	0.00014000	0.00008200
	Railroad Trains	2663	0.15	1.1	2.66300000	0.00015000	0.00110000
	Ships	2663	0.15	1.1	2.66300000	0.00015000	0.00110000
Gasoline	Light -duty Gasoline Vehicles						
	Tier 2	2289	0.14	0.022	2.28900000	0.00014000	0.00002200
	Tier 1	2289	0.23	0.47	2.28900000	0.00023000	0.00047000
	Tier 0	2289	0.32	0.66	2.28900000	0.00032000	0.00066000
	Light-duty Gasoline Trucks						
	Tier 2	2289	0.14	0.022	2.28900000	0.00014000	0.00002200
	Tier 1	2289	0.24	0.58	2.28900000	0.00024000	0.00058000
	Tier 0	2289	0.21	0.66	2.28900000	0.00021000	0.00066000
	Heavy-duty Gasoline Vehicles						
	Three-way Catalyst	2289	0.068	0.2	2.28900000	0.00006800	0.00020000
	Non-catalytic Controlled	2289	0.24	0.58	2.28900000	0.00024000	0.00058000
	Uncontrolled	2289	0.21	0.66	2.28900000	0.00021000	0.00066000
	Off-Road Vehicles	2289	2.7	0.05	2.28900000	0.00270000	0.00005000
	Aviation	2342	2.2	0.23	2.34200000	0.00220000	0.00023000
	Boats	2289	1.3	0.066	2.28900000	0.00130000	0.00006600
Propane	Heater	1510	0.027	0.108	1.51000000	0.00002700	0.00010800
	Vehicle	1510	0.024	0.108	1.51000000	0.00002400	0.00010800
Butane	Heater	1730	0.024	0.108	1.73000000	0.00002400	0.00010800
		g/m3 fuel	g/m3 fuel	g/m3 fuel	t/m3 fuel	t/m3 fuel	t/m3 fuel
Natural Gas	Utility Boiler	1891	0.49	0.049	0.001891	0.00000049	0.000000049
	Industrial Boiler	1891	0.037	0.033	0.001891	0.000000037	0.000000033
	Commercial Boiler	1891	0.037	0.035	0.001891	0.000000037	0.000000035
		g/l fuel	g/l fuel	g/l fuel	t/m3 fuel	t/m3 fuel	t/m3 fuel
Natural Gas	Natural Gas Vehicles	1.89	0.009	0.00006	0.00189000	0.00000900	0.00000006
		g/l fuel			t/m3 fuel		
Naptha	Non-Energy Uses	680			0.68		
		g/kg fuel1	g/kg fuel	g/kg fuel	t/tonne fuel	t/tonne fuel	t/tonne fuel
Coal	Utility Boiler		0.022	0.032	0	0.000022	0.000032
	Fluidized Boiler		0.015	2.11	0	0.000015	0.00211

Fuel	Use	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	Industrial Boiler		0.03	0.02	0	0.00003	0.00002
	Commercial Boiler		4	0.02	0	0.004	0.00002
		g/l fuel	g/l fuel	g/l fuel	t/m3 fuel	t/m3 fuel	t/m3 fuel
Petroleum Coke, Liquid Derived	Energy, Coking applications	4200	0.12	0.064	4.2	0.00012	0.000064
Petroleum Coke from Catalytic Cracker	Energy, Coking applications	3800	0.12	0.064	3.8	0.00012	0.000064
		g/kg fuel	g/kg fuel	g/kg fuel	t/tonne fuel	t/tonne fuel	t/tonne fuel
Anthracite		2387	0.015	0.05-2.11	2.39	0.000015	.00005 - .00211
U.S. Bituminous		2288-2432	0.015	0.05-2.11	2.288-2.432	0.000015	.00005 - .00211
Canadian Bituminous		1852-2254	0.015	0.05-2.11	1.852-2.254	0.000015	.00005 - .00211
Sub-Bituminous		1740-2520	0.015	0.05-2.11	1.733-1.765	0.000015	.00005 - .00211
Lignite		1424-1476	0.015	0.05-2.11	1.424-1.476	0.000015	.00005 - .00211
Coke		2480	0.015	0.05-2.11	2.48	0.000015	.00005 - .00211
		g/kg (oven dry fuel)	g/kg	g/kg	t/tonne fuel	t/tonne fuel	t/tonne fuel
Wood Fuel/Wood Waste	Industrial Combustion	840	0.09	0.02	0.84	0.00009	0.00002
		kg/kg explo-sives			t/tonne explosives		
ANFO Explosives		0.189			0.189		

