


Greenhouse Gas Reduction Opportunities in the Newfoundland and Labrador Iron Ore Sector: Final Report

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1. Introduction and Methodology

1.1 About This Report

This document represents the first of three milestone reports for the Government of Newfoundland and Labrador (GNL) Office of Climate Change, Energy Efficiency and Emissions Trading (CCEET) under the auspices of the **Study to Identify Greenhouse Gas Reduction Opportunities and Competitiveness Implications: Iron Ore Mining – Newfoundland and Labrador**.

The overall study objective is to provide an objective and independent review of GHG regulation and opportunities for the iron ore industry to inform policy development. The main outputs from the study are:

- An assessment of GHG abatement solutions for the iron ore sector in Newfoundland and Labrador (NL) and how these solutions would rank on a marginal GHG abatement cost curve;
- A profile of how the mining industry is regulated, from a GHG reduction perspective, in other jurisdictions and lessons learned to date; and
- Identification of any technical and cost considerations that may arise from the application of performance standards to reduce GHG emissions on the iron ore industry in NL.

The objective of this task is to generate an assessment of GHG abatement solutions for the iron ore sector in NL and how these solutions would rank on a marginal GHG abatement cost curve.

This report presents the following main outputs:

- The technical and economic potential of GHG abatement opportunities in the iron ore industry,
- A detailed account of the range, type and cost of existing, emerging and potential GHG abatement technologies, capital equipment, processes and management practices that could potentially be employed in the province's iron ore industry and
- The costs and benefits of the GHG abatement opportunities as expressed in a marginal abatement curve.

Please note that in this document, we use the following abbreviations:

- GNL- government of Newfoundland and Labrador
- NL - Newfoundland and Labrador
- CCEEET- Office of Climate Change, Energy Efficiency and Emissions Trading.

A glossary is provided in Appendix A and a list of abbreviations is provided in Appendix B.

1.2 Context

The context for this assignment is elaborated below under two topics: i) the GNL policy thrust on how climate change will be addressed in the province and ii) the importance of the mining sector as both a key economic player in the province and a current and future GHG emitter.

1.2.1 The GNL Policy Thrust on Climate Change

In its 2011 Climate Change Action Plan, the GNL reaffirmed its commitment to reduce the province's GHG emissions by 10% below 1990 levels by 2020 and between 75%-85% below 2001 levels by 2050. In order to meet those objectives, the GNL also committed to develop and release in 2012 a detailed approach for reducing GHG emissions from the energy-intensive sectors.

The GNL Action Plan recognizes that economy-wide action will be needed and that the energy intensive large industrial sectors (electricity generation, mining, newsprint, and offshore oil and refining) will be of particular importance as they account for approximately 50% of provincial GHG emissions.

Within the scope of the province's Climate Change Action Plan 2011, the province has earmarked three early actions to move forward with this sector as it develops its broader policy approach, of which one these is to "apply best available control technology requirements in the air pollution control regulations to GHG emissions for new investments in the large industrial sector". This approach is to be consistent with emerging approaches such as those being advanced by the U.S. Environmental Protection Agency and, therefore is a key focus of this assignment.

1.2.2 Importance of the Mining Sector

Mining is a key sector in the NL economy and the industry currently accounts for almost 7% of GDP and 4% of employment. Iron ore shipments were valued at $3 billion in 2011. Mining royalties and taxes are estimated to be about $349 million in 2011-12, up from $21 million in 2005-06.

Real GDP in the mining industry doubled between 2005 and 2010 and continued real GDP growth is anticipated, driven by iron ore. In the iron ore sector, up to $15 billion of investment is currently in the planning cycle.

The mining companies that operate in the NL economy are price takers in global commodities markets, so it is imperative that any approach be balanced to advance progress on climate change while promoting strong economic activity and investment. Consequently, the business competitiveness and risk implications of potential GHG policy and regulatory frameworks are key components of this study (addressed under a separate project phase and milestone report).

Historically, the mining sector has been an active player in federal and provincial GHG policy and regulatory planning and discussion, both through the Mining Association of Canada (MAC) and at the level of individual companies.

1.3 Overview of Methodology

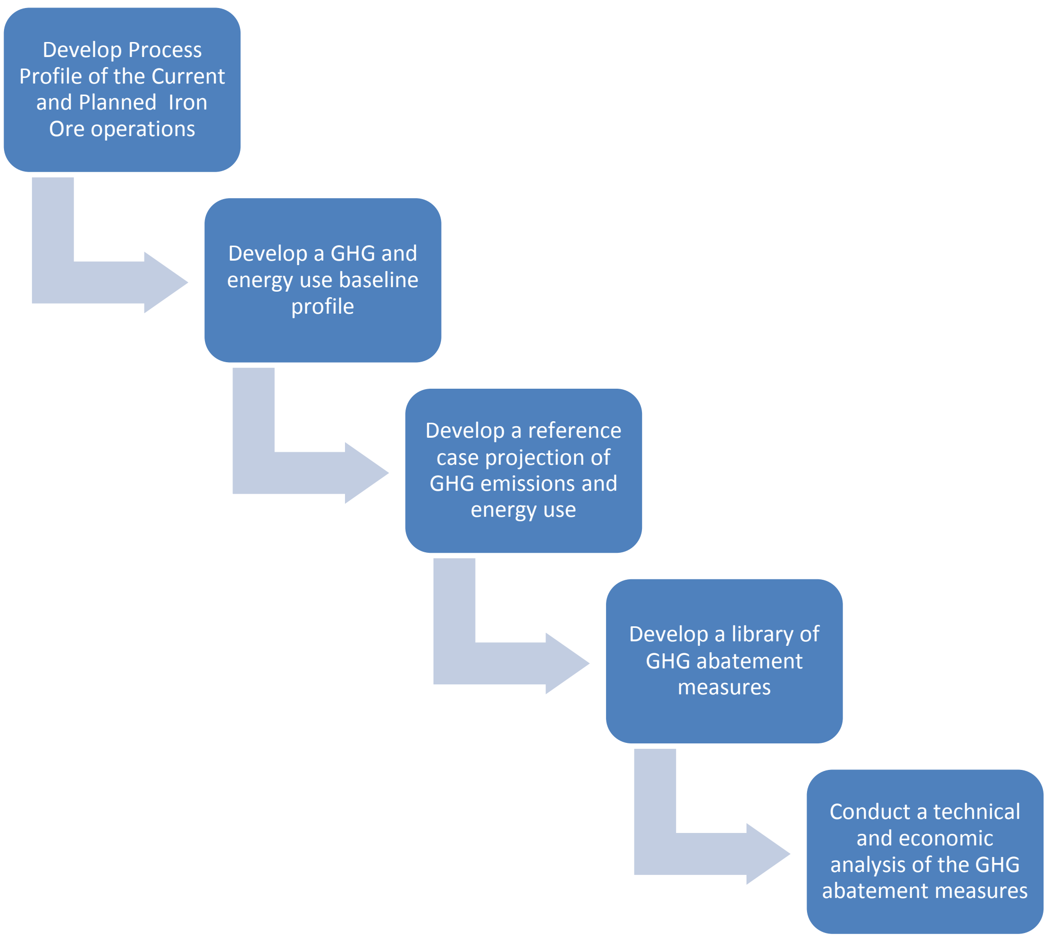
This sub-section presents an overview of the methodology employed to generate the milestone outputs reported in this document. This overview is elaborated under the following topics.

- GHG Abatement analysis: Major analysis steps
- Modelling Platform
- Analysis scope and
- Iron ore company recruitment.

1.3.1 GHG Abatement Analysis: Major Analysis Steps

Exhibit 1 illustrates the major analysis steps undertaken to carry out the GHG abatement analysis. Further elaboration of these steps is provided in each of the subsequent sub-sections in the report.

Exhibit 1 Steps Undertaken to Carry out GHG Abatement Analysis



1.3.2 Modelling platform

The technical and economic assessment of the GHG abatement measures is completed using ICF Marbek's proprietary industrial sector energy modeling platform.[1] This modeling platform comprises two linked modeling platforms:

- **IEEM** *(Industrial Energy Efficiency Model*), an Excel based simulation model, developed for modeling energy use and GHG emission in industrial sectors and
- **ISEEM** *(Industrial Sector Energy End-use Model*), a spreadsheet based macro model used to calculate total energy use and GHG emissions, by fuel, and end-use at the sector level and aggregated industry level (in cases where more than one sector is being assessed).

Operating in an Excel platform enables the model to be fully transparent, with all inputs and assumptions easily available for review and adjustment, if needed. Further elaboration of how the model is used is provided below as part of the Task descriptions.

1.3.3 Analysis Scope

The analysis scope is elaborated under the following topics:

- Coverage of the iron ore mining operations
- Scope of GHG Quantification and GHG Abatement Measures Analysis
- Analysis period

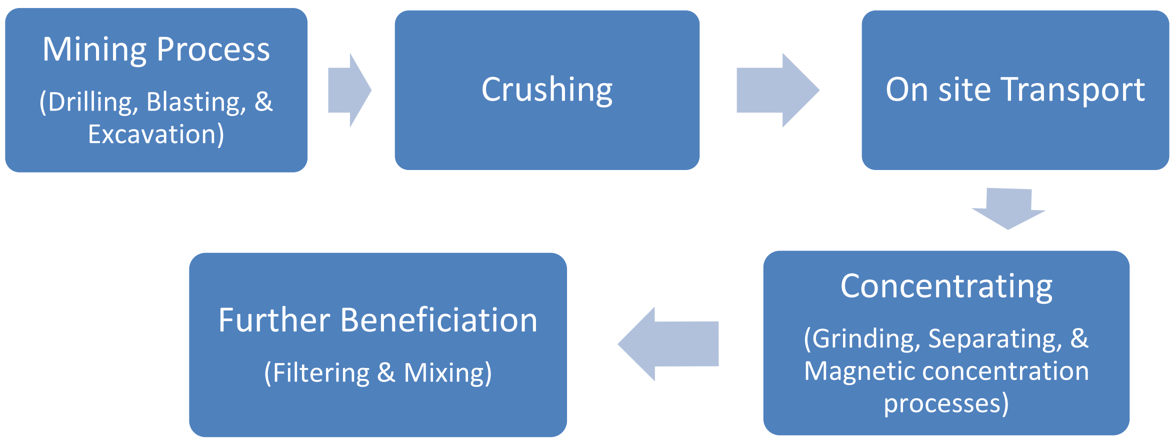
Coverage of the Iron Ore Mining Operations

Exhibit 2 is a generic description of the major steps involved in iron ore mining operations. For this study, the analysis covers the GHG emissions, energy use and activities of each of these steps. There is a final step not shown in this diagram, pelletization, which is not included in the scope of this report.

We refer to these steps as being “inside the fence”. As shown, the scope of coverage does not include the GHG emissions associated with transport of concentrate or pellets beyond the fence gate, referred to as rail and port.

[1] The ICF Marbek modeling platform has been used extensively in Canada and internationally as the basis for sector and industry wide energy use benchmarking studies and conservation potential studies that have been extensively peer reviewed as part of utility regulatory processes.

Exhibit 2 Schematic of Iron Ore Mining Operations



Scope of GHG Quantification and GHG Abatement Measures Analysis

As further elaborated in section 2, the analysis focuses on direct GHG emissions within the operational boundary of the NL iron ore mining operations. Direct emissions result from sources that are owned or controlled by the company and are sometimes referred to as scope 1 emissions. The GHG source categories within scope 1 include: stationary combustion, mobile combustion, process emissions and fugitive emissions.

The scope of GHG quantification does not include electricity consumption sourced from grid power. It does include GHG emissions associated with on-site generation of power from diesel combustion, which is a very small percentage of overall GHG emissions emitted by the sector in NL. Consequently, the analysis of the GHG abatement measures does not include opportunities to improve electricity use efficiency.

Analysis Period

This analysis covers a 20-year period. The base year is the calendar year 2010, with output milestones in 2020 and 2030.

As a consequence, the analysis includes current iron ore mining operations in NL as well as iron ore mining operations planned for start-up within the next five years or so.

1.3.4 Iron Ore Company Recruitment and Participation

A key step was to recruit iron ore companies into the study and establish the conditions under which these companies could have a meaningful and productive involvement in the study. Although the CCEEET had previously consulted with some of the companies currently operating or planning to develop mining operations in the province, none of the companies had been formally recruited into the study. A total of six companies have been recruited into the study, representing three existing operations and three planned operations.

Exhibit 3 illustrates the steps involved in securing the recruitment of the iron ore companies. The initial outreach involved communicating the intent and scope of the study and elaborating the data requirements needed to develop a robust analysis. This step led to the negotiation and finalization of non-disclosure agreements (NDAs) between ICF Marbek and the participating companies governing the use of confidential data.

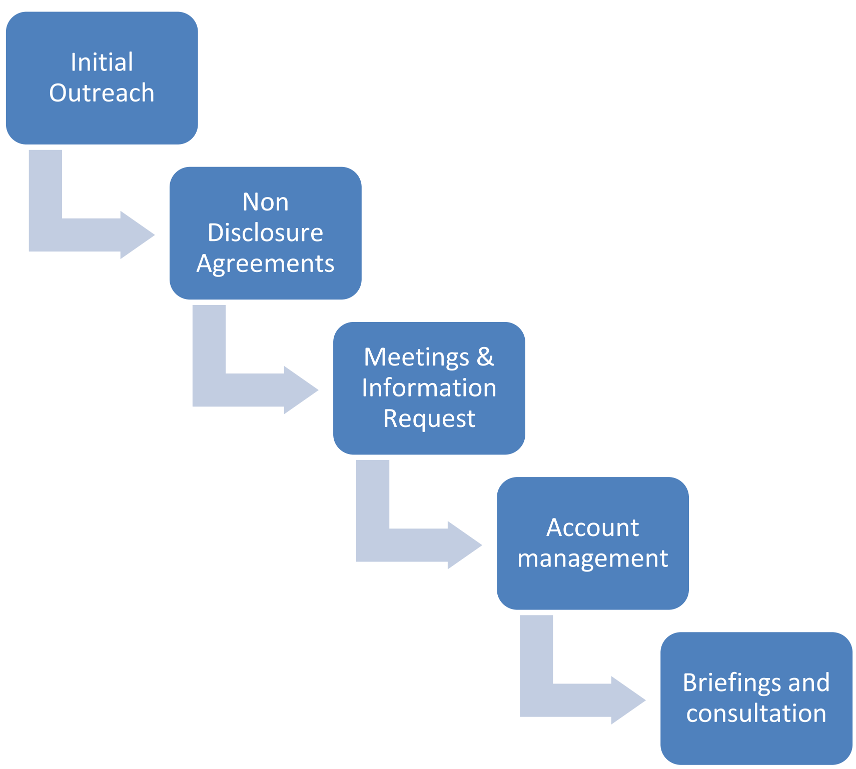
Once the NDAs were finalized, the participating companies were engaged into a data acquisition process. Each company was treated as an account to ensure sufficient attention was paid to enable a meaningful and productive engagement in the study.

As shown, the last step in the recruitment and participation was to consult with the companies on the analysis results. Each participating company was provided with a confidential plant report comprising three main outputs:

- Baseline energy use/cost and GHG profile,
- Baseline energy and GHG intensity
- GHG abatement measure technical and economic assessment.

A discussion was held with each company on the results of the draft confidential plant report and based on feedback the final plant reports were completed. The plant specific analyses then fed into the sector analysis. All data shown in this report represents the aggregation of participating companies and not the industry as a whole.

Exhibit 3 Steps Undertaken in Recruitment and Participation



2 GHG Emissions, Base Year Energy Use Profile, and Reference Case Projection

This section presents the results of the NL iron ore sector base year and reference case GHG emissions profile.

The base year is the starting point for the analysis and depicts the GHG emissions in the NL iron ore sector according to three categories: i) GHG emissions reporting scope, ii) iron ore mining process steps and iii) energy end-use. As noted, the base year for the analysis is calendar year 2010.

The reference case is a projection of future GHG emissions in the NL iron ore mining sector profiles absent any GHG abatement efforts beyond those reasonably expected from company business as usual activities. The GHG reference case projection is the metric against which the potential sector wide GHG reduction potential is calculated.

2.1 Method Employed

The method used to generate the base year and reference case GHG profiles is described under the following topics:

- GHG quantification method
- Selection of applicable GHG quantification methods
- Base Year method and
- Reference case method.

2.1.1 GHG Quantification Method

Given the focus of this assignment, an operational boundary is selected to ensure that all emissions quantified are site specific.

Within the operational boundary, only direct GHG emissions are considered. Direct emissions result from sources that are owned or controlled by the company and are sometimes referred to as scope 1 emissions. The source categories within scope 1 can include:

- Stationary Combustion. This source category includes on-site stationary equipment that combusts solid, liquid, or gaseous fuel for the purpose electricity, heat, or steam generation, such as boilers, furnaces, and turbines. In general, emergency generators are not included within this category.
- Mobile Combustion. This includes emissions from company owned/controlled mobile sources, such as mining equipment, trucks, and trains. The equipment must be used on-site.
- Fugitive Emissions. These emissions can be intentional or unintentional releases, such as equipment leaks, venting, blasting, hydrofluorocarbon (HFC) emissions during the use of refrigeration and air conditioning equipment.
- Process Emissions (Physical or Chemical). These emissions result from the manufacture or processing of chemicals and materials. An example of process emissions in the iron ore industry includes the emissions released from the pelletizing process.

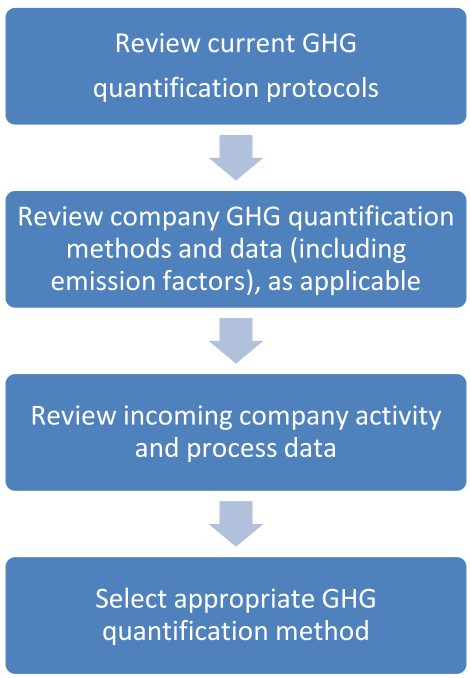
2.1.2 Selection of GHG Quantification Methods

General Approach

It's imperative that the quantification of GHG emissions in this analysis be robust and defensible. Consequently, every effort has been made to employ what is considered to be good practice in GHG quantification. Arriving at an appropriate GHG quantification method is not straightforward because, at the present time, there are several protocols at play under different jurisdictions and regulatory frameworks.

Exhibit 4 illustrates the steps involved to select and apply an appropriate GHG quantification method (in the absence of regulation), which are further elaborated below.

Exhibit 4 Selection of GHG Quantification Method



GHG quantification protocols typically outline specific methods to quantify GHG emissions by source category. There is a number of existing GHG quantification protocols which have varying degrees of applicability to the mining sector. The initial task is to review these protocols for applicability to the mining sector, in terms of specific mining activities (i.e., source categories, such as stationary combustion, mobile combustion, and process emissions). This review is discussed in further detail below.

Finally, within each source category, there can also be several different "tiers" or levels to quantify GHG emissions. The higher the tier, the more detailed data required, and the greater assurance associated with the analysis results. For example, a low tier method might employ a default global or national, fuel based emission factor, while a higher tiered method would rely on site-specific data, based on for example fuel characteristics (e.g., carbon content) of the fuel consumed, emission control technologies employed, and so on. The quantification method with the highest assurance would be the use of emissions data directly from a Continuous Emissions Monitoring System (CEMS).

In the absence of regulation (which typically mandates use of specific tiers based on a variety of factors, such as availability of data, size/capacity of operations/equipment, level of fuel consumption, etc.), it is good practice to use the highest level or tier possible to quantify GHG emissions. Also, when the source of emissions is a key category (i.e., it is a significant contributor to total emissions), it is good practice to use the most detailed, site-specific approach possible.

Review current GHG quantification protocols

The following GHG quantification protocols and guidance documents were reviewed for applicability to the NL iron ore sector:

- [US EPA] U.S. EPA Mandatory Reporting of Greenhouse Gases Rule (74 FR 56260)
- [2006 IPCC] 2006 IPCC Guidelines for National Greenhouse Gas Inventories
- [WCI] Western Climate Initiative, Final Essential Requirements of Mandatory Reporting (December 2010) and 2011 Amendments for Harmonization of Reporting in Canadian Jurisdictions (December 2011)
- [WRI/WBCSD] World Resources Institute and World Business Council for Sustainable Development, The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, Revised Edition (March 2004)
- [EC] Environment Canada, Guidance Manual for Estimating Greenhouse Gas Emissions (March 2004)[2]
- [QC] Quebec Environmental Quality Act (R.S.Q., c. Q-2), Mandatory reporting of certain emissions of contaminants into the atmosphere (December 2010)
- [ON] Ontario Environmental Protection Act, Regulation 452/09, Guideline for Greenhouse Gas Emissions Reporting (February 2012)
- [BC] British Columbia Reporting Regulation Methodology Manual (December 2009)

Initially, the protocols were reviewed to determine source category coverage, the gases covered specifically within the relevant guidance, and if the protocol supports a multi-tiered approach. Exhibit 5 presents a summary of the GHG quantification protocols that were reviewed in this manner.

Exhibit 5 Summary of the GHG Quantification Protocols Reviewed

Protocols	Source					Gases						Multiple Tiers Approach
	Stationary Combustion	Mobile Combustion	Process Emissions									
			Indurating Furnace	Calcination	Blasting	CO2	CH4	N2O	SF6	HFCs	PFCs	
US EPA	Y	N	Y	Y	N	Y	Y	Y	N	N	N	Y
2006 IPCC	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
WCI	Y	Y	Y	N	N	Y	Y	Y	N	N	N	Y
WRI/WBCSD	Y	Y	N	Y	N	Y	Y	Y	N	N	N	Y
EC	Y	Y	N	Y	N	Y	Y	Y	N	Y	N	Y
QC	Y	N	N	Y	N	Y	Y	Y	N	N	N	Y
ON	Y	N	Y	N	N	Y	Y	Y	N	N	N	Y
BC	Y	Y	N	Y	N	Y	Y	Y	N	N	N	Y

[2] Revisions to source categories presented in the 2004 Manual were identified in the recent Environment Canada publication, *Greenhouse Gas Emissions Reporting: Technical Guidance on Reporting Greenhouse Gas Emissions*, April 2012.

Review company GHG quantification methods and data

Company specific GHG quantification methods were reviewed and used for each source category, including GHG emissions factors, if and as provided.

Review company activity and process data

Plant specific activity data was reviewed to assess the data against the GHG quantification protocols, methods, and tiers (by source category). Appendix C provides an overview of the type of data that was provided and the associated limitations with respect to GHG quantification.

Select GHG quantification method

Based on this review, a “hybrid” approach was employed that combines the methods from several protocols. These include: the British Columbia Reporting Regulation Methodology Manual (December 2009); the Environment Canada, Metal Mining: Guidance Manual for Estimating Greenhouse Gas Emissions (March 2004); and the Western Climate Initiative, Final Essential Requirements of Mandatory Reporting (December 2010) (including 2011 Amendments for Harmonization of Reporting in Canadian Jurisdictions (December 2011).

Appendix D presents the equations and emissions factors used to estimate the GHG emissions for the base year and reference case.

2.1.3 Base Year GHG Profile: Method Employed

The NL iron ore sector 2010 base year GHG profile was developed using a bottom-up data acquisition approach involving data from each of the participating companies. The data collection and baseline profile development consisted of the following steps:

- Initial profiles describing the major process steps within each facility were developed,
- A technical assessment template was created to acquire data needed to generate estimates of GHG emissions from both energy and non-energy sources. The template was customized according to GHG source categories and iron ore mining process steps.
- The assessments were pre-filled with inventories of equipment from information publicly available on company websites and company technical reports,
- The pre-filled assessments were sent to the participating companies to complete,
- A review of the incoming information was carried out and an energy balance was conducted to align the fuel consumption with the estimated consumption of the major end uses based on equipment sizes, efficiency levels and hours of operation and
- Once the alignment was completed, the GHG emissions were calculated by multiplying each fuel type by the appropriate emission factor.

2.1.4 Reference Case GHG Profile: Method Employed

The reference case provides a projection of GHG emissions to 2020 and 2030, in the absence of any new GHG abatement measures planned for implementation after 2010. The reference case is the baseline against which the scenarios of energy savings are calculated. The reference case includes existing iron ore operations and those operations planned for development within the study period and scope defined in section 1.3.4.

The reference case development involves the following steps:

- Data on projected energy use, mining output and equipment changes was part of the initial data request to the participating companies.

- There were circumstances where the companies were not able to provide insights to changes in the percentage of total energy use allocations by specific energy end-use. In such circumstances, the base year energy end-use allocations were frozen for the reference case period.

2.2 NL Iron Ore Sector Base Year GHG Emissions

This sub-section profiles the NL iron ore sector base year GHG emissions.

Exhibit 6 profiles base year GHG emissions according to the GHG source categories. As shown, over 54% of base year GHG emissions come from on-site mobile emission sources, followed by GHG emissions generated from stationary combustion.

Exhibit 6 Base Year GHG Emissions by Source Category

Emission Type	Emissions (tonne CO_2e)	% of Total Emissions
Stationary	156,089	43.6%
Mobile	194,465	54.3%
Fugitive	7,481	2.1%
Total	358,036	100%

Exhibit 7 profiles base year GHG emissions according to the fuels (and products) used in these operations. As shown, diesel use accounts for the majority of all base year GHG emissions. Included in the “other” category are propane, and non-fuel sources, such as blasting material (e.g., ANFO).

Exhibit 7 Base Year GHG Emissions by Emission Source

Emission Source	Emissions (tonne CO_2e)	% of Total Emissions
Gasoline	3,821	1.1%
Diesel	269,316	75.2%
Fuel Oil	77,347	21.6%
Other	7,553	2.1%
Total	358,036	100.0%

2.3 NL Iron Ore Sector Reference Case GHG Emissions Projection (2020 and 2030)

This sub-section profiles the NL iron ore sector base reference case GHG emissions.

Exhibit 8 profiles the reference case GHG emissions according to the GHG source category. As shown, emissions levels are expected to increase in the period up to 2020 and then to decrease. The increase in emissions is attributable, in part, to the anticipated opening of new mining operations, while the projected decrease is due, in part, to the anticipated closing of another mine.

Exhibit 8 Reference Case GHG Emissions by Source Category

Source Category	Emissions (tonne CO_2e)		
	2010	2020	2030
Stationary	156,089	180,297	105,141
Mobile	194,465	664,855	447,474
Fugitive	7,481	19,855	17,543
Total	358,036	865,007	570,158

Exhibit 9 profiles reference case GHG emissions according to the fuels (and products) used in these operations. As shown, emissions from the category of “other” are expected to increase to 2020 and then decrease between 2020 and 2030, whereas emissions from gasoline are expected to increase through to 2030, and diesel and fuel oil are expected to increase between 2011 and 2020 and then remain fairly constant until 2030.

Exhibit 9 Reference Case GHG Emissions by Emission Source

Emission Source	Emissions (tonne CO_2e)		
	2010	2020	2030
Gasoline	3,821	7,936	8,117
Diesel	269,316	732,027	439,365
Fuel Oil	77,347	105,119	105,115
Other	7,553	19,926	17,561
Total	358,036	865,007	570,158

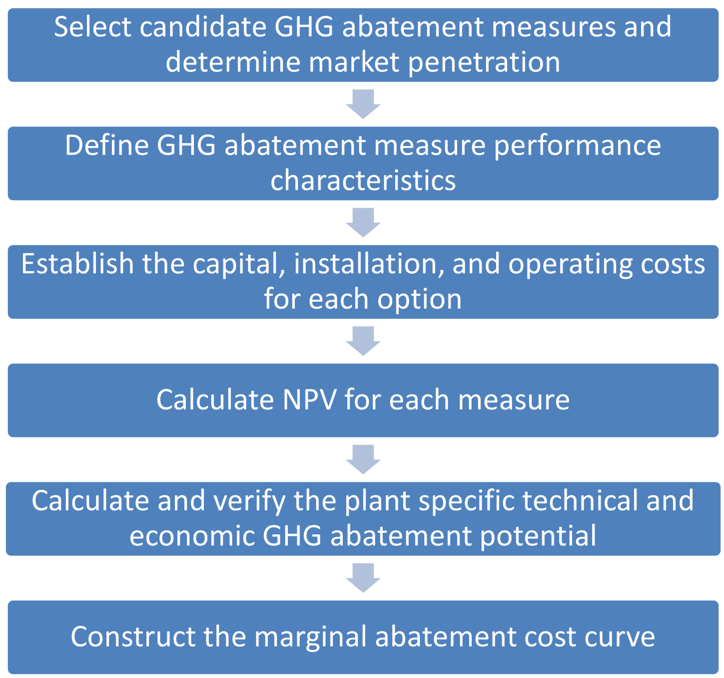
3 GHG Abatement Measures Assessment

This section presents the analysis of the technical and economic performance of GHG abatement measures for the NL iron ore sector. The discussion is organized and presented according to the following topics:

- Method
- GHG abatement technologies
- Summary of results
- Marginal abatement cost curves (MACC)

3.1 Method

The following steps were employed to assess the GHG abatement measures:



A brief description of each step is provided below.

Step 1 Select Candidate GHG Abatement Measures

The purpose of this step is to assemble a long list of candidate GHG abatement measures for the NL iron ore sector. As noted, the scope of the GHG abatement measures is limited to those measures applicable to scope 1 direct GHG emissions. Electricity saving measures are not included unless diesel generator produced electricity is used on-site.

The GNL "Climate Change Action Plan 2011" calls for "early actions" which includes extension of the Best Available Control Technology (BACT) requirements in the provincial Air Pollution Control Regulations to GHG emissions for new investments in the large industrial sector. For the purposes of this analysis, we use the USEPA "definition" for Best Available Control Technology (BACT), as follows:

BACT is an emissions limitation that is based on the maximum degree of control that can be achieved by a particular facility. It is a case-by-case decision that takes into account technical feasibility, cost, and other energy, environmental, and economic impacts. BACT can be add-on control equipment or modification of the production processes or methods. BACT may be a design, equipment, work practice, or operational standard if imposition of a numeric emissions standard is infeasible.

Step 1 involves the following elements:

- The candidate GHG abatement measures were assembled based on extensive literature research and use of ICF Marbek's existing in-house library of measures. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry.
- This long-list of GHG abatement measures was then reviewed and those that are applicable to the processes for the mining companies in NL were selected for the short-list of measures.
- The short list of GHG abatement measures was assembled into a BACT assessment template and sent to participating companies to be filled in. The baseline market penetration of the candidate GHG abatement measures was determined from the mining company input.
- Company responses indicating partial or no implementation of GHG abatement measures triggered further research into those abatement opportunities. This was carried out using in-house expertise, discussion with technical experts and estimation of costs though equipment suppliers for the appropriate plant specific size required for adoption of the technologies.

Step 2 Define GHG Abatement Measure Performance Characteristics

The purpose of this step is to profile the GHG abatement measures performance characteristics.

Exhibit 10 presents the template used to profile the GHG abatement measures.

Exhibit 10 Template for GHG Abatement Solutions Profile

GHG Abatement Measure Profile			
Measure Profile:	Brief description of measure	**Commercially Available**	Yes/No
Applicable industry sector	Mining	**Applicable to new or existing facilities**	New/ Existing
Applicable Sub-process	e.g. Extraction/Concentration/ Transport/ Shipping	**GHG savings %**	%
Affected Fuel	**Source** (yes / no)	**% Savings (relative to baseline)** (range or average)	**Summary Description and Energy Savings**
Natural Gas	No		A summary of the description and the associated energy savings
Electricity	No		
Diesel	Yes	e.g. 10%	
Other Refined Petroleum Products (RPP)	No		
Other Fuel (specify)			
Description			
Description of technology, implementation or engineering issues associated with adoption in the context of Newfoundland and Labrador			
Implementation Costs			
Cost parameters			
Assumptions for Costs:			
Calculation/assumptions for costs			
Other Notes:			
Reference Sources			
Sources of information			

Using the ICF Marbek modelling platform, the technical GHG savings potential was estimated for each applicable GHG abatement measure.

Step 3 Establish the Capital, Installation, and Operating Costs for Each Option

The purpose of this step was to develop a costing profile for each measure used to populate the templates in Step 2 above. The key cost inputs are: abatement measure capital cost and abatement measure O&M Cost.

The definition of the key cost inputs is presented below.

Topic	Method
Measure useful life	The length of time the savings can be expected to persist. In the case of an equipment replacement measure, this will be the equipment useful life.
Definition and applicability of incremental cost measure	Incremental cost is defined as the cost difference for the GHG abatement measure relative to the baseline technology. The incremental cost is applicable when: ▪ An upgrade to equipment in a new facility design, prior to the purchase of a standard performance equipment ▪ A measure is installed at the end of equipment's useful life in an existing facility.
Definition and applicability of full cost measure	The full cost is applicable when: ▪ Equipment in an existing facility is replaced with a more efficient model prior to the end of its useful life. ▪ Equipment add-ons to existing operations ▪ Equipment add-on in a new facility design.
Operating costs	The change in operating and maintenance costs associated with the implementation of a GHG abatement measure

All cost inputs are expressed in constant 2012 dollars.

Step 4 Calculate NPV for Each Measure

The purpose of this step is to calculate the net present value (NPV) of the GHG abatement measures. To reiterate, this is an economic analysis which considers the costs and benefits from a societal perspective. All results are provided in current 2012 dollars.

The NPV is calculated as the cost of investing in a GHG abatement measure minus the value of the stream of energy and monetized GHG savings during the useful life of the investment. For those mines that are still on the drawing board, we have assumed the cost of doing something now in the absence of knowing what future capital costs will be.

Each stream of benefits and costs over the lifetime of the equipment/technology is expressed as a single "current year" value according to the following equation:

$$NPV = Capital\ Cost - PV(Annual\ Avoided\ Fuel\ Costs) + PV(Annual\ Avoided\ GHG\ Costs) - PV(Annual\ O\&M\ Costs)$$

Where:

Capital Cost = Total or incremental capital costs of measure implementation, for end of life or retrofit measure implementation, respectively

Annual Avoided Fuel Costs = Value of fuel savings resulting from measure implementation
Annual Avoided GHG Costs = $30/tonne CO_2e
Annual O&M Costs = Change in O&M costs resulting from measure implementation

The PV of each stream is calculated according to the following equation:

$$PV = \frac{R_t}{(1+i)^t}$$

Where:

t = the time of the cash flow
i = the discount rate (taken to be 4% real, in this analysis)
R_t = cash flow at time t

In addition, the NPV analysis was based on the following assumptions:

- As provided by the CCEEET, the schedule of societal cost of fuel is taken from a submission by NALCOR to the Newfoundland and Labrador Board of Commissioners of Public Utilities which includes a schedule of fuel prices derived from the US Energy Information Administration (EIA). The analysis used 2010 industry "reference" prices for diesel (distillate fuel oil) and bunker C (residual oil) and propane (LPG). The 2010 prices were escalated at 2%/yr, which is what Nalcor assumed.