*Use Carbon content of Coal type to determine CO_2 emissions (Source: Canada's Climate Change Inventory)

Indirect Emissions from Electric Energy by Province		
	2008	**2008**
Province	kg CO_2e / kWh	tonne CO_2e / kWh
Newfoundland and Labrador	0.020	0.000020

Prince Edward Island	0.001	0.000001
Nova Scotia	0.850	0.000850
New Brunswick	0.550	0.000550
Quebec	0.002	0.000002
Ontario	0.100	0.000100
Manitoba	0.005	0.000005
Saskatchewan	0.720	0.000720
Alberta	0.880	0.000880
British Columbia	0.025	0.000025
NWT / Nunavut / Yukon	0.050	0.000050

Global Warming Potentials: [7]

The concept of 'global warming potential' (GWP) was developed to allow scientists and policy-makers to compare the ability of each GHG to trap heat in the atmosphere relative to another gas. By definition, a GWP is the time-integrated change in radiative forcing[8] due to the instantaneous release of 1kg of the gas expressed relative to the radiative forcing from the release of 1kg of CO_2. In other words, a GWP is a relative measure of the warming effect that the emission of a radiative gas might have on the surface troposphere. The GWP of a GHG takes into account both the instantaneous radiative forcing due to an incremental concentration increase and the lifetime of the gas.[9]

Greenhouse Gas		**Chemical Formula**	**Global Warming Potential (100 years)***
Carbon Dioxide		CO2	1
Methane		CH4	25
Nitrous Oxide		N2O	298
HFCs			
	HFC-23	CHF3	14,800
	HFC-32	CH2F2	675
	HFC-41	CH3F	150
	HFC-43-10mee	C5H2F10	1,640
	HFC-125	C2HF5	3,500
	HFC-134	C2H2F4	1,000
	HFC-134a	CH2FCF3	1,430
	HFC-143	C2H3F3	300

[7] Government of Canada – National Inventory Report, Greenhouse Gas Sources and Sinks in Canada, 1990-2011: https://www.ec.gc.ca/Publications/default.asp?lang=En&xml=A07ADAA2-E349-481A-860F-9E2064F34822

[8] Radiative Forcing: The amount of heat trapping potential for any given GHG. It is measured in watts/m^2. The radiative forcing effect of a gas within the atmosphere is a reflection of its ability to cause atmospheric warming)

[9] Olsen, K., Wellisch, M., Boileau, P., Blain, D., Ha, C., Henderson, L., Liang, C., McCarthy, J. & McKibbon, S. (2003), Canada's Greenhouse Gas Inventory, 1990-2001, Environment Canada, August

	HFC-143a	C2H3F3	4,470
	HFC-152a	C2H4F2	124
	HFC-227ea	C3HF7	3,220
	HFC-236fa	C3H2F6	9,810
	HFC-245ca	C3H3F5	560
Perfluorocarbons (PFCs)			
	Carbon Tetrafluoride	CF4	7,390
	Carbon Hexafluoride	C2F6	12,200
	Perfluoropropane	C3F8	7,000
	Perfluorobutane	C4F10	8,860
	Perfluorocyclobutane	c-C4F8	8,700
	Perfluoropentane	C5F12	7,500
	Perfluorohexane	C6F14	9,300
Sulphur Hexafluoride		SF6	22,800

Appendix E – Energy Action Process Checklist

Elements	Completed
UNDERSTAND YOUR ENERGY COSTS: • Review invoices to verify the consumption and demand charges for all energy sources match stated as well as actual consumption and demand (eliminate billing errors) • Confirm that regulated energy tariff structures for utility based energy supply match actual consumption and demand levels • Confirm that commodity contracts for market based energy supply match forecasted annual energy consumption volume requirements • Confirm that energy transportation contracts match forecasted peak energy demand levels	☐ ☐ ☐ ☐
UNDERSTAND HOW ENERGY IS USED The analysis done in this section will support the review undertaken to understand energy costs; the efforts to identify energy waste; and the potential to improve infra-structure and production process energy efficiency • Review the real time energy demand profile over a complete production cycle for all major energy sources (i.e. electricity, natural gas) at the facility level in order to determine facility use patterns with respect to baseload; production process loads; production demand timing; and peak demand • Inventory the energy use of the systems and equipment that make up the infra-structure component of the facility. (i.e. baseload) • Link production schedule to production load and time of use energy prices • Determine the duration of the peak demand level (Load duration analysis) • Develop a performance model (regression, CUSUM) that represents the synchronized relationship between energy use and energy use drivers (e.g. production units and weather) and determine the events that cause variability in energy requirements • Develop energy baselines for the facility and production processes • Develop energy balances for the facility and production processes	☐ ☐ ☐ ☐ ☐ ☐ ☐

ELIMINATE ENERGY WASTE (Energy is wasted when the energy used exceeds true requirements of workforce health and safety, infra-structure sustainability and production process energy requirements)	
• Match the 'operating time' infrastructure energy consuming systems and components to workforce and production schedules o Lighting o HVAC o Pumping o Underground Auxiliary Ventilation Fans o Exhaust fans o Conveying o Natural gas space heating o Compressed air distribution and driven equipment o Steam distribution, traps, space heating	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
• Match the 'sizing' of infrastructure energy consuming systems and components with true production process and facility service requirements o Lights o Fans o Heaters o Air conditioning units o Pumps o Steam traps o Piping distribution systems o Compressors o Pneumatic equipment	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
• Match the 'operating time' of production process energy consuming systems and components with the production schedule	☐
• Match the 'sizing' of production process energy consuming systems and components with the true production processing capacities	☐
• Match the 'production schedule' with Time of Use electricity tariffs	☐
• Turn down (using thermostats, dampers, control valves, regulators, variable speed drives) o Temperature levels for space heating o Cooling requirements for Air Conditioning and refrigeration systems o Pressure of compressed air and steam systems o Flow of pumping, ventilation, compressed air and steam system	☐ ☐ ☐ ☐
• Automate control of (This allows the system or component to vary automatically and consistently meet the service requirement it senses) o Production process systems and equipment o Lighting systems o HVAC systems o Steam boilers o Air compressors	☐ ☐ ☐ ☐ ☐ ☐

o Space heating systems o Pumping systems o Exhaust fans o Underground auxiliary ventilation fans o Surface mine air intake and exhaust fans	☐ ☐ ☐
o Cleaning of ducts, piping systems, conveyor structures, steam traps, air dryer water traps, etc. o Changing of air filters o Replacement of worn impellers in pumps and fans o Cleaning of electrical connections o Insulate piping systems, duct work, buildings in order to minimize heat losses o Install energy efficient equipment where appropriate o Lighting o Motors o Variable speed drives o Benchmark more energy efficient production processes and technologies and review the feasibility of their application	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
USE ENERGY EFFICIENTLY Energy is used efficiently when the energy losses associated with energy consuming systems and components are eliminated or minimized	☐
❑ **Ensure operating procedures** outline the energy efficient operation of auxiliary and production process systems and equipment	☐
❑ **Ensure effective maintenance procedures** are in place to sustain designed performance of infrastructure and production process systems and equipment o Lubrication of bearings , rollers, etc. o Alignment of belts, chains and pulleys o Cleaning of ducts, piping systems, conveyor structures, steam traps, air dryer water traps etc o Changing of air filters o Replacement of worn impellers in pumps and fans o Cleaning of electrical connections	☐
❑ **Insulate** piping systems, duct work, buildings in order to minimize heat losses	☐
❑ **Improve power factor**	☐
❑ **Install energy efficient** equipment where appropriate o Lighting o Motors o Variable speed drives ❑ **Implement recommendations** from focused technical audits on specific equipment ❑ **Carryout Energy Balance** analysis to determine if lost energy can be re-used	☐ ☐