- Also provided by the CCEEET, the societal cost of electricity supply is pegged at 6 cents/kWh in 2010 and apply same escalator.

Step 5 Calculate and verify the Plant specific technical and economic GHG abatement potential

The abatement potential for the iron ore sector as a whole is built up from the analysis of potential within each of the participating iron ore mining operations. As noted, each participating company was provided with a confidential plant report comprising of three main outputs:

- Baseline energy use/cost and GHG profile,
- Baseline energy and GHG intensity
- GHG abatement measure technical and economic assessment.

Following submission of the draft plant report a discussion was held with the company officials to review the results and make modifications if needed.

Step 6 Construct the Marginal Abatement Cost Curve

The final step in the assessment of the selected energy efficiency measures is the generation of the marginal abatement cost curve (MACC). The MACC is an evidence-based tool to assess the potential for GHG abatement in a region and/or sector of the economy according to the cost of abatement. The MACC presents the absolute GHG emissions potential from the various GHG abatement measures and the costs of achieving these GHG reductions.

The MACC curve is developed based on the analysis of the reduced GHGs and the NPV for each measure. In the MACC, the costs are presented on the Y axis in NPV $/tonnes of CO_2e. The GHG abatement potential is presented on the Y axis in tonnes of CO_2e.

The following approach is followed:

- The GHG abatement measures are introduced in sequence from lowest to highest average NPV
- Where more than one GHG abatement measure affects the same energy end use, the savings shown for the second measure are incremental to those already shown for the first, i.e., the savings are applied to the net GHG emissions remaining after implementation of the previous GHG abatement measure.
- The Marginal Abatement Cost (MAC) for each GHG abatement measure ($/t CO_2e) on the Y axis is calculated as:

  Measure Net Present Value ($) / Cumulative GHG emissions saved from abatement project during measure lifetime (t CO_2e).

- Since the MACC is generated for the sector as a whole, the calculation of measure NPV must take into account that the cost of implementation and the associated GHG emissions reduction varies from plant to plant. Therefore, measure NPV is calculated as:

  PV Total Cost for all measures – PV Total Savings for all measures, across all plants.

3.2 Results

3.2.1 Abatement Measures Assessed in the Study

Exhibit 11 lists the GHG abatement measures that were included in the study, organized according to GHG source category. Only a small subset from this list was included in the sector analysis, determined on the basis of applicability and cost.

Exhibit 11 GHG Abatement Best Available Control Technologies Included in the Study

End-Use	Measure	Process Step
On-site transport systems	Trolley assisted dumpers	Transport
	Efficient haul truck fleet	Transport
	Shutdown of unused mobile equipment	Transport
	Fuel displacement with biodiesel	Transport
	In-pit crushing and conveying system	Transport
	Pneumatic capsule pipelines for ore transport	Transport
	Slurry pipelines	Transport
	Optimized road haul condition	Transport
	Payload management	Transport
	Computerized vehicle dispatch	Transport
Stationary Combustion	Improved blast design	Concentrating
	Optical sorting / separation system	Concentrating
	Carbon dioxide injection during concentration	Concentrating
	Interval and sub-metering	System
	Heat recover on water cooled compressor	Compression Systems

End-Use	Measure	Process Step
	Boiler system type	Boiler Systems
	Economizer system	Boiler Systems
	Boiler load management study	Boiler Systems
	Advanced boiler controls	Boiler Systems
	High efficiency boiler burners	Boiler Systems
	Preheating of boiler makeup water	Boiler Systems
	Preheating of boiler combustion air	Boiler Systems
	Boiler system blow down heat recovery	Boiler Systems
	Automated blowdown control for boiler system	Boiler Systems
	Boiler condensate return	Boiler Systems
	Steam trap survey	Boiler Systems
	Minimize boiler deaerator vent losses	Boiler Systems
	Boiler water treatment	Boiler Systems
	Boiler insulation	Boiler Systems
	Boiler maintenance program	Boiler Systems
	Optimized air-fuel ratio for boiler combustion	Boiler Systems
	Advance process control of heating system	Heating and Drying Systems
	Flue gas heat recover for heating system	Heating and Drying Systems
	High efficiency heater/dryer burners	Heating and Drying Systems
	Heater/dryer insulation	Heating and Drying Systems
	Heater/dryer maintenance program	Heating and Drying Systems
	Optimized air-fuel ratio for heater/dryer combustion	Heating and Drying Systems
Fugitive Emissions	Air-deck blasting technique	Blasting
	Improved blast design	Blasting

3.2.2 Management Best Practices

This sub-section reports on the current and planned actions that the iron ore companies have with regard to the implementation of organizational and management best practices in support of improving energy use and GHG performance. The implementation of management best practices increases the probability that the potential performance benefits of technical GHG abatement measures will be realized.

As noted, one of the three reports produced for this study highlights some of the main technical and cost risks associated with implementation of GHG abatement measures as well as the risks of accommodation to a potentially new GHG regulatory framework for the province. A short survey was carried out to inform the risk assessment and, in the survey document, we included some questions pertaining to the adoption of organizational and management practices in support of energy management.

The risk assessment questionnaire listed organizational and management best practices. Respondents were then asked to assess implementation of these practices using the following scale:

- Fully adopted
- Partially adopted
- Not adopted

Exhibit 12 presents the results and includes a second column that indicates, in qualitative terms, the potential GHG abatement impact that could result if a specific management measures is implemented. Based on the work that ICF Marbek and others have done in energy use benchmarking, there is a robust evidence file that shows how the absence of fully implemented management practices highly correlates to low performance as measured by the adoption of technical measures to improve energy use performance.

Exhibit 12 indicates that, overall, there has been a partial implementation of the best practices. The management practices that have a relatively high impact on GHG abatement appear to have a lower level of implementation than those measures that would have less of an overall GHG reduction impact.

It must be noted that some companies that have not begun operations have rated implementation of management measures in future operations as “too early to determine”, but have indicated what the intention would be once operations are initiated.

Exhibit 12 Results of GHG Abatement-Management Measures

Question	Response summary
Has the company adopted a carbon management plan for the facility which establishes performance targets?	Ranges from No (with some plans in the future) to Fully Adopted
If no, does the company intend to develop such a carbon management plan?	No, but some sites have plans in the future to Fully Adopt
The company has a documented corporate energy management policy and plan which: ▪ Defines long-term strategic energy management commitments and objectives; ▪ Specifies responsibilities and sets targets for controlling energy use and cost.	Ranges from Partially to Fully Adopted
The company requires energy management investments to be assessed using a life-cycle cost analysis methodology that converts estimated savings and cost data into a cash-flow and integrates that cash-flow with other decision-making metrics.	Ranges from Partially to Fully adopted (with a weighting to the latter)
The facility maintains an active energy procurement plan that reviews energy bills, reviews energy consumption data and assesses tariff structure.	Fully Adopted
The facility tracks the difference between actual and targeted energy consumption and production process levels and causes of increased or decreased consumption are assessed.	Fully Adopted
The plant uses a consistent communications and reporting protocol to channel key performance indicator results and relevant energy use information to business units and staff.	Ranges from No to Fully Adopted (with a weighting to the latter)
The facility has implemented optimal training vehicle operational practices (e.g., proper excavator operating position provides efficient digging and use of the accelerator pedal during dumping affects fuel consumption).	Ranges from Partially to Fully Adopted
The facility intends to adopt the ISO 50001 Energy Management Standard.	Not at present, some with plans for future adoption
The facility has adopted or intends to adopt the Guiding Principles associated with the TSM (Towards Sustainable Mining Initiative)	Ranges from Partially to Fully Adopted

3.3 Marginal Abatement Cost Curve

3.3.1 Results

Exhibit 13 presents the marginal abatement cost curve (MACC) for the NL iron ore sector in 2030. Exhibit 14 presents the detailed results for the GHG abatement measures included in the MACC. The number labels in Exhibit 13 refer to the GHG abatement measure number shown in Exhibit 14. The following observations emerge (refer to both Exhibits):

- Final GHG abatement measures analyzed: As shown, a total of 20 BACT GHG abatement measures were modelled. This is the final set of measures deemed to be applicable to the opportunities in the existing mine operations and for the mine operations that are planned for development in approximately the next 5 years.

- Annual abatement: Column A in Exhibit 14 presents the abatement impact of the one measure in 2030, relative to the reference case GHG emissions in that year that would have occurred in the absence of the abatement measure.

- Cumulative abatement: Column B in Exhibit 14 presents the cumulative abatement impact of the one measure achieved over 2010-2030. By 2030, implementation of all of the applicable BACT GHG abatement measures will result in a cumulative GHG emissions reduction of 5,373kt CO_2e. Again, as previously noted, this value is higher than what would be the achievable potential because of the fact that some of the abatement measures relevant to a specific end-use are not additive.

- Average NPV: Column C in Exhibit 14 presents the average NPV of the abatement measure. Most of the abatement measures generate a positive benefits stream over the study period (indicated as negative NPV).

- Cost of Abatement: Column D in Exhibit 14 presents the unit cost per tonne of abatement. In Exhibit 13, the modeled GHG abatement measures are shown on the Y axis starting on the left side of the graph with the least cost measure (per tonne CO_2e reduction) and then moving to the right in sequence with the next least cost measure.

  As shown, the majority of the GHG abatement measures (17 of 20) represent a negative cost to achieve one tonne of GHG emissions reduction meaning that, over the lifetime of the GHG abatement measure, the stream of economic benefits will be greater than the stream of costs incurred to implement and maintain the measure. Within this group of GHG abatement measures there are two sub-groups:

  - So-called “big ticket” abatement measures involving large capital outlays generating significant GHG emission reductions and benefit streams over the useful life of the measures, (e.g., in-pit crushing and conveying system and trolley assisted dumpers).
  - Low cost management and operational best practices (e.g., computerized vehicle dispatch, sub-metering energy use and payload management).

- Total cost of Abatement: Column E in Exhibit 14 presents the total cost of achieving the GHG emissions abatement over the study period. The cost estimates pertain to capital costs only as determined from an estimate of the costs of implementation in the mining operations where they were deemed to be applicable. As shown, the most costly investments would be for the in-pit crushing and conveying system and the trolley assisted dumpers.

Exhibit 13 GHG Marginal Abatement Cost Curve for the Iron Ore Sector, 2030

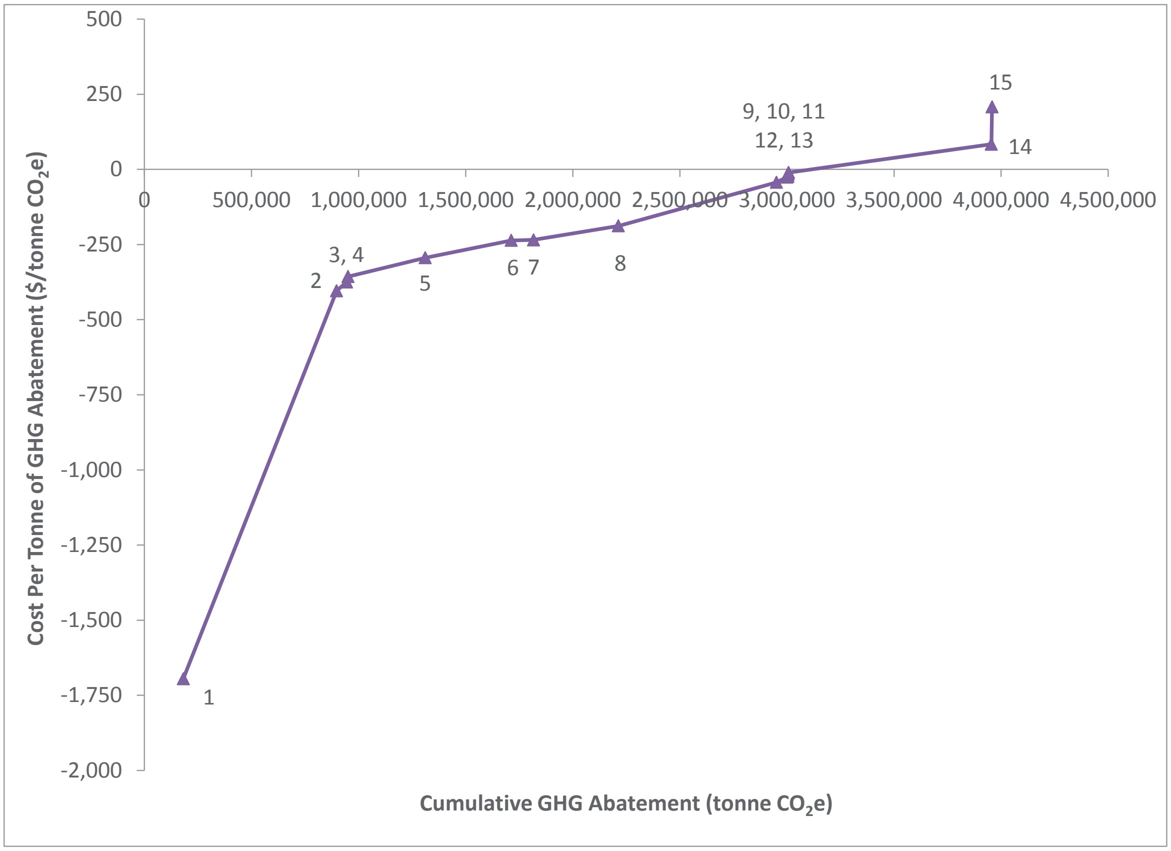


Exhibit 14 Summary of Mining Sector GHG Abatement Measures, 2030

#	End-use	Measure	Total Abatement (tonne/ CO_2e/year)	Cumulative Abatement (tonne/ CO_2e/year)	NPV Abatement (thou $)	Cost of Abatement ($/tonne CO_2e)	Total Cost of Abatement (thou $)
			A	B	C	D	E
1	Transport	Computerized vehicle dispatch	105,190	105,190	(202,323)	(2,883)	6,765
2	Transport	Efficient haul truck fleet	729,479	834,668	(39,355)	(364)	1,111
3	Transport	Shutdown of unused mobile equipment	51,500	886,168	(1,527)	(264)	0
4	Transport	Optimized road haul condition	372,284	1,258,452	(28,037)	(251)	0
5	System	Interval and sub-metering	51,844	1,310,296	(11,001)	(217)	57
6	Transport	Payload management	442,861	1,753,157	(26,775)	(206)	5,969
7	Heating & Drying Systems	Heater/dryer maintenance program	34,682	1,787,838	(1,331)	(205)	0
8	Transport	Trolley assisted dumpers	813,915	2,601,753	(219,868)	(187)	39,775
9	Heating & Drying Systems	Optimized air-fuel ratio for heater/dryer combustion	54,564	2,656,317	(593)	(185)	480
10	Heating & Drying Systems	Flue gas heat recover for heating system	146,309	2,802,627	(20,818)	(161)	2,984
11	Heating & Drying Systems	Heater/dryer insulation	20,727	2,823,354	(2,949)	(161)	10
12	Heating & Drying Systems	Advance process control of heating system	80,836	2,904,190	(11,502)	(161)	1,194
13	Heating & Drying Systems	High efficiency heater/dryer burners	108,377	3,012,567	(19,532)	(153)	2,984
14	Compressor for Process Air or Gas System	Heat recover on water cooled compressor	11,279	3,023,846	(1,344)	(135)	338
15	Transport	In-pit crushing and conveying system	1,559,945	4,583,791	(161,946)	(116)	239,327
16	Concentrating	Improved blast design	737,913	5,321,704	(39)	(29)	0
17	Blasting	Air-deck blasting technique	51,504	5,373,207	(116)	(18)	0
18	Boiler Systems	Economizer system	9	5,373,217	644	57,972	646
19	Boiler Systems	Automated blowdown control for boiler system	1	5,373,218	106	76,066	35
20	Boiler Systems	Preheating of boiler combustion air	6	5,373,224	3,735	696,149	2,109

3.3.2 Recap of Key Findings

Recap

Finding	Commentary
GHG abatement measures	A total of 20 GHG abatement measures were determined to be technically viable and applicable to all or some of the sector mining operations. Of this set, 7 measures pertain to abatement of emissions associated with on-site transportation.
Cumulative impact	The measures with the largest GHG abatement potential are: in-pit crushing and conveying system affecting on-site transportation; improved blast design and trolley assisted dumpers for transportation.
Economic business case	Seventeen of the 20 abatement measures generate a positive net present value and a negative cost per tonne of abatement. Of the 4 measures that do not show an economic business case, preheating of boiler combustion air represents the largest abatement potential.
Capital investment required	While the 20 abatement measures are not necessarily additive in terms of total abatement impact, if all were to be implemented it would require a capital investment of about $304 million.

Commentary on the Analysis Precision

The analysis presented in this report is robust and defensible, based on the thorough bottom up method as elaborated. Nevertheless, in terms of precision, the analysis is high level and should be viewed as falling somewhere between what the mining sector would characterize as a “venture analysis” and a “prefeasibility analysis”. At the discretion of the CCEEET, the outcomes could be subject to further feasibility studies.

4 Technical and Economic GHG Abatement Potential

This section presents the results of the technical and economic GHG abatement potential for the NL iron ore sector.

It's important to note an important distinction between the cumulative GHG emissions reduction shown in the MACC and what is calculated in the technical and economic potential and presented in this section.

- GHG Emissions savings: As noted, the cumulative impact is the sum of all emissions reduction from all GHG abatement measures implemented over the full study period.