IMPROVE SYSTEM AND PRODUCTION PROCESS TECHNOLOGIES As auxiliary systems advance their technologies and as new production processess are developed, it is important that they be considered in the efforts to control and reduce energy use and GHG emissions	
Conduct technical energy efficiency audits of auxiliary systems (e.g. compressed air, HVAC, combustion burners, boilers, etc.)	☐
Review advances in specific production process technologies (e.g. hoisting systems, underground haulage systems, open pit haulage trucks, fan systems, diesel power generation)	☐
Rationalize existing production processes (e.g. minimize production processes operating at low capacity)	☐
Benchmark more energy efficient production processes and technologies and review the feasibility of their application	☐

Appendix F – Technological Solutions for Energy Consumption and GHG Emissions Reductions

Likely importance: H - high; M - medium; L - low

Solution Type	Technology Details	Open Pit Mining	Facility Infra-structure	Underground Mining	Minerals Processing
Detailed Technical Audits	Compressed air systems - compressors, dryers, distribution system		H	H	H
	Metallurgical and mining production process benchmarking	H		H	H
	HVAC Systems		H		L
	Insulation - building envelop; piping; ductwork		H	H	H
	Steam/Hot water systems - boiler efficiency; distribution system		H	H	H
Potential Technology Upgrades	Air compressors and compressed air systems	L	H	H	H
	Boiler controls, steam systems		H	H	H
	Building air conditioners and space heating	L	H	L	L
	Insulation of buildings – insulation	L	H	L	M
	Insulation of piping and ductwork distribution systems		H	M	H
	Combined heat and power (co-generation)				M

Solution Type	Technology Details	Open Pit Mining	Facility Infra-structure	Underground Mining	Minerals Processing
	Computerized energy management system - metering; data network; servers/PLC's; PI;	H	M	H	H
	Drive belts and coupling systems	M		M	M
	Fuel efficient diesel engines	H		H	
	Power generation fuel substitution: grid electricity or natural gas for diesel	H		H	H
	Boiler fuel substitution: Bio-mass or natural gas for HFO		M	M	H
	Furnace controls and improvements				H
	Heat Pumps	L		M	M
	Waste heat recovery - metallurgical processes		H		H
	High efficiency electric motors	H		H	H
	Lighting systems	M	M	M	M
	Optimization of face shovel and dragline performance	H			
	Remote area power supplied photovoltaic panels	M			
	Automated mine dispatch and telemetry system	H		H	
	Solar water heating and solar cells	L		L	L

Solution Type	Technology Details	Open Pit Mining	Facility Infra-structure	Underground Mining	Minerals Processing
	Trolley wire assist for haulage trucks	M		M	
	Variable speed drives for fans	L		H	H
	Variable speed drives for pumps	L		H	H
	Waste heat recovery - mining processes	M		H	
	Mine Ventilation fan controls; main surface intake and exhaust; auxiliary u/g			H	
Metallurgical Processes	Energy efficient metallurgical processes	M		M	H
	Metallurgical process rationalization				H
	Metal recovery improvements				H
	Fine grinding technology	H		H	H
	Automated refinery cell hot spot detection				H
	Oil reclamation system	M		M	L
	Substitution of chemicals in recovery process				M
	Furnace off gas temperature and flow control				H
	Electric furnace bath temperature control				
	Waste Heat Recovery	M		M	H
	Water management	M		M	M

Solution Type	Technology Details	Open Pit Mining	Facility Infra-structure	Underground Mining	Minerals Processing
Mining Processes	Replace truck and LHD haulage with conveyors	H		H	
	Improve recovery of resource	H		H	H
	Ramp design optimization	H		H	
	Mine heating /cooling automation			H	
	Removal of compressed air, water, and ventilation distribution systems from abandoned workings			H	
	Larger more fuel efficient trucks, shovels, graders	H			
	Reduced weight of dragline and shovel buckets	H			
Explosives	Dilution control – selectivity	H		H	
	Blast management - fragmentation	H		H	
Training	Energy efficiency improvement opportunity identification and financial evaluation	H	H	H	H
	General energy awareness	H	H	H	H
	Energy performance analysis	H	M	H	H
	Operating procedures containing energy elements	H	L	H	H

Solution Type	Technology Details	Open Pit Mining	Facility Infra-structure	Underground Mining	Minerals Processing
	Maintenance procedures for major energy consuming equipment	H	H	H	H
Renewable Energy and Land Reclamation	Wind Turbine Electricity Generation	L		M	M
	Geothermal Heating		L	M	L
	Mine Tailings Reclamation	M		M	
	Bio-mass Fuel		L		L
	Bio-diesel Fuel	M		M	
	Tree planting and revised rehabilitation programs	M		L	L

Appendix G – Energy Management Website References

There is substantial information on energy use management on the internet. A small number of websites that provide additional information that MAC member companies may find to be particularly useful are listed below.

NRCan – Office of Energy Efficiency

- Energy Awareness Training
- Equipment energy efficiency (Boilers, Motors, Variable Speed Drives, Compressed Air Systems, Lighting, Refrigeration, Heating-Air-Conditioning-Ventilation)
- Sector Benchmarking
- Success Stories

www.oee.nrcan.gc.ca/industrial/technical-info/

RETScreen International

- Energy efficiency savings calculator tool
- Renewable energy case studies
- Energy efficiency technical manual

www.retscreen.net/

ANSI / MSE 2000:2005 A Management System for Energy

- Energy Management System Standard

www.webstore.ansi.org

Pacific Carbon Trust

- *Guide to Determining Additionality*

www.pacificcarbontrust.com

Appendix H – Glossary

Activity Data: Data on the magnitude of a human activity resulting in emissions or reductions taking place during a given period of time. Data on energy use, miles traveled, input material flow, and product output are all examples of activity data that might be used to compute GHG emissions.

Biofuel: Fuel made from biomass

Biomass: Plants or parts of plants, animal waste or any product made of either of these, and includes wood and wood products, agricultural residues and wastes, biologically derived organic matter found in municipal and industrial wastes, landfill gas, bio-alcohols, spent pulping liquor, sludge gas, and animal or plant-derived oils.

Business unit: A logical element or segment of a company representing a specific business function or a definite place on the organizational chart, under the domain of a manager, or a functional geographic area. This may include, but is not limited to, a series of mines located in a defined physical area, a series of mines producing the specific product, or the combination of a mine and smelter. For the purpose of the energy use and GHG emissions management protocol, a business unit is defined by the company but requires a documented rationale for why two or more facilities have been grouped together in the business unit.

Calendar year: A period of 12 consecutive months commencing on January 1 and terminating on December 31.

Calculation-Based: Any of various emission quantification methodologies that involve the calculation of emissions based on emission factors and activity data such as input material flow, fuel consumption, or product output.

Carbon Offset: A unit of carbon dioxide-equivalent (CO_2e) that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere, in this case at a mine or smelter. Offsets work in a financial system where, instead of reducing its own carbon use, a company can comply with emissions caps by purchasing an offset from an independent organization that completed and certified an emissions reduction, avoidance or sequestration project. For the purpose of TSM an offset must be independently verified by an accredited body, fungible, and passed a credible additionality test.

Cogeneration emissions: Releases resulting from cogeneration units.

Cogeneration unit: A stationary fuel combustion device which simultaneously generates electrical and thermal energy that is:

1. Used by the operator of the facility where the cogeneration unit is located; or
2. Transferred to another facility for use by that facility.

Combined Heat and Power (CHP): Same as cogeneration.

Concentrate: The final ore product recovered in the concentration or separation stage of the milling process.

Co-product metal: A metal that results from the production of copper, nickel, lead, zinc or cobalt and that is found in the residue from the production of copper, nickel, lead, zinc or cobalt.

Control Approach: An emissions accounting approach for defining organizational boundaries in which an entity reports 100 percent of the GHG emissions from operations under its financial or operational control.