- GHG Emission Level Reductions: Conversely, the technical and economic potentials are "snapshots" in time that represent the difference in a given year between the reference case GHG emissions levels and the GHG emissions levels in that year as a result of all GHG abatement measures implemented over the full study period.

4.1 Technical GHG Emission Abatement Potential

The technical GHG abatement potential is an estimate of the GHG emission reduction potential in 2020 and 2030 that would exist in the NL iron ore sector in the absence of economic constraints to the implementation of the abatement measures. The analysis is based on all of the GHG abatement measures included for the MACC analysis.

4.1.1 Method

The steps involved in modelling the technical potential are as follows:

- As noted, the GHG abatement measures are costed on either a full or incremental cost basis. Incremental cost abatement measures are modelled at the end of the equipment useful life in existing facilities or immediately in the case of a new facility design. Full cost abatement measures are modelled in the first study milestone year (2020 or 2030) in existing facilities or immediately in the case of a new facility design.
- Individual abatement measures savings are cascaded, with each abatement measures saving a percentage of the remaining GHGs in an applicable GHG source category.
- The GHG technical potential is calculated as the difference between the reference case GHG emissions for milestone years 2020 and 2030 and the GHG emissions for the same milestone years that exist after the abatement measures are implemented.

4.1.2 Results

The technical GHG emission abatement potential results, by source category, are presented in Exhibit 15. As shown, emissions from stationary and mobile fuel sources have the highest levels of technical GHG emission abatement potential, while no process emission reduction measures were identified.

Exhibit 15 Technical GHG Emission Abatement Potential Results by Source Category

Source Category	GHG Emissions Savings (tonne CO_2e)	
	2020	2030
Stationary	32,386	30,380
Mobile	162,312	197,919
Fugitive	4,681	3,858
Process	-	-
Total	199,389	232,158

The technical GHG emission abatement potential results, by emission source, are presented in Exhibit 16. As shown, diesel and fuel oil use have the highest technical GHG emission abatement potential, while very little GHG emission abatement potential was identified for gasoline use.

Exhibit 16 Technical GHG Emission Abatement Potential Results by Emission Source

Source Category	GHG Emissions Savings (tonne CO_2e)	
	2020	2030
Gasoline	69	70
Diesel	164,962	199,085
Fuel Oil	29,677	29,144
Other	4,682	3,859
Total	199,389	232,158

4.2 Economic GHG Emission Abatement Potential

The economic GHG emission abatement potential is an estimate of the GHG emission reduction opportunity that would exist in 2020 and 2030. The analysis is based on the GHG abatement measures included for the MACC analysis that were assessed to be economically feasible.

4.2.1 Method

As noted in section 3, the GHG abatement measure NPV analysis is applied to each of the measures deemed to be applicable to existing and planned iron ore operations in NL. The GHG abatement measures that generated a positive NPV were screened into the economic analysis.

The steps involved in modelling the economic potential are the same as those followed for the technical potential. The absolute GHG economic potential is calculated as the difference between the reference case GHG emissions for milestone years 2020 and 2030 and the GHG emissions for the same milestone years that exist after the economic abatement measures are implemented.

4.2.2 Results

The technical GHG emission abatement potential results, by source category, are presented in Exhibit 17. As shown, emissions from stationary and mobile fuel sources continue to have the highest levels of technical GHG emission abatement potential.

Exhibit 17 Economic GHG Emission Abatement Potential Results by Source Category

Source Category	GHG Emissions Savings (tonne CO_2e)	
	2020	2030
Stationary	31,862	30,379
Mobile	155,459	139,771
Fugitive	2,961	3,242
Process	-	-
Total	190,282	173,392

The technical GHG emission abatement potential results, by emission source, are presented in Exhibit 18. As shown, diesel and fuel oil use have the highest economic GHG emission abatement potential.

Exhibit 18 Economic GHG Emission Abatement Potential Results by Emission Source

Source Category	GHG Emissions Savings (tonne CO_2e)	
	2020	2030
Gasoline	69	70
Diesel	158,109	140,936
Fuel Oil	29,143	29,143
Other	2,961	3,243
Total	190,282	173,392

4.2.3 Recap of GHG Emission Reduction Potential

Exhibit 19 presents a graphical recap of the technical and economic GHG reduction potential in 2020 and 2030, relative to the level of GHG emissions that would have occurred under the reference case projection. As previously noted, the bend on the curve post 2020 is due to the fact that the reference case GHG emissions are projected to decline during this period.

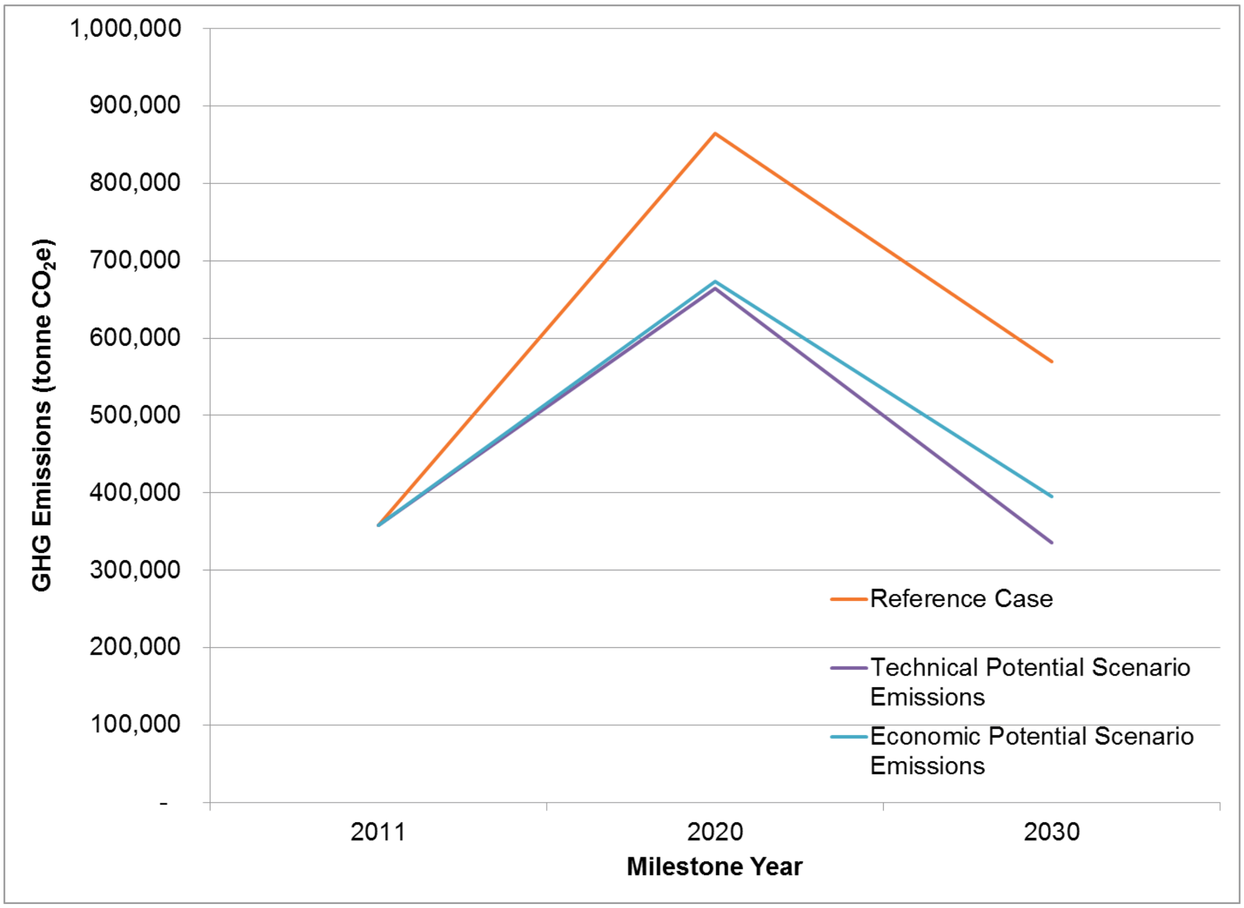
In 2020, the technical potential to reduce GHG emissions is about a 23% reduction in level of emissions relative to the reference case GHG emissions and this potential increases to about a 41% reduction in 2030.

The technical potential in 2020 is about a 56% reduction in the level of emissions relative to the baseline GHG emissions and in 2030 is about a 65% reduction in 2030 relative to the baseline.

In 2020, the economic potential to reduce GHG emissions is about a 22% reduction in level of emissions relative to the reference case GHG emissions and this potential increases to about a 31% reduction in 2030.

The economic potential in 2020 is about a 54% reduction in the level of emissions relative to the baseline GHG emissions and in 2030 is a 49% reduction in the level of emissions relative to the baseline.

Exhibit 19 Graphical Depiction of Technical and Economic GHG Emissions Reduction Potential in the Iron Ore Sector: 2020 and 2030



Appendix A Glossary

Baseline technology
The existing equipment against which upgrade technologies are compared and to GHG abatement measures are applied.

Base Year
The Base Year is the year to which all potentials are compared. It provides a detailed description of “where” and “how” GHG emissions are generated. For this study, it is the calendar year 2010.

Economic Potential
The Economic Potential scenario provides an estimate of the level of savings that would occur if all the technical best practices that passed the economic benefit cost tests are applied to the iron ore sector sources of GHG emissions.

Economically feasible
A GHG abatement measure is considered economically feasible if it has a negative NPV.

Energy efficiency, energy conservation best practices and GHG abatement technology
The management and operation practices that represent the most advanced practices available to an industry.

Energy end use profile
The percentage breakdown, by fuel type and end use, of energy use in a given sub-sector.

Energy management
The focus of the energy management potential analysis is to quantify the potential reduction in energy consumption due to energy management actions. In this context, energy management addresses energy consumption and not energy demand.

Greenhouse gas emissions
The emission of gases, most often through the burning of fossil fuels, that act to trap heat in the atmosphere, contributing to global warming.

Marginal Abatement Cost Curve
An evidence-based tool to assess the potential for GHG abatement in a region and/ or sector of the economy according to the cost of abatement, derived by generating expectations about the potential for abatement relative to a reference case (representing emissions profiles absent any extraordinary effort to abate) and the cost of abatement relative to the reference case.

Market penetration rate
The level at which a given measure is adopted in the market place.

Milestone years
Key years over the study period at which estimates of GHG emissions and potential reductions are estimated.

Replacement measure/technology
An energy efficiency measure/technology that can be installed to replace a less efficient piece of equipment. Replacement measures are usually applied on an incremental cost basis, as they are most often implemented once the existing piece of equipment has reached the end of its useful life and is due for replacement.

Reference Case
This is a projection of energy use to 2030, in the absence of any new energy management market interventions after 2010 (i.e., incremental to what utilities and government have already planned for this period). The Reference Case is the reference against which the scenarios of energy savings are calculated.

Retrofit measure/technology
An energy efficiency measure/technology that can be used to upgrade an existing piece of equipment, as opposed to replacing it. Retrofit measures are applied on a full cost basis and may be implemented immediately.

Technical best practices
A set of measures that represent the most energy efficiency technologies available.

Total Resource Cost test
An economic test that compares the total costs of energy efficiency investments to the cost of energy production. Un-priced environmental and social costs may be accounted for by changing the cost of either the investment under consideration or the total cost of each fuel type in such a way that relative un-priced impacts are reflected.

Appendix B Abbreviations

CO_2: Carbon dioxide

CO_2e: Equivalent carbon dioxide CO_2

EM: Energy management

EOL: End of life

GHG: Greenhouse gas

MACC: Marginal Abatement Cost Curve

NEB: National Energy Board

NPV: Net present value

RPP: Refined petroleum products

BACT: Best Available Control Technology

TRC: Total resource cost

Appendix C Review of Data Provided with Regard to GHG Quantification

This section provides an overview of the type of data that was provided and the associated limitations with respect to GHG quantification.

Stationary Combustion

The type of company activity data provided included the following:

- Fuel type (e.g., diesel, fuel oil, gasoline, etc.)
- Lower Heating Value of fuels
- Fuel consumption (in volume or mass)
- Basic equipment type (e.g., boiler, furnace, etc.)

As discussed above, the greater amount of site-specific detail provided, the higher tiered methodology that can be applied, and the greater assurance associated with the emissions results. The activity data provided was not detailed in nature. For example, a detailed approach to quantifying GHG emissions from fuel consumption would require the quantity of fuel combusted and measurements[3] of fuel carbon content, conducted by the operator or provided by the fuel supplier. Another detailed approach would be to use quantity of fuel combusted, a default fuel-specific emission factor, and the high heat value provided by the supplier or measured by the operator.

However, given a lack of detailed site-specific data, this tier of quantification is not possible. Therefore, the GHG method selected for this inventory is to estimate emissions based on quantity of fuel combusted (as provided) and a default fuel- and gas- (CO_2, CH_4, N_2O) specific emission factor.

Mobile Combustion

The type of company activity data provided included the following:

- Fuel type (e.g., diesel, gasoline)
- Lower Heating Value of fuels
- Fuel consumption (in volume)
- Basic equipment type (e.g., excavator, pickup truck, etc.)

Similarly for mobile combustion, the greater amount of site-specific detail provided, the higher tiered methodology that can be applied. The activity data associated with mobile combustion was generally not detailed in nature. For example, specific models of vehicle identifying specific emission control technologies (e.g., advanced, moderate, uncontrolled for diesel vehicles or three-way catalyst, non-catalytic controlled, uncontrolled for gasoline) were generally not provided.

As a result, assumptions have to be made on the level of emission control technologies on the mobile equipment. To ensure a conservative estimate, default fuel- and vehicle type- specific emission factors are selected with moderate control, as applicable.

[3] Note: There are strict requirements for on-site and supplier measurements associated with each different protocol.

Fugitive Emissions

In this inventory, blasting emissions are the only fugitive emissions considered. Another possible source of fugitive emissions at mines would be HFC emissions from refrigeration or cooling equipment; however, no information was provided on these sources, therefore they have been excluded from the inventory.

The type of company activity data provided included the following:

- Blasting material (brand name)
- Blasting quantities (in mass)

Different types of fuel are used to detonate explosives. GHG emissions resulting from the detonation of explosives are due to the following reasons: the carbon content of the fuel type (e.g., diesel) used in the mixture[4]; and to the condensed materials in the explosives that are transformed to gases[5]. Emissions for blasting material can be estimated using the mass of explosives and an appropriate emission factor.[6] Although not as broadly published, emission factors for specific blasting materials have been developed and can be found in several studies, reports, and journal articles. As such, this GHG quantification includes emissions from the detonation of explosives.

[4] Environment Canada, Metal Mining: Guidance Manual for Estimating Greenhouse Gas Emissions, March 2004.

[5] Richard Martel, et al., *Carbon monoxide poisoning associated with blasting operations close to underground enclosed spaces – Part 1 – CO production and migration mechanisms*, Can. Geotech. J. 41: 371–382 (2004).

[6] Environment Canada, *Metal Mining: Guidance Manual for Estimating Greenhouse Gas Emissions*, March 2004.

Appendix D Equations Used to Estimate GHG Emission Factors

This section presents the equations used to estimate the GHG emissions for the iron ore mining activity in NL.

Stationary Combustion

For stationary combustion, each calculation must be carried out for one fuel at a time. Total equivalent carbon dioxide (CO_2e) is calculated by summing the CO_2e for each individual fuel.

$$CO_2e = \left(Fuel_{\,s} \times EF_{f,CO2}\right) + \left(Fuel_{\,s} \times EF_{f,CH4} \times GWP_{CH4}\right) + \left(Fuel_{\,s} \times EF_{f,N2O} \times GWP_{N2O}\right)$$

Where:
CO_2e = Annual equivalent carbon dioxide mass emissions for the specific fuel type
$Fuel_s$ = Annual volume (or mass if a solid fuel) of fuel combusted in stationary equipment
EF_n = Fuel- and gas$_n$-specific default emission factor
GWP_n = Gas$_n$-specific global warming potential

Mobile Combustion

For mobile combustion, each calculation must be carried out for one fuel and one vehicle type at a time. Total equivalent carbon dioxide (CO_2e) is calculated by summing the CO_2e for each individual fuel/vehicle type.

$$CO_2e = \left(Fuel_{\,m} \times EF_{f,CO2,e}\right) + \left(Fuel_{\,m} \times EF_{f,CH4,e} \times GWP_{CH4}\right) + \left(Fuel_{\,m} \times EF_{f,N2O,e} \times GWP_{N2O}\right)$$

Where:
CO_2e = Annual equivalent carbon dioxide mass emissions for the specific fuel type
$Fuel_m$ = Annual volume of fuel combusted in mobile equipment
EF_n = Fuel-, gas$_n$, and equipment-specific default emission factor
GWP_n = Gas$_n$-specific global warming potential

Process Emissions

$$CO_2 = (A_{\,FM1} \times EF_{FM1}) + (A_{\,FM2} \times EF_{FM2}) + (A_{\,C} \times EF_C) + (A_{\,CB} \times EF_{CB})$$

Where:
CO_2 = Annual CO_2 mass emissions from the indurating furnace
A_{FM} = Annual mass of flux materials fed into the furnace
EF_{FM} = Emission factor for each flux material (limestone, dolomite)
A_C = Annual mass of concentrate fed into the furnace
EF_C = Emission factor for concentrate
A_{CB} = Annual mass of coke breeze used in the process
EF_{CB} = Emission factor for coke breeze

Stoichiometric Check:

$$CO_2 = \left[\left(\frac{44}{100}\right) \times f_{ls} \times Q_{ls}\right] + \left[\left(\frac{2 \times 44}{184}\right) \times f_d \times Q_d\right]$$

Where:
CO_2 = Annual CO_2 mass emissions from the indurating furnace
f_{ls} = Fractional purity of limestone
Q_{ls} = Quantity of limestone consumed
f_d = Fractional purity of dolomite
Q_d = Quantity of dolomite consumed
44/100 = stoichiometric ratio of $CO_2/CaCO_3$ (limestone)
(2x44)/184 = stoichiometric ratio of $CO_2/CaCO_3 \cdot MgCO_3$ (dolomite)

Note: Process CH_4 emissions are determined either using a CEMS or using site-specific emission factors. Neither method is possible given the type of data acquired.

Fugitive Emissions

Similar to stationary and mobile combustion, each calculation must be carried out for one blast material at a time. Total equivalent carbon dioxide (CO_2e) is calculated by summing the CO_2e for each individual blast material.

$$CO_2e = (Blast \times EF_{b,CO2}) + (Blast \times EF_{b,CH4} \times GWP_{CH4}) + (Blast \times EF_{b,N2O} \times GWP_{N2O})$$

Where:
CO_2e = Annual equivalent carbon dioxide mass emissions for the specific blast material
Blast = Annual mass of material detonated
EF_n = Blast material- and gas$_n$-specific default emission factor
GWP_n = Gas$_n$-specific global warming potential

Emission Factors and Global Warming Potential

Table D-1, overleaf, presents the emission factors and sources used in calculating the baseline GHG inventory.

The following GWP values are used:

- CH_4 : 21
- N_2O : 310

Table D-1: Emission Factors

SOURCE CATEGORY	FUEL TYPE	MODE	EF - CO2	EF - CH4	EF - N2O	Units	REFERENCE
Stationary Combustion	Diesel	Stationary	2663	0.133	0.4	g/L	Canada NIR 1990 -2009 (Table A8-4)
	Light fuel oil	Stationary	2725	0.006	0.031	g/L	Canada NIR 1990 -2009 (Table A8-4)
	Heavy fuel oil (#6)	Stationary	3124	0.12	0.064	g/L	Canada NIR 1990 -2009 (Table A8-4)
	Distillate oil (fuel oil no. 2)	Stationary	2672	0.0062	0.031	g/L	Guidance Document for Emissions Calculator: Airborne Contaminant Emissions from Fuel Oil Combustion
	Propane	Stationary	1510	0.024	0.108	g/L	Canada NIR 1990 -2009 (Table A8-3)
Mobile Combustion	Diesel	Off-road	2663	0.15	1.1	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Diesel	HDDV - moderate control	2663	0.14	0.082	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Diesel	LDDT - moderate control	2663	0.068	0.21	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Diesel	LDDV - moderate control	2663	0.068	0.21	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Diesel	Railway	2663	0.15	1.1	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Gasoline	HDGV - Non-catalytic Controlled	2289	0.29	0.047	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Gasoline	LDGT - Oxidation catalyst	2289	0.43	0.2	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Gasoline	LDGV - Oxidation catalyst	2289	0.52	0.2	g/L	Canada NIR 1990 -2009 (Table A8-11)
	Propane	Off-road	1510	0.64	0.028	g/L	Canada NIR 1990 -2009 (Table A8-11)

SOURCE CATEGORY	BLAST MATERIAL	-	EF - CO2	EF - CH4	EF - N2O	Unit	REFERENCE
Fugitive Emissions	Unimax	-	299.82	-	-	kg/tonne	Martel et al. (2004)
	Blastex 75X400	-	102.74	0.15	8.29	kg/tonne	Martel et al. (2004) Note: Blastex Plus used as a proxy for Blastex.
	BlastGel 1070 (125mm)	-	102.74	0.15	8.29	kg/tonne	D. Lynn Gordon, Dyno Nobel Inc. Note: Blastex Plus used as a proxy for Blastgel 1070.
	BlastGel 1070 (95mm)	-	102.74	0.15	8.29	kg/tonne	D. Lynn Gordon, Dyno Nobel Inc. Note: Blastex Plus used as a proxy for Blastgel 1070.
	ANFO	-	167.3	0.09	18.23	kg/tonne	Mineralogy Pty Ltd. (2006) Martel et al. (2004)
	WR ANFO	-	167.3	0.09	18.23	kg/tonne	Martel et al. (2004) Note: ANFO used as a proxy for WR ANFO.
	Titan XL 1000	-	95.55	-	-	kg/tonne	D. Lynn Gordon, Dyno Nobel Inc. Assumed to be approximately 93% of Blastex.

High Level Risk Assessment of GHG Abatement in the Newfoundland and Labrador Iron Ore Sector-Final Report

December 2012

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1. Introduction and Methodology

1.1 About This Report

This document represents the fourth milestone report for the Government of Newfoundland and Labrador (GNL) Office of Climate Change, Energy Efficiency and Emissions Trading (CCEET) under the auspices of the **Study to Identify Greenhouse Gas Reduction Opportunities and Competitiveness Implications: Iron Ore Mining – Newfoundland and Labrador**.

In its 2011 Climate Change Action Plan, the GNL reaffirmed its commitment to reduce the province's GHG emissions by 10% below 1990 levels by 2020 and between 75%-85% below 2001 levels by 2050. In order to meet those objectives, the GNL also committed to develop and release in 2012 a detailed approach for reducing GHG emissions from the energy-intensive sectors.

The overall study objective is to provide an objective and independent review of GHG regulation and opportunities for the iron ore industry to inform policy development. The main outputs from the study are:

- An assessment of GHG abatement solutions for the iron ore sector in Newfoundland and Labrador (NL), including pelletizing, and how these solutions would rank on a marginal GHG abatement cost curve.
- A profile of how the mining industry is regulated, from a GHG reduction perspective, in other jurisdictions and lessons learned to date.
- Identification of any technical and cost considerations that may arise from the application of performance standards to reduce GHG emissions on the iron ore industry in N&L (this report).

The objective of this task and milestone is to conduct a preliminary, high level risk assessment of GHG abatement in the NL iron ore sector and is a companion report to the other main project deliverables. As elaborated in this document, the risk assessment considers issues of technical uncertainty, cost recovery and other considerations that may arise from the application of a regulatory framework to reduce GHG emissions in the iron ore industry in Newfoundland and Labrador.

This risk assessment is characterized as preliminary and high level for two reasons:

- As discussed below, the risk assessment is based, in part, on the findings of the GHG abatement potential analysis. The GHG abatement analysis is also high level at best and subject to further feasibility studies if needed.
- At this time, we do not know what the GNL will ultimately propose as the preferred GHG regulatory framework for the iron ore sector. Again, as discussed below, some "straw man" regulatory framework features have been discussed with the participating mining companies but they would need to be revisited again in the future once the full scope of the preferred framework comes to light.

1.2 Mining in the NL Economy and Perspectives on Risk

Mining is a key sector in the NL economy and the industry currently accounts for almost 7% of GDP and 4% of employment. Iron ore shipments were valued at $3 billion in 2011. Mining royalties and taxes are estimated to be about $349 million in 2011-12, up from $21 million in 2005-06.

Real GDP in the mining industry doubled between 2005 and 2010 and continued real GDP growth is anticipated, driven by iron ore. In the iron ore sector, up to $15 billion of investment is currently in the planning cycle.

Iron ore is a global commodity and iron ore mining and production is exposed to international competition and international commodity prices change. Iron ore companies are price takers in global commodities markets, so it is imperative that policy and regulatory approaches be balanced to advance progress on climate change while promoting strong economic activity and investment. In this context, Exhibit 1 shows iron ore mining company perspectives of risk associated with investment in GHG abatement measures can be influenced by:

- The potential costs of GHG abatement for both existing and new facilities (as estimated from the GHG abatement analysis),
- The governing GHG policy and regulatory framework (to be determined),
- The global and domestic economic drivers affecting the business climate (e.g., taxation, cost inflation, interest rates, exchange rates, metal prices, product demand, competition, and
- Other related federal and provincial regulatory and market drivers (e.g., the Base-Level Industrial Emissions Requirements-BLIERS and
- Other market drivers (e.g., the long-term supply of electricity to western Labrador).

Exhibit 1 Potential Factors Influencing GHG Abatement Risk

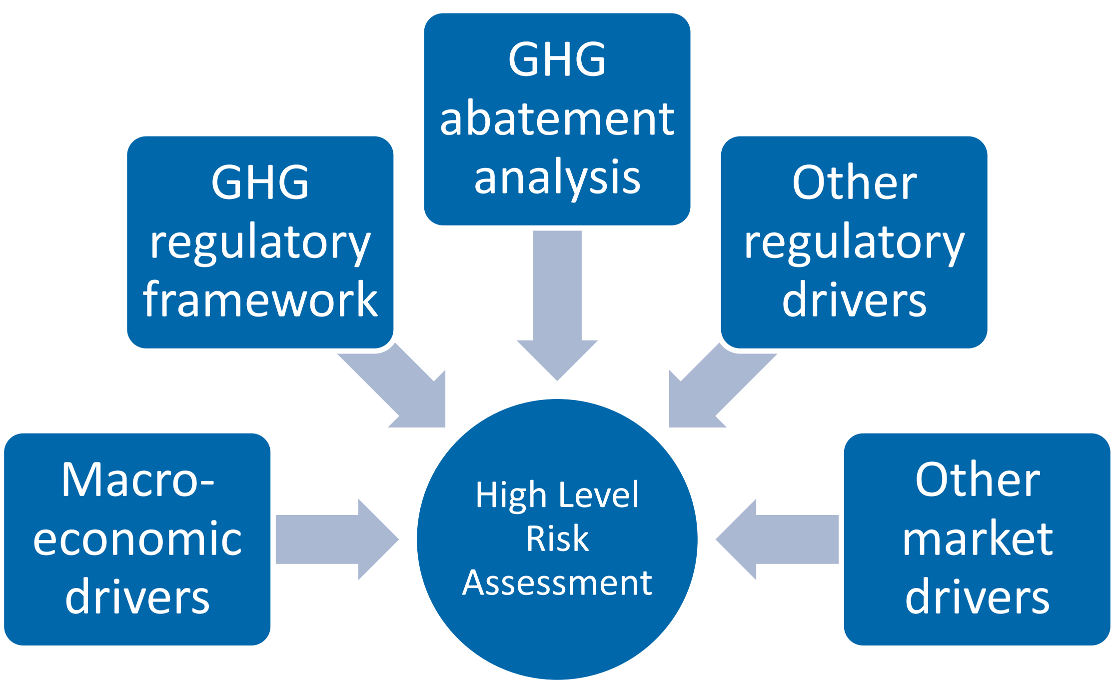

Exhibit 2 identifies the main themes explored in this report:

Exhibit 2 Study Themes

Study Themes	Elaboration
Technical risk	GHG abatement measures may pose technical uncertainties that encompass the following dimensions: ▪ Reliability of the measure ▪ Ability to effectively procure the implementation of the measure ▪ Corporate and facility management practices ▪ Challenges with regard to the knowledge, competencies to operate the new equipment ▪ Incremental health and safety issues.
Cost risk	GHG abatement measures and the potential transaction costs of participating in a GHG regulatory framework may pose costs incremental to the current expected cost of doing business that, to a varying degree, are not fully recoverable as a function of pricing in these additional costs. These incremental costs might include: ▪ Net capital and operating costs of abatement ▪ Net costs of purchase of credits ▪ Net transaction costs.
Regulatory framework design risks	A study also reviews GHG regulatory frameworks in a small number of jurisdictions where the iron ore sector is affected. The main characteristics of such regulatory frameworks serve as a reference point to discuss risk to the iron ore sector.

As shown in Exhibit 2, there is a thematic progression that starts with specific technical and cost risks and then brings them together for an overall consideration of risk to the iron ore sector. Trade exposure is top of mind for potentially affected industry sectors. In turn, governments worry about the possibility of carbon leakage, which refers to when industries move their economic activities and associated GHG emissions to other non-regulated (or less regulated) jurisdictions to avoid or minimize the cost of compliance.

1.3 Methodology

Exhibit 3 presents the methodology used to conduct the high level risk assessment which comprised 5 main tasks.

Exhibit 3 Methodology

Desktop research	• supplementary literature review
Design survey questionnaire	• questionnaire designed that covers the key thematic topics
Recruit iron ore companies to participate in the survey	• CCEET and ICF Marbek outreach
Implement survey	• combination of remote and telephone administration
Compile results	• this report

A key step was to recruit iron ore companies into the study and establish the conditions under which these companies could have a meaningful and productive involvement in the study. A total of six companies participated in the study, representing three existing operations and three planned operations.

As elaborated in the GHG Abatement Potential report, a high level assessment of GHG abatement measures was conducted with each participating mining company.[1] Each company received a confidential plant "report card" which itemized the energy savings, GHG reduction and NPV performance for each of the applicable abatement measures that were assessed. The confidential plant reports were used to inform and serve as the key point of reference for the discussion on risk.

A questionnaire was developed as the main tool to solicit insight and commentary from each participating mining company. The questionnaire was customized for each company according to the specific GHG abatement measures identified in their plant report. Five of the six companies participated in the survey.

[1] Notionally, somewhere between what mining companies refer to as a venture analysis and pre-feasibility study.

2 High Level Risk Assessment: Results

2.1 Introduction

This section presents the results of the high level risk assessment, under the following topics:

- GHG abatement measures and technical uncertainty
- GHG abatement and compliance cost recovery
- Design characteristics of GHG regulatory frameworks
- Final discussion.

The first two topics deal directly with the GHG abatement measures identified and assessed at a high level for each of the confidential plant reports. These are the measures that passed the economic threshold based on having achieved a positive net present value (NPV). The risk assessment rating for these two categories of risk are indicative, not definitive. The following factors come into play:

- The companies have responded to what is characterized as a preliminary high level analysis and would likely give the topic of risk further consideration as the direction of the NL regulatory framework is further clarified and
- The sector level profile of risk does not make a distinction between the companies that are currently operating a mine in NL versus those that have plans for the development of new mining operations.

It's important to reiterate that the risk issue of cost recovery focuses on the ability of companies to recover all or a portion of the additional costs through pricing of the commodity going forward. The discussion of risk did not explore how risk could be partially mitigated through a potential return on investment due to energy savings and potential monetization of reduced GHG emissions. Some respondents did take note that there would be economic value beyond the GHG reduction effect.

2.2 GHG Abatement Measures and Technical Uncertainty

As noted, the investment of GHG abatement measures may pose technical uncertainties that encompass the following dimensions:

- Reliability of the measure
- Ability to effectively procure the implementation of the measure
- Corporate and facility management practices
- Challenges with regard to the knowledge, competencies to operate the new equipment
- Incremental health and safety issues.

The risk assessment questionnaire listed the GHG abatement measures that were assessed for their mining operations. Respondents were then asked to assess potential technical risk using the following scale:

1 = GHG abatement measure represents an **insignificant** level of technical uncertainty

2 = GHG abatement measure represents a **significant** level of technical uncertainty
3= GHG abatement measure represents a **very significant** level of technical uncertainty.

Exhibit 4 presents the results based on the GHG abatement measures identified in the plant reports. The second column in the table indicates, in qualitative terms, the GHG abatement impact that the measure represents, relative to the overall GHG emissions being produced by the mining operations.

The results indicate, to a degree, that company risk perspectives are influenced by the relative difficulty of implementation of the GHG abatement measure. In general, measures that imply only a small degree of intrusiveness on the operation will be seen as a less technically uncertain and less risky option. These are most commonly management and operational practice changes such as computerized vehicle dispatch and implementing changes in the rolling resistance of the truck fleet. On the other hand, the capital intensive measures are seen as more intrusive to existing operations. The GHG abatement measure, trolley assisted dumpers, is a case in point; existing operations would have to change configuration and truck designs would have to be changed to be compatible to using electricity.

However, as indicated in the table, some management measures are still seen as technically risky choices (i.e., rated as a significant risk). As noted by one respondent, “if the technical risk is too high, it doesn’t matter what the savings are.”

Exhibit 4 Results of GHG Abatement Measures and Technical Uncertainty

GHG abatement measure	Relative Impact of the GHG Abatement Measure (exclusive of the pelletization process)	Technical Uncertainty rating
Computerized vehicle dispatch optimizes transport, excavation, drilling and production processes and can save up to 20% in diesel fuel for transport.	Medium	Insignificant
Payload management optimizes the payload to fuel consumption: up to 20% savings in fuel consumption	High	Ranges from insignificant to significant, weighted to the latter
More Efficient Haul Truck Fleet: up to 9% reduction in diesel use	High	Significant
Shut down mobile equipment during unoccupied hours	Low	Ranges from insignificant to very significant
Optimized road haul condition, A change of rolling resistance improves fleet productivity and decreases fuel consumption	Medium	Insignificant
Trolley Assisted dumpers using electricity on climb and regenerating on descent: savings of up to 35% on diesel used for transportation	High	ranges from significant to very significant

GHG abatement measure	Relative Impact of the GHG Abatement Measure (exclusive of the pelletization process)	Technical Uncertainty rating
In-pit crushing and conveying combines crushing, transport and mobile equipment into a single solution, reducing transport of overburden by heavy trucks: 10-15% energy reduction	Medium	Very significant
Air-deck Blasting technique reduces use of explosives to fracture rock: up to 30% reduction of explosive use.	Medium	Ranges from significant to very significant
Improved blast design, use of electronic detonator delay sequences and improved blast design. Reductions of 5% or more in GHG emissions through the use of electronic detonator delay sequences and improved blast design.	Low	Ranges from insignificant to very significant
Interval and sub-metering	Low	Somewhat significant

2.3 GHG Abatement and Compliance Cost Recovery

As noted, the investment of GHG abatement measures and the potential transaction costs of participating in a GHG regulatory framework may pose costs incremental to the current expected cost of doing business that, to a varying degree, are not fully recoverable from sales of the commodity. These incremental costs might include:

- Net capital and operating costs of abatement
- Net costs of purchase of credits
- Net transaction costs.