CO_2 Equivalent (CO_2e): The universal unit for comparing emissions of different GHGs expressed in terms of the GWP (Global Warming Potential) of one unit of carbon dioxide.

Direct Emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Emissions Factor (EF): GHG emissions expressed on a per unit activity basis (for example: metric tonnes of CO_2 emitted per million BTUs of coal combusted, or metric tons of CO_2 emitted per kWh of electricity consumed).

Equipment leak emissions: Releases of fugitive emissions from equipment including valves, pump seals, flanges, compressors, sampling connections, and open-ended lines and excluding storage emissions.

Facility: All buildings, equipment, structures and stationary items that:

- Are located on a single site, or on contiguous sites or adjacent sites;
- Are owned or operated by the same entity; and
- Function as a single, integrated site.

Feedstock: Any raw material that is used in or upgraded by an industrial process.

Fugitive Emissions: Uncontrolled releases of a substance, including releases resulting from the production, processing, transmission, storage, distribution, or use of fuels or other substances.

Global warming potential (GWP): A factor, identifying the warming potential of a given mass of a particular greenhouse gas relative to the same mass of carbon dioxide. (**NOTE:** GWP conversion table is provided in **Appendix F**)

Greenhouse Gases (GHG): For the purpose of the Registry, GHGs are the six internationally recognized gases identified in the Kyoto Protocol: carbon dioxide

(CO_2), nitrous oxide (N_2O), methane (CH_4), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Hydrofluorocarbons (HFC): A group of manmade chemicals with various commercial uses (e.g., refrigerants) composed of one or two carbon atoms and varying numbers of hydrogen and fluorine atoms. Most HFCs are highly potent GHGs with 100-year GWPs in the thousands.

Indirect Emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity. For example, emissions of electricity used by a manufacturing entity that occur at a power plant represent the manufacturer's indirect emissions.

Industrial Process: A process where a component of which involves:

- A chemical reaction other than stationary fuel combustion and not for the purpose of producing new energy; or
- A physical action such as distillation, evaporation, friction, handling, impaction, or separation of a substance or feedstock that is subjected to the industrial process.

Industrial process emissions: Releases from an industrial process.

Loading and Unloading Emissions: Releases of fugitive emissions from the loading or unloading of a fuel, a feedstock or a product that is located at the facility.

Materiality: Information that is both relevant and consequential. For the purpose of this protocol, energy use and/or GHG emissions are to be considered material for a facility and/or business unit if:

- Exceeds 25kt (GHG) system and target and/or uses more than 250,000GJ
- Elects to define energy use and/or GHG emissions as material.

Material fuel source: A fuel used by the facility that does not account for a significant percent of overall consumption. Companies may choose to set thresholds to define materiality by fuel source.

Milling: The part of the mining process by which minerals are recovered by crushing and grinding, ore separation or concentration, and dewatering of the ore, in order to separate minerals from the rock in which they occur.

On-site Mobile Combustion Emissions: Releases from mobile machinery used for the on-site transportation of substances and includes mobile mining equipment emissions.

Pre-Treatment: Any activity to which a concentrate is subjected at the base metal smelting facility prior to production of copper, nickel, lead, zinc, cobalt or a co-product metal.

Process Emissions: Emissions resulting from physical or chemical processes rather than from fuel combustion.

Reducing Agent: A substance that brings about reduction by becoming oxidized and losing electrons.

Stationary Fuel Combustion Emissions: Releases from non-vehicular combustion of fuel for the purpose of producing energy and includes cogeneration emissions.

Storage Emissions: Releases of fugitive emissions from a storage tank, pile, silo or other means of storage of a fuel, a feedstock or a product that is located at the facility.

Venting Emissions: Controlled releases that occur due to the design of the facility, due to procedures used in the manufacture of processing of a substance or product, or due to pressure beyond the capacity of the manufacturing or processing equipment at a facility, excluding industrial process emissions and incineration emissions.

Verification: An independent assessment of the reliability (considering completeness and accuracy) of a GHG inventory.