The company specific questionnaire listed the GHG abatement measures that were assessed for their mining operations. Respondents were then asked to assess potential cost recovery risk using the following scale:

1 = GHG abatement measure would impose an incremental cost that is **easily recoverable**,
2 = GHG abatement measure would impose an incremental cost that is **somewhat challenging to recover**
3 = GHG abatement measure would impose an incremental cost that is **likely unrecoverable**.

Exhibit 5 presents the results, based on the sector GHG abatement measures assessed in the study (exclusive of the pelletization process). The second column in the table indicates, in qualitative terms, the GHG abatement impact that the measure represents, relative to the overall GHG emissions being produced by the mining operations.

As shown, the results do not indicate any clear pattern of response. Not surprisingly, the results indicate that, generally speaking, significant capital cost outlays are seen to be less likely to be cost recoverable. For example, the measure “more efficient haul truck fleet” is rated from easily recoverable to the costs being likely unrecoverable.

Again, it's the individual company circumstances that have a lot of influence on how these abatement costs are viewed. The context here is as previously noted. These companies are price takers operating in global commodity markets and compete against countries that have lower costs of production.

Typically, the iron ore companies operate on the basis of long term supply contracts where projected margins are based on assumptions about which costs are recoverable and which ones cannot be recovered. It's possible that even the companies with planned operations at the design stage are already making deals for long term supply contracts. All of the respondents indicated that it's not easy to pass on these costs up the global supply chain.

Exhibit 5 Results of GHG Abatement and Compliance Cost Recovery

GHG abatement measure	Relative Impact of the GHG Abatement Measure (exclusive of the pelletization process)	Unrecoverable cost rating
Computerized vehicle dispatch optimizes transport, excavation, drilling and production processes and can save up to 20% in diesel fuel for transport.	Medium	Ranges from easily recoverable to somewhat challenging to recover costs
Payload management optimizes the payload to fuel consumption: up to 20% savings in fuel consumption	High	Easily recoverable
More Efficient Haul Truck Fleet: up to 9% reduction in diesel use	High	Ranges from easily recoverable to the costs being likely unrecoverable
Optimized road haul condition, A change of rolling resistance improves fleet productivity and decreases fuel consumption	Medium	Somewhat challenging
Shut down mobile equipment during unoccupied hours	Low	Easily recoverable
Trolley Assisted dumpers using electricity on climb and regenerating on descent: savings of up to 35% on diesel used for transportation	High	Ranges from somewhat challenging to the costs being likely unrecoverable
In-pit crushing and conveying combines crushing, transport and mobile equipment into a single solution, reducing transport of overburden by heavy trucks: 10-15% energy reduction	Medium	Costs being likely unrecoverable
Air-deck Blasting technique reduces use of explosives to fracture rock: up to 30% reduction of explosive use.	Medium	Ranges from easily recoverable to costs being likely unrecoverable

GHG abatement measure	Relative Impact of the GHG Abatement Measure (exclusive of the pelletization process)	Unrecoverable cost rating
Improved blast design, use of electronic detonator delay sequences and improved blast design. Reductions of 5% or more in GHG emissions through the use of electronic detonator delay sequences and improved blast design.	Low	Ranges from somewhat challenging to the costs being likely unrecoverable, but more weighted to the former
Interval and sub-metering	Low	Somewhat challenging

2.4 Design Characteristics of GHG Regulatory Frameworks in Other Jurisdictions

A companion study to this assignment reviews GHG regulatory frameworks in a small number of jurisdictions where the iron ore sector is affected. The main characteristics of such regulatory frameworks serve as a reference point from which to discuss potential risk implications for the iron ore sector.

At the risk of over simplification, taken as a whole, these different regulatory frameworks either singularly or together, constitute:

- A tax on carbon emissions
- A cap and trade system and
- Other measures aimed at facilitating the implementation by affected companies of GHG abatement measures.

The main design characteristics of these regulatory frameworks are organized under the categories of:

- Compliance requirements- refers to what a regulation might impose as hard or mandatory obligations on the part of a company or company facility operating in the province.
- Design characteristics to bring some degree of flexibility to the system and
- Measures aimed at facilitating the implementation of GHG abatement measures.

2.4.1 Risk Associated with Compliance Requirements

Respondents were asked to assess the potential risk associated with each of the listed compliance features, using the following scale:

1 = compliance requirement would impose an insignificant risk
2 = compliance requirement would impose a somewhat significant risk
3 = compliance requirement would impose a very significant risk

Exhibit 6 presents the results. As shown, there is a considerable range of response to most of the questions and no real response patterns emerge. This means that at least one or more of the company participants view the compliance requirements as a potentially significant risk. However, as one respondent noted, “the devil is in the details”. It’s tough for industry to engage on the topic of risk without further elaboration of the substance of a proposed regulatory framework.

Exhibit 6 Results of Risk Associated with Compliance Requirements

Compliance requirements	Risk Rating
Carbon tax	Ranging from somewhat of a significant risk to a very significant risk
Scope (including stationary combustion sources, vehicle fuel, industrial process emissions, fugitive emissions).	Ranging from an insignificant risk to a very significant risk
Absolute emissions cap- set at the facility level	Ranging from somewhat of a significant risk to a very significant risk (weighted to the former)
Intensity based emissions cap- set at the facility level	Rated as somewhat of a significant risk
Reference benchmark for setting the emissions cap	Ranging from an insignificant risk to a very significant risk
Allowances	Ranging from an insignificant risk to a very significant risk
Price	Ranging from an insignificant risk to a very significant risk.

Additional observations provided by respondents on the topic of compliance requirements include:

- Crafting policy measures that provide certainty (long-term signals) while addressing competitiveness concerns is very important. An emissions allowance system must provide some certainty for the post-2020 period so that investment decisions can be made on the best possible assumptions for the short to the longer term. In the end, what will be important is the price treatment of emissions through the allowance mechanism under any scope scheme.

- Other systems are already in place in Canada and it would be advisable that the substance of the NL regulatory framework be consistent with other comparable initiatives in Canada.

- A key issue is going to be the percentage reduction of emissions that would be required over time and how the cap will evolve.

- Benchmarking may represent a higher risk for older facilities where major investments would be required to advance them to “best of the class”. In addition, benchmarking may not be a practical solution when there is no other similar or comparable facility in the jurisdiction.

2.4.2 Features that Enable Flexibility

Respondents were asked to assess the extent to which regulatory framework features may be able to help reduce risk, by providing flexibility in the means of response. The following scale was used:

1 = feature does not significantly help to reduce risk
2 = feature somewhat helps to reduce risk

3 = feature significantly helps to reduce risk.

Exhibit 7 presents the results. As shown, there is a considerable range of response and no real response patterns emerge. However, it's clear that a phasing in of GHG emission caps is viewed as a measure that would significantly help to reduce risk. The other measures are viewed as offering some degree of risk management to the sector.

Exhibit 7 Results of Features that Enable Flexibility

Features that Enable Flexibility	Flexibility Rating
Phasing in of the caps	Ranges from feature somewhat helps to reduce risk to significantly helps to reduce risk
Varying degrees of free permits	Ranges from feature somewhat helps to reduce risk to feature significantly helps to reduce risk (weighted to the former)
Permits acquired through trading	Ranges from feature somewhat helps to reduce risk to feature significantly helps to reduce risk
Safety valves	Ranges from feature somewhat helps to reduce risk to feature significantly helps to reduce risk
Banking of allowances	Ranges from feature somewhat helps to reduce risk to feature significantly helps to reduce risk (weighted to the former)
Early reduction credits	Ranges from feature somewhat helps to reduce risk to feature significantly helps to reduce risk (weighted to the latter)

Additional observations provided by respondents on the topic of features that enable flexibility include:

- Providing transitional compensation for energy-intensive, trade-exposed industry is a key element of flexibility. Varying degrees of free permits is necessary to help enterprises maintain their competitive position while taking measures to further reduce emissions. This support should be provided until at least 80% of a sector globally is covered by similar emissions reduction objectives.

- Early reduction credits are necessary to recognize efforts that have led to significant emission reductions prior to the period retained for the coverage of the new system. Those reductions may now make it much more difficult for a facility to further reduce its emissions.

- Although not specifically addressed in the survey questionnaire, the use of offsets was identified as a flexibility measure as a possible means of securing emissions reductions at lower cost but that the offsets would need to be of high quality.

2.4.3 Features to Help Mitigate GHG Abatement Costs

Respondents were asked to assess the extent to which regulatory framework features may be able to help reduce risk, by mitigating the potential incremental costs of GHG regulatory compliance. The following scale was used:

1 = feature does not significantly help to reduce risk
2 = feature somewhat helps to reduce risk
3 = feature significantly helps to reduce risk.

Exhibit 8 presents the results. Perhaps not surprisingly, financial support for implementation of GHG abatement measures is rated as the feature that would most help to reduce risk through mitigation of implementation costs. In this context, it's also important to note that the NL iron ore sector has already implemented many energy efficiency measures with the view to manage operating costs.

Exhibit 8 Results of Features to Help Mitigate GHG Abatement Costs

Direct support to address costs	Risk Mitigation Rating
Financial support for R, D&D	Ranges from somewhat helps to mitigate costs to significantly helps to mitigate costs (weighted to the latter)
Financial support for implementation	Ranges from a feature that does not significantly help to mitigate costs to a feature that significantly helps to mitigate costs..

On the topic of features that help to mitigate GHG abatement costs, it was noted that allowing the energy-intensive sector to reclaim their contributions to a “technology fund” would be a very positive, “win-win” measure. It was suggested that a fund of this nature could support the accelerated development and deployment of a portfolio of low emission technologies to help meet future emissions targets, in the most cost-efficient manner possible. It was also suggested that a fund of this nature should extend well beyond 2020 to deliver the step-change technologies necessary to meet medium and longer term emissions reduction targets.

2.5 Final Discussion

Although high level and preliminary in nature, the company insight to potential risk associated with GHG abatement is informative and useful. In particular, the study design enabled companies to consider issues of technical uncertainty and cost risk associated with GHG abatement measures specifically pertinent to their operations.[2]

There is a considerable range of response to most of the questions and no real response patterns emerge. However, within this range of response it's clear that at one or more companies have indicated the potential for significant risk associated with technical uncertainty and cost recovery of the abatement measures. This isn't surprising in that as noted, the companies are price takers operating in global commodity markets.

There had been an attempt to have the participating companies speak to the overall implications of a GHG regulatory framework on future plans for development and expansion of operations. Taken together, it's entirely possible that cost and other factors could contribute to

[2] Based on the company reviewed confidential GHG abatement plant reports.

circumstances whereby the company might reach a "tipping point" and make business choices potentially negative for the province's economy. However, this particular dimension to the topic of risk was not ultimately addressed by the companies. This is largely due to the preliminary nature of the discussion; the companies will need to see more detail on a proposed regulatory framework to make additional assessment of risk.

Finally, the discussion of risk did not explore the possible cost implications to companies having to also comply to the proposed base-level industrial emissions requirements (BLIERs) under the Comprehensive Air Comprehensive Air Management System (CAAQS). The BLIERs will be set as quantitative performance requirements and will apply to new and existing facilities. Iron ore pelletizing is one of the sectors for which a sub-group has determined the appropriate emissions requirements. Hence, the "intersect" between GHG abatement and compliance to the BLIERS is a topic that needs to be further addressed as greater clarification is brought to the proposed GHG regulatory framework.



ICF INTERNATIONAL

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an ICF International Company

Review of GHG Regulatory Frameworks: Final Report

December, 2012

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List of Exhibits

1 Introduction and Methodology

1.1 About This Report

This document is one of the three milestone reports for the Government of Newfoundland and Labrador (GNL) Office of Climate Change, Energy Efficiency and Emissions Trading (CCEET) under the auspices of the Study to Identify Greenhouse Gas Reduction Opportunities and Competitiveness Implications: Iron Ore Mining – Newfoundland and Labrador.

The overall study objective is to provide an objective and independent review of GHG regulation and opportunities for the iron ore industry to inform policy development. The main outputs from the study are:

- An assessment of GHG abatement solutions for the iron ore sector in Newfoundland and Labrador (NL), including pelletizing, and how these solutions would rank on a marginal GHG abatement cost curve (Milestone 2).
- A profile of how the mining industry is regulated, from a GHG reduction perspective, in other jurisdictions and lessons learned to date (Milestone 3, this report).
- Identification of any technical and cost considerations that may arise from the application of performance standards to reduce GHG emissions on the iron ore industry in NL (Milestone 4).

The objective of this Task is to conduct a detailed review of the GHG regulatory frameworks in Europe, WCI member jurisdictions and Australia that cover or are expected to cover mining operations (i.e., not solely limited to the iron ore sector). The report provides an account of how the sectors and facilities are or will be regulated, the coverage, how industry responded or is expected to respond to the introduction of regulation and lessons learned to date.

1.2 Context

The context for this assignment is elaborated below under two topics: i) the GNL policy thrust on how climate change will be addressed in the province and ii) the importance of the mining sector as both a key economic player in the province and a current and future GHG emitter.

1.2.1 The GNL Policy Thrust on Climate Change

In its 2011 Climate Change Action Plan, the GNL reaffirmed its commitment to reduce the province's GHG emissions by 10% below 1990 levels by 2020 and between 75%-85% below 2001 levels by 2050. In order to meet those objectives, the GNL also committed to develop and release in 2012 a detailed approach for reducing GHG emissions from the energy-intensive sectors.

The GNL Action Plan recognizes that economy-wide action will be needed and that the energy intensive large industrial sectors (electricity generation, mining, newsprint, and offshore oil and refining) will be of particular importance as they account for approximately 50% of provincial GHG emissions.

Within the scope of the province's Climate Change Action Plan 2011, the province has earmarked three early actions to move forward with this sector as it develops its broader policy approach, of which one these is to "apply best available control technology requirements in the air pollution control regulations to GHG emissions for new investments in the large industrial sector". This approach is to be consistent with emerging approaches such as those being advanced by the U.S. Environmental Protection Agency and, therefore is a key focus of this assignment.

1.2.2 Importance of the Mining Sector

Mining is a key sector in the NL economy and the industry currently accounts for almost 7% of GDP and 4% of employment. Iron ore shipments were valued at $3 billion in 2011. Mining royalties and taxes are estimated to be about $349 million in 2011-12, up from $21 million in 2005-06.

Real GDP in the mining industry doubled between 2005 and 2010 and continued real GDP growth is anticipated, driven by iron ore. In the iron ore sector, up to $15 billion of investment is currently in the planning cycle.

The mining companies that operate in the NL economy are price takers in global commodities markets, so it is imperative that any approach be balanced to advance progress on climate change while promoting strong economic activity and investment. Consequently, the business competitiveness and risk implications of potential GHG policy and regulatory frameworks are key components of this study (addressed under a separate project phase and milestone report).

Historically, the mining sector has been an active player in federal and provincial GHG policy and regulatory planning and discussion, both through the Mining Association of Canada (MAC) and at the level of individual companies.

1.3 Methodology

1.3.1 Scope

The Milestone 1 report (final work plan) confirmed a focus on the following jurisdictions: Europe-emissions trading system (ETS), WCI member jurisdictions, Australia and Canada's federal policy initiatives. The scope was further refined to ensure that the regulatory review be tuned to the mining sector realities and circumstances. Exhibit 1 maps the countries that lead iron ore production globally to where GHG regulations exist or are planned. Following discussions with the CCEET, the final scope was narrowed to an intensive review of the Australia and European Union Emissions Trading System (ETS), with the focus on the latter jurisdiction on its application in Sweden which has an active mining sector. An overview of the Quebec cap and trade system has also been conducted; Quebec is a WCI member.

Exhibit 1 Mapping of Iron Ore Production and GHG Regulatory Frameworks

Jurisdiction	Iron Ore Production Million Tonnes as Iron/year[1]	Greenhouse Gas Regulation	Implementation Date	Observations
❑ China	280	-	-	
✓ Australia	228	Clean Energy Plan	July 2012	
❑ Brazil	199	-	-	
❑ India	157	-	-	
❑ Russia	53	-	-	
❑ Canada	12[2]	-	-	Unknown mining policy[3]
❑ United States	17	-	-	
✓ Sweden	12	EU ETS	January 2005[4]	
✓ Quebec	8	Environmental Quality Act[5]	January 2013	WCI Member
❑ Europe	1[6]	EU ETS	January 2005[7]	EU addressed via Sweden

The jurisdiction specific reviews are presented in Appendix A.

1.3.2 Review Template

Exhibit 2 presents the final review template employed in the jurisdictional review.

Exhibit 2 Final Review Template

Categories	Output
Executive Summary	Summarize the salient points of the legislation, with specific emphasis on iron ore mining as a trade-exposed energy-intensive sector, focusing on: ▪ Providing industry with long term certainty; ▪ Encourage new investment in the jurisdiction; ▪ Impact on the government, including government revenue and expenditures, and jobs; ▪ Encourage energy efficiency; and ▪ Industrial response in those jurisdictions with trade-exposed energy-intensive resource exploitation sectors.
Scope	What is the scope of the regulations: ▪ Economy wide? ▪ Selected sectors? ▪ Is iron ore mining specifically addressed? ▪ What is the threshold for inclusion in the regulation?

Legislative Framework	Describe the basis and core attributes of the legislation, including:
	▪ Legal basis;
	▪ Enforcement and party responsible for compliance;
	▪ Duration of legislation and termination or statutory review date, if applicable;
	▪ Amendment mechanisms, specifically, do amendments require:
	  ▪ Legislative votes; and/or
	  ▪ Simple amendment powers of administering bodies.

1 U.S. Geological Survey Minerals Yearbook – 2009 (Advance Release); iron content in ore can be as low as 25% or as high as 60%
2 Excluding Quebec production
3 Government of Canada GHG emissions management focus is on emissions from (i) coal-fired electricity and (ii) the oil and gas sector, including oil refining.
4 Phase 1 2005 – 2007; Phase 2 2008 – 2012; and Phase 3 2013 – 2020
5 Environmental Quality Act (R.S.Q., c. Q-2) *Regulation respecting the cap-and-trade system for greenhouse gas emissions*
6 Excluding Swedish production
7 Phase 1 2005 – 2007; Phase 2 2008 – 2012; and Phase 3 2013 – 2020

Categories	Output

GHG Emissions Goals	What are the overarching goals of the program? Are the goals to reduce:
	▪ Overall emissions?
	▪ To a specific target? If so, is the target an:
	  ▪ Absolute target (cap), and if so, how is economic growth or new investment treated; or
	  ▪ An intensity target, and if so, what mechanisms exist to reduce absolute emissions?
	▪ Describe how targets are established for existing and new facilities, i.e. are targets set based on:
	  ▪ BATEA (Best Available Technology Economically Achievable);
	  ▪ BACT (Best Available Control Technology);
	  ▪ Historic emissions from:
	    ▪ The facility;
	    ▪ The sector,
	  ▪ Benchmarking,
	▪ Emissions from specific industrial sectors?
	▪ Emissions specifically from iron ore mining?

Compliance	What options does a regulated facility have to comply with the regulations?
	▪ Reduce emissions
	▪ Emissions trading
	  ▪ If so, is trading bilateral, or
	  ▪ Through an exchange, or
	  ▪ Both
	▪ Offset credits analogous to the [8]UNFCCC-CDM system
	How are emissions credits or permits allocated by the government?
	▪ Free allocation?
	  ▪ If so, is there a free or “gratis” allocation for a portion of the facilities emissions?
	▪ Through an auction

Reporting	For the purposes of complying with the regulations: ▪ Which greenhouse gases must be reported? ▪ How often must reports be filed, and by when? ▪ How is a reporting facility defined? ▪ Must reports be verified or audited by an independent third party? ▪ If so, to what standard?
System Transparency	How transparent is the system with respect to: ▪ Reporting; ▪ Targets; and ▪ Pricing

Competitiveness Impacts	How does the program account for the competitiveness of trade exposed sectors, in particular iron ore mining:
	▪ What are the other/auxiliary programs to mitigate increased costs?
	▪ Does the program address cost-pass-through or increased energy costs?
	How does the program encourage new industrial investment?
	▪ How are new facilities treated relative to existing facilities?
	▪ How is carbon leakage and shifting production to lower cost jurisdictions addressed?
	Does the system include any form of protection mechanism to guard against price excursions by:
	▪ Setting a cap on the cost or credits or permits through:
	  ▪ Setting up an external fund or compliance payment system, or
	  ▪ Releasing additional credits into the market,

Trading System Efficiency	How efficient and effective is the trading system with respect to: ▪ Transaction costs ▪ Market efficiency Is participation in the trading system: ▪ Limited to regulated entities; or ▪ Open to non-regulated entities, i.e. non-industrial traders trading for profit?

[8] UNFCCC refers to United Nations Framework Convention on Climate Change.

Categories	Output

Government Revenue	Was the impact on government revenues considered with respect to:
	▪ Program operating costs?
	▪ Increased revenue through:
	  ▪ Auctioning of emissions permits?
	  ▪ Financial compliance mechanisms?
	▪ Decreased revenue through:
	  ▪ Reduced corporate taxes (i.e. lower profits and/or higher costs)?
	  ▪ Lower royalties (i.e. reduced production and/or higher costs)?

Stakeholder Engagement	How did the government consult with: ▪ The iron ore industry? ▪ Other stakeholders? ▪ Other jurisdictions? ▪ Environmental community? How did the government engage with these groups? Through: ▪ Working groups? ▪ Industry associations? ▪ Legislative/regulatory commenting process?

2 Regulatory Framework Summary and Discussion

2.1 Introduction

This section presents a summary and discussion of the regulatory framework profile findings. As noted, the review was confined to three GHG regulatory frameworks; their relevance is summarized as follows.

- Sweden is a member of the European Union (EU) Emissions Trading System (ETS) and the profile of how Sweden as adapted to the EU-ETS provides insight to how the EU ETS was applied in a country with an iron ore mining and processing sector. The Sweden ETS profile is a "rear view" assessment opportunity as well as an opportunity to consider how the EU has applied the lessons of the system to date in application of Phase 1 and Phase 2 and in the plans for Phase 3 which is slated to begin in 2013.

  The EU's overall objective is to undertake emission reductions of 30% in comparison with 1990 emissions levels by 2020 (binding reduction) with a view to achieving a reduction in the order of 80% by 2050. The current intent is to move to a "climate-friendly" economy based on a combination of low-carbon technologies and energy sources.

- The Australia profile is significant for two reasons. First, the Australian government went through a long and extensive design process which itself drew on the lessons of the ETS. [9] Second, Australia is a major producer of iron ore, mainly for export mining and, indeed, is the world's largest exporter of iron ore.[10] More broadly, mining is a very significant economic sector in Australia and accounts for about 11% of the country's total GHG emissions. The government was involved and continues to be in extensive consultations with the mining sector.

  The goals of the Australian Clean Energy Act 2011 are to:

  - Comply with Australia's obligations under the UNFCCC and the Kyoto Protocol;
  - Reduce Australia's emissions by at least 5% below the 2000 emission levels by 2020, regardless of what other nations do;
  - Reduce Australia's emissions by up to 15% to 25% below the 2000 emissions levels by 2020, depending upon the scale of global action;
  - Take action directed towards meeting Australia's long-term target of reducing Australia's net greenhouse gas emissions to 80% below 2000 levels by 2050; while doing so in a flexible and cost-effective way.

- Quebec is an important jurisdiction to examine for two reasons. First, with the continued uncertainty of when and how the federal regulatory framework will unfold, Quebec is the first jurisdiction in Canada to adopt a formal cap-and-trade program based on an absolute emissions cap and analogous to the EU ETS. At the end of 2011, the government of Quebec passed the "*Regulation Respecting the Cap-and-Trade System for GHG Emission Allowances*" which came into force the start of 2012. Second, NL's iron ore sector is in many respects closely tied to Quebec. There are companies currently operating in NL who maintain facilities that will be regulated in Quebec. Concentrate and pellets are currently shipped to Quebec for transport to other North American and international markets. It's

[9] It's important to note that, at the time of wring this report, there are some indication that the Australian Climate Change Policy regime is under threat from Federal Opposition which vows to abolish it and from constitutional challenges.
[10] Resources and Energy Quarterly, Volume 1, No. 3, March Quarter 2012, Australian Bureau of Resources and Energy Economics – BREE.

likely that future iron ore mines will ship product through Quebec and may have a regulated facility in Quebec.

It's important to note that Quebec is a Western Climate Initiative (WCI) "Partner". Each WCI Partner jurisdiction will have an emission allowance budget under the cap-and-trade program that is consistent with its jurisdiction-specific emissions goal for 2020. Each Partner has the flexibility to decide how best to allocate its allowance budget within its jurisdiction. However, it's important to note that the WCI is only relevant to the extent on where members agree on what the rules should be within the framework of the initiative. The WCI has no enforceable powers within the provincial jurisdiction.

2.2 Summary and Discussion

The results of the regulatory framework profile are discussed under the following topics:

- Key Features of the Regulatory Systems
- Regulatory Regimes and the Mining Sector
- How the Regulatory Regimes Account for the Trade Exposed Nature of the Affected Sector
- Industry Response and
- Fiscal Impact on Government.

It should be noted that this summary narrative presents key observations but is not meant to be totally exhaustive of the framework features as the detailed profiles serve that purpose.

2.2.1 Key Features of the Regulatory Systems

Generally speaking, the regulatory frameworks consist of a multi-faceted set of requirements and measures that, taken as a whole, fall into three categories: i) hard compliance requirements, ii) features that enable flexibility and options in meeting hard compliance requirements and iii) direct support to address the costs and effectiveness of meeting the hard compliance requirements. Exhibit 3 presents an overview of some of the key features discussed in the review of the three regulatory frameworks, organized according to these three categories.

All three systems are based on variations of remitting a permit for every tonne emitted, with the following highlights:

- Some systems focus on CO_2, while others include more or all GHGs,
- All of the systems phase in market based carbon pricing with an initial period in which the government has fixed the price with escalators built in,
- All of the systems aim to transition to full auctioning of permits over the longer term,
- There is a phase in with varying degrees of governments issuing free permits ("gratis allocation") and allowing regulated facilities to buy from the government, either at a fixed price or through an auction, varying amounts of permits,
- All include emissions trading, and compliance includes use of various forms of domestic and international "offsets" and
- Program designs include provisions for economic growth and new entrants.

All three systems operate or will operate in an environment in which some form of carbon tax is in play. In Sweden, industries pay a carbon tax and those industries in the ETS pay a smaller level to avoid double payment. In Australia, the planned reduction in fuel tax credits effectively introduces a carbon tax on fuels used by heavy vehicles. In Quebec a carbon levy has been in place since 2008. The 2012-2013 Budget stipulates that the levy will be extended until December 31, 2014 but will exempt major industrial emitters covered by the cost of the GHG emission cap-and-trade system.

It's clear that, the more ambitious and broad the regulatory framework, the greater the need to amend and/or align and/or introduce other legislation or regulations to address issues relating to compliance, enforcement, taxation and royalties. As noted, the EU-ETS offers the best opportunity to assess lessons learned from the experience of the system to date and how the EU has responded to these lessons. For instance, the inability to bank and use credits between Phase I and Phase II contributed to a price collapse at the end of Phase I and some firms deferred investments until longer term rules were understood. In Phase 2, any surplus allowances can be banked between trading periods and borrowing from the following year within a trading period is also allowed.

All three of the systems include or intend to include financial support to help affected sectors cost-effectively find their own mitigation solutions. However, affected sectors and facilities cannot use these funds as a compliance option. This financial support is dedicated to a wide range of initiatives generally falling into the categories of "clean energy" and "energy management". The financial support also covers the full research, development and deployment cycle.

Exhibit 3 Overview of Key Features

Hard compliance requirements	Summary
Hard cap	Emissions cap set at the facility level (e.g. for the Quebec system, the emissions cap is set by the government relative to a BAU and then decreases by an average of 4% annually). Quebec has adopted the proposed WCI design for transportation fuel GHG emissions. Effective in 2015, it will affect any fuel supplier (wholesaler or retailer) within the participating WCI Partner jurisdiction that distributes liquid transportation fuel sold or imported for consumption in the participating Partner jurisdiction. Australia does not differentiate between stationary combustion and industrial process emissions when setting targets or allocating allowances.
Permit costs	Combination of government set prices and market based pricing; government sets a floor or minimum price but does not generally intervene. The Australian system will go through a fixed carbon (CO_2e) pricing stage over 2012-13 to 2015-16 and then an auctioning phase, 2013 to 2015-16, with market determined prices. The government issued a discussion paper describing how their price floor will function but, to date, they have not described how the price ceiling mechanism will function.
Enforcement through fines	In the Australian system, during the period when permits are sold at fixed price by the government, fines for non-compliance will be levied In the EU-ETS, in case of discrepancy between verified emissions and surrendered allowances, a penalty fee is charged and the operator is obliged to also surrender emission allowances for its excess emissions.
Features that enable flexibility	
Phasing in of the caps	In the Australian system the caps won't be announced until 2014. If the clean energy and energy efficiency funds can go operational earlier, this will provide help to some of the affected facilities to adopt abatement measures prior to the cap. In Phase 2 of the EU-ETS, the allocation caps by Member State are determined under the auspices of the member country National Allocation Plans. Each country determined total quantity of allowances that was in line with its target within the framework of meeting the Kyoto Protocol targets. In Phase 3 it will be a European-wide cap declining annually by 1.74% of the average annual level of the Phase II cap with burden sharing by member countries.

Hard compliance requirements	Summary
Varying degrees of free permits	Phase in with varying degrees of governments issuing free permits ("gratis allocation") and allowing regulated facilities to buy from the government, either at a fixed price or through an auction, varying amounts of permits.
Permits acquired through trading	Bilateral transactions, trading on exchanges
International credits and offsets	Acquire offset credits through certified emissions reductions (CERS) from CDM projects and Emission Reduction Units (ERUs from JI projects)
offsets	Compliance includes various categories of domestic offsets. Quebec has not formally identified they offset types acceptable to its framework and the geographic coverage for offset eligibility. WCI has identified a short list of offset types they endorse which appears to be limited geographically to North America as the region. It's likely there will be no access to the CDM and to JI.
"safety valves"	Systems generally include "safety valves", often in the form of "floors and caps" on permit prices, to manage unanticipated adverse consequences, In the proposed Quebec auction, the floor price starts at $10.00 in 2012. In the Austrlian system, when the auctioning phase starts, the floor price will be set at $15/tonne. The price ceiling will be set at AUS$20/tonne over the anticipated international price of allowances.[11]
Banking of allowances	In the EU-ETS Phase 2, any surplus allowances can be banked between trading periods. Borrowing from the following year within a trading period is also allowed. Borrowing of allowances from future years is not permitted under WCI while banking of allowances is allowed. Australia will allow a firm to borrow up to 5% of the next years allowances, and those allowances can only be used against the facility's compliance obligation.
Early reduction credits	In the Quebec system, all emitters under the regulations during Phase 1 are eligible for early reduction credits. Note that emissions reduction credits cannot be attributed to reductions arising from on-site transportation or sequestration activities.
Direct support to address costs	
Clean energy funds	
Financial and other support for energy management investments	Australia is funding a range of initiatives through the Clean Energy Finance Corporation including (low emission technology support NOT including Carbon Capture and Storage), a Clean Technology Investment Program (energy efficiency support).
Financial support for R, D&D	support for research and development, demonstration and commercialization of renewable energy

2.2.2 Regulatory Regimes and the Mining Sector

Exhibit 4, below, summarizes how the mining sector is affected in the regulatory frameworks. Some of the key observations are:

Of note is that Sweden and Australia have both acknowledged that the pelletizing of iron ore is a "sector economic activity" that is at risk of carbon leakage, which refers to when industries move their economic activities and associated GHG emissions to other non-regulated (or less regulated) jurisdictions to avoid or minimize the cost of compliance. However, pelletizing of iron ore is not specifically mentioned in any of the EU-ETS decisions or Directives.

It's also important that the systems account for differences between existing and new operations in establishing the allocations. For instance, in the EU-ETS, allocations to existing installations are calculated in proportion to each installation's average emissions during a historical period. Allocations to new entrants are calculated on the basis of either output-based benchmarks or a comparison with the best available technology.

[11] At the time of writing the final report, the international price was at about 6.6 euros/tonne.

The successful design and implementation of the systems is predicated, in part, on a robust benchmarking of facility emissions and performance, as well as on the analysis of abatement measure best available practices. As noted, allocations for existing and new plants in the EU-ETS are determined according to different benchmarks and formulae. In Australia, industry performance benchmarks will be used to enable free allocations for trade exposed plants. In the Quebec system, early reduction credits will be determined according to a baseline determined during 2005 to 2007.

Another key element is how these regulatory frameworks treat “process emissions”.

- EU-ETS: For reference, the EU-ETS Measuring & Reporting Guidelines (MRG) define process emissions as “greenhouse gas emissions other than combustion emissions, occurring as a result of intentional and unintentional reactions between substances or their transformation, including the chemical or electrolytic reduction of metal ores, the thermal decomposition of substances, and the formation of substances for use as product or feedstock”.[12] The guidelines note that in the metal ore “roasting, sintering or pelletization” installations, GHG emissions result from a range of sources and source streams, one of which is “raw materials” (calcination of limestone, dolomite and carbonatic iron ores, e.g. FeCO3). In the EU-ETS allocation plan, raw-material related GHG emissions are those that cannot be reduced in the short-term other than by decreasing production. Consequently, to address the potential vulnerability of these industries, an adjustment can be made, on a case by case basis that corresponds to the installation’s increase of raw-material related emission as a result of the projected increase in output during the period 2008-2012 period relative to the period used for allocation based on historical emissions. (refer to the ETS profile in Appendix A).

- In the Australian system, process emissions are referred to as “industrial process emissions” and are reported and tracked separately. However, the program will not differentiate between stationary combustion and industrial process emissions when setting targets or allocating allowances. Similar to the EU-ETS, Australia has issued an “Activity Definition for the Production of Iron Ore Pellets” that indicates GHG direct emissions from the processes are to be included. The direct emissions from the production of iron ore concentrate feed to the pelletizing plant is excluded.

- Quebec sets the allocation of free allowances based on the facility receiving 100% free allowances for process emissions and 80% for combustion emissions, relative to the baseline period. Therefore, if a facility is able to reduce its process emissions relative to its baseline, that reduction may be used towards compliance. By the 2015-2020 period, the level of gratis allocation will decrease by 1-2% per year.

[12] Calculations of process emissions are discussed in the ETS activity-specific guidelines (Annex II- IX), specifically Annex V, CO_2

Exhibit 4 How Mining Sector Affected by the Regulatory Frameworks

Categories	Summary
Facility versus corporate thresholds	▪ All three systems require compliance based on emissions at the facility level. Both the Australian and Quebec systems refer to facilities emitting more than 25,000 tonnes per year CO_2e as the threshold. ▪ The EU ETS provides the list of installations that are covered by the EU ETS and the CO_2 threshold is mentioned only for small installations which have been part of the EU ETS scope during Phase I and Phase II. In Phase III, Member States will be allowed to exclude these small facilities, provided certain conditions are met, including where reported emissions were lower than 25,000 tCO_2eq in each of the 3 years preceding the year of application.
Existing vs new plants	▪ In the EU-ETS, new entrants joining the EU ETS in 2013 will be able to benefit from free allocation of allowances. ▪ Allocations for existing and new plants in the EU-ETS are determined according to different benchmarks and formulae.
Scope	▪ Emissions from the use of energy (including stationary combustion sources and vehicle fuel), industrial process emissions, fugitive emissions and emissions from waste must be reported. ▪ In the EU-ETS allocation plan, the raw-material related GHG emissions from the pelletization process have been recognized as those that cannot be reduced in the short-term other than by decreasing production. The system enables case by case adjustments to be made that helps protect affected faciloities from being penalized for increasing their production. ▪ In the Australian system, the direct emissions from the production of iron ore concentrate feed to the pelletizing plant is excluded from compliance.
Process focus	▪ Pelletizing iron ore has been specifically acknowledged by Australia and Sweden as the most emissions intensive activity within the iron ore sector and, at the same time, it has been recognized as “a sector at risk” of carbon leakage. ▪ In the Australian system, stationary combustion and industrial process emissions are tracked and reported separately. An “Activity Definition for the Production of Iron Ore Pellets” has been issued that lists which emissions are included and excluded. ▪ Quebec sets the allocation of free allowances based on the facility receiving 100% free allowances for process emissions relative to the baseline period. Thus if a facility is able to reduce its process emissions relative to its baseline, that reduction may be used towards compliance. ▪ Fuel use by mining equipment is covered under other programs, ranging from tax changes to fuel standards.
Protection for trade exposure	▪ See below
Baselines and benchmarks	▪ In the EU-ETS, different formulae for allocations to existing and new installations. In the Australian system, industry performance benchmarks will be used to enable free allocations for trade exposed plants. In the Quebec system, early reduction credits are determined according to a baseline determined during 2005 to 2007

2.2.3 How the Regulatory Regimes Account for the Trade Exposed Nature of the Affected Sector

As noted, iron ore is a global commodity and iron ore mining and production is exposed to international competition and international commodity prices change. Trade exposure is top of mind for potentially affected industry sectors when governments consider various regulatory solutions. In turn, governments worry about the possibility of carbon leakage. If carbon leakage occurs, it can undermine efforts to achieve global reductions in GHG emissions while, at the same time, harm the domestic economy in terms of lost GDP and jobs.

The profiles reveal that regulatory systems can include various means to protect domestic production from increased compliance costs. Of particular relevance is that the Australian government has designated certain industry sectors as trade exposed, referred to as Emissions Intensive Trade Exposed (EITE) industries. Protection of the EITE industries is administered under a "Jobs and Competitiveness Program". If companies can demonstrate trade exposure, the system will enable companies to receive a significant percentage of the permits for free, based on a determination of industry average performance.[13]

In Sweden, the Agency for Economic and Regional Growth is a member of the council established to allocate allowances to each particular installation and the Swedish government reduced the level of the existing carbon tax for industries participating in the EU-ETS. In the EU-ETS, the pelletizing of iron ore has been recognized as a sector at risk of carbon leakage. The Swedish National Implementation Measures (NIMs) submitted to the EU Commission for EU-ETS Phase 3 includes three iron ore sinter pellet installations. Otherwise, the mineral and production and processing of ferrous metals is not considered to be a sector at risk of carbon leakage.

The design of mechanisms to protect certain affected sectors of the economy from potentially adverse financial effects of a regulatory regime is challenging, both in terms of design and the possibility that the solution could lead to distortions in the economy by rewarding "laggards" and penalizing "leaders". For instance, in the Australian system, the formula awards higher free allocations to those companies with ever greater emissions as measured on the basis of tonnes CO_2e/million $ of revenue. In this context, the determination of the industry average benchmark will be challenging in that it will have to take into account the type of mining process, the nature of the mining operation and account for existing versus new facilities.

In the final analysis, even those companies eligible to receive free permits will have to carefully assess the financial effect of the portion of GHG emissions not covered by the free allocations. Under those circumstances, marginal production above and beyond that free allocation bears the cost of compliance and marginal production decisions will take that into account.

2.2.4 Mining Sector Response

The design and implementation for all three systems involved extensive consultation with the mining sector. In Australia, the Australian Association of Mining and Exploration Companies helped to represent the mining sector and individual companies were also represented in the consultation process. The mining sector criticized the rate and timing of program implementation, particularly in light of the global recession. The Australian government did partially address the concerns and, in 2009, amended the original program proposal under a Global Recession Buffer program.

The biggest iron ore producer in Europe, LKAB, has said that the pelletizing process within the Mining of Iron Ores sector is significantly exposed to carbon leakage and listed three main reasons.[14] Of particular note, LKAB explains that, in iron ore sector, prices are calculated based on the Asian spot price for standard grade Fe (iron)-content pellets, and publicly available. LKAB noted that, despite its strong position in Europe, it is only a marginal player on the world market (2 % of total trade) therefore is a price taker. They note that "there are only small price

[13] In the case of the iron ore industry, only pelletizing qualifies for protection given the government's quantitative criteria for receiving support.

[14] Draft Commission Guidelines for State aid in the context of the amended EU Emissions Trading Scheme post 2012-Response on public consultation from LUOSSAVAARA-KIIRUNAVAARA AB, Jan 2012

variations for the quality add-on, and no margin for diverging prices for indirect CO2 costs." LKAB concludes that it would be impossible to attempt to raise prices within Europe (or anywhere else in the world) without significant loss of market share. In conclusion, LKAB states that the company: i) is unable to pass on indirect ETS costs to its customers, ii) the direct and indirect costs for CO2 will lead to a risk of carbon leakage.

2.2.5 Fiscal Impact on Government

The Quebec government revenue projection from the proposed system, to 2020, is estimated at approximately $2.7 billion. The projections indicate that the system will be neutral in the sense that all of the $2.7 billion is earmarked for operating the system, most of which will be for support initiatives to help affected sectors.

The Australian government assessment in the Climate Change Plan indicates a net cost of slightly more than a billion dollars.

Appendix A Core Regulatory Design Features & Attributes

Australia – Clean Energy Act 2011 (In force: July 1st 2012)

Categories	Findings
Executive Summary	The Australian government passed their broad based economy wide climate change **Clean Energy Act** in 2011. Their program introduces a carbon trading system for industrial emitters, encourages energy efficiency, reinforces existing programs to expand the use of renewables, and through a reduction in fuel tax credits, effectively introduces a carbon tax on fuels used by heavy vehicles. The system, which comes into force on July 1st 2012, includes programs to shield the general population from rising costs and protects jobs in export industries through a **Jobs and Competitiveness Program** which will spend $9.2 billion to, among other things, protect and support local jobs. This expenditure is nearly 3% of the projected annual revenue of the Australian Government for fiscal 2012/13.[15] The Australian system has two phases, fixed carbon (CO_2e) pricing over 2012-13 to 2015-16, then an ETS with market determined prices. No international permits can be used in the fixed price phase but they can be used in the ETS phase. Iron ore mining is not singled out or specifically referenced in the Act. The iron ore mining industry is eligible to make a claim for assistance under the Jobs and Competitiveness Program which, if successful, would result in partial granting of free permits. Analysis by third parties indicate that while the iron ore industry meets the criteria for being classified as trade exposed, only iron ore pelletizing meets the minimum criteria (defined as emitting more than 1,000 tonnes of GHG per $1 million[16] of revenue) to obtain partial protection. Although the system does not differentiate between stationary combustion and industrial process emissions when setting targets or allocating allowances, Australia has issued an "Activity Definition for the Production of Iron Ore Pellets" which lists which emissions are included and excluded from coverage in the cap. The actual production of iron ore concentrate feed to the pelletizing plant is excluded. The iron ore mining and production industry is also concerned about the cumulative adverse effects of the Australian government's climate change program combined with an increase in taxes on mining through the Minerals Resource Rent Tax, which also comes into force on July 1st 2012. The Australian Productivity Commission will review the Jobs and Competitiveness Program in 2014 – 2015. Through their legislation, the government will create a: ▪ **Climate Change Authority** to advise on caps, progress towards meeting targets, and undertake reviews of the carbon pricing mechanism;

[15] http://www.budget.gov.au/2012-13/content/overview/html/overview_36.htm
[16] Unless specifically stated, all references to dollars are in Australia dollars, with AUS $1.0 equivalent to CAN $1.0697 (Bank of Canada February 2012).

Categories	Findings
	▪ **Clean Energy Regulator** to administer the carbon pricing mechanism; ▪ **Clean Energy Finance Corporation** which will invest $10 billion in clean energy projects; and an ▪ **Australian Renewable Energy Agency** which will administer $3.2 billion in Government support for research and development, demonstration and commercialization of renewable energy. The government's Productivity Commission will also undertake reviews relating to industry assistance, fuel tax arrangements and carbon pollution reduction activities internationally. In total, and to illustrate the breadth and scope of the Australian legislation, the Clean Energy Act 2011 amends, adds and/or encompasses 14 other Acts. The government believes that by implementing these measures, including providing a clear signal on pricing carbon, they have removed the climate cost risks corporates had faced, specifically the unknown cost of compliance, when making investment decisions and investments in Australia. It's important to note that, at the time of writing this report, there are some indication that the Australian Climate Change Policy regime is under threat from Federal Opposition which vows to abolish it and also from possible constitutional challenges.
Scope	The Australian legislation is a broad based program including carbon pricing through: ▪ An emissions trading system for all facilities emitting more than 25,000 tonnes per year CO_2e (excluding agriculture and land based emissions); and ▪ Reducing fuel tax credits available to heavy transportation vehicles, effective July 2014. The reduction in fuel tax credits will apply to off-road diesel use under the Diesel Fuel Rebate Scheme (DFRS). The DFRS will be reduced from A38 cents/litre to A32 cents/litre to reflect the carbon tax offset. The Australian system has two phases, fixed carbon (CO_2e) pricing over 2012-13 to 2015-16, then an ETS with market determined prices. For Phase 1, the carbon price has been set by government at A$23.00/tonne as of July 1st 2012, escalating at 5% (2.5% real plus 2.5% inflation) on July 1st 2013 and again on July 1st 2014. When the auctioning phase commences, the floor price will be set at A$15/tonne (increasing by 4% per annum). The government has issued a discussion paper describing how their price floor will function; through a combination of an auction reserve floor price combined with a surrender charge for international units. The price ceiling ("safety valve") applies in the first three years of the auctioning phase which commences on July 1st 2015. The price ceiling will be set at AUS$20/tonne over the international price of allowances, and the role of this mechanism will be reviewed by the Climate Change Authority in 2017. To date they have not described how the price ceiling mechanism will function; the Climate Change Authority has been given the mandate to recommend to the government a price ceiling system design. Permits that are bought at fixed prices must be used for compliance in the year for which they were acquired.

Categories	Findings
	In addition to pricing carbon, the government will also increase the role of renewables in Australia by continuing their Renewable Energy Target (RET) program as well as support investment in renewables through the Clean Energy Finance Corporation (which also supports other low emissions technologies such as gas cogeneration and energy efficiency) and funding for an Australian Renewable Energy Agency. Improving energy efficiency is the other key component of the plan and will be achieved through: ▪ Funding of a range of initiatives by the $10 billion Clean Energy Finance Corporation; ▪ Funding (on a co-funding basis) under initiatives such as a Clean Energy Technology Investment Program, ▪ Energy Efficiency grants for providing energy efficiency advice to small and medium business and community organisations and consideration of establishing a national White Certificate Program (no decision by April 2012). ▪ Extension of *Energy Efficiency Opportunities Act* to 2017: this legislation requires entities using +0.5 PJ/year of energy to identify energy efficiency opportunities and report on uptake action. ▪ Implementing recommendations from the Prime Minister's Task Group on Energy Efficiency;
Legislative Framework	In total, and to illustrate the breadth and scope of the Australian legislation, the Clean Energy Act 2011 amends, adds and/or encompasses 14 other Acts: ▪ Clean Energy Regulator Act 2011; ▪ Clean Energy (Charges – Excise) Act 2011; ▪ Clean Energy (Charges – Customs) Act 2011; ▪ Clean Energy (Unit Issue Charge – Auctions) Act 2011; ▪ Clean Energy (Unit Issue Charge – Fixed Charge) Act 2011; ▪ Clean Energy (Unit Shortfall Charge - General) Act 2011; ▪ Clean Energy (International Unit Surrender Charge) Act 2011; ▪ Clean Energy (Consequential Amendments) Act 2011; ▪ Clean Energy (Customs Tariff Amendment) Act 2011; ▪ Clean Energy (Excise Tariff Legislation Amendment) Act 2011; ▪ Clean Energy (Fuel Tax Legislation Amendment) Act 2011; ▪ Clean Energy (Household Assistance Amendment) Act 2011; ▪ Clean Energy (Income Tax Rates Amendments) Act 2011; and ▪ Clean Energy (Tax Laws Amendments) Act 2011. During the period when permits are sold at fixed price by the government, fines for non-compliance are levied at 1.3 times the price of permits, and thereafter at 2.0 times the average annual price of permits. Fines are not tax deductible.
GHG Emission Reduction Goals and Allocations	The goals of the Australian Clean Energy Act 2011 are to: ▪ Meet Australia's obligations under the Climate Change Convention, the Kyoto Protocol and the Copenhagen Accord; ▪ Support the development of an effective global response to climate change, consistent with Australia's national interest ▪ Take action directed towards meeting Australia's long-term target of reducing Australia's net greenhouse gas

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	emissions to 80% below 2000 levels by 2050. The government will announce their first set of five year caps in the 2014 Budget (and do so no later than by May 31st 2014). Each year the government will announce the new "fifth year" target so that at any time five years of targets are known.
Compliance	The operator of a facility is responsible for compliance. The affected parties must surrender one permit (1 tonne of CO_2e) for every tonne of CO_2e emitted. As noted, the system has two phases, fixed carbon (CO_2e) pricing over 2012-13 to 2015-16, then an ETS with market determined prices. In the fixed price period, the affected parties will be able to purchase permits from the government at the fixed price up to the number of their emissions for the compliance year. Up to 5% of permits in this phase can be accessed from the Australian carbon credit units (ACCUs), that is, by using the Carbon Farming Initiative (CFI). Use of permits bought during the initial "fixed price" stage of the regulations is limited and cannot be exported. In the ETS cap and trade phase, from 1 July 2015 permits can be purchased from the government auctioning system (not yet designed) of permits under the annual cap and can also be accessed from: ▪ international permit sources (CER, ERU permits – some exceptions) not EUAs as yet, for up to 50% of a party's liabilities, ▪ unlimited purchase of CFI ACCUs; and ▪ Other credits that may be allowed in the future. Australian permits are treated as financial products and their acquisition, trading and disposal is covered under relevant regulations, as amended as necessary. Compliance is also a tax deductible business expense, although payment of penalties is not.
Reporting	Reporting is required under Australia's National Greenhouse and Energy Reporting Act 2007. Reporting is required for: ▪ Individual facilities that emit more than 25 kT/yr; and ▪ Corporations that emit more than 50 kT/yr or consume more than 200 TJ/a of energy (including energy, for example steam or power) that is bought by the facility or company but not necessarily produced by them. Emissions from the use of energy (including stationary combustion sources and vehicle fuel), industrial process emissions, fugitive emissions and emissions from waste must be reported. Reporters are required to report all 6 greenhouse gases (CO_2, CH_4, N_2O, HFC's, PFC's and SF_6). Reports are to follow the core principles of transparency, comparability, accuracy; and completeness. The Greenhouse and Energy Officer can order an audit of a facility or corporation, but must specify what specifically is being audited and state if they are being audited: ▪ As part of a broader program compliance program, in which case the cost is born by the government; or ▪ Because the Greenhouse and Energy Data Officer has reasonable grounds to suspect that a registered

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	corporation has not met, is not meeting or proposes not to meet its obligations under the legislation, in which case the cost of the audit will be borne by the corporation. Carbon permit trading and transactions will be treated in accordance with international accounting standards, as adopted in Australia. The auditing of potential emissions liabilities will continue to meet Australian auditing standards which conform with the International Standards on Auditing (issued by the International Auditing and Assurance Standards Board).

System Transparency	The Australian government is establishing an affected Entities Public Information Database. The database will include the identities and emissions of entities governed under the Clean Energy Act 2011, as well as the names and addresses of holders of Registry accounts.
	
	The government also intends to make available a summary of permit auction results, including:
	▪ Vintage year;
	▪ Amount auctioned;
	▪ Price paid;
	▪ Total number of fixed price permits issues; and
	▪ Under the Jobs and Competitiveness Program;
	    ▪ The identity of those who received free units;
	    ▪ How many free credits they received;
	    ▪ The vintage year of the credits;
	    ▪ The activities for which they were granted; and
	    ▪ The total issued under program.
	▪ Identities and penalties of those who have violated the programs rules and requirements.

Competitiveness Impacts	The Australian government has included measures in their legislation aimed at protecting the competitiveness of Australia's Emissions Intensive Trade Exposed (EITE) industries. To qualify for protection, an applicant must demonstrate that: ▪ The ratio of imports and exports to total domestic production is greater than 10%; and ▪ Demonstrate that the industry isn't able to pass along costs due to international competition. The iron ore mining sector meets that criteria, but only pelletizing qualifies for protection given the government's quantitative criteria for receiving support, which states that if you emit: ▪ Between 1,000 t CO_2e/$m and 1,999 t CO_2e/$m of revenue, you will receive 66% of your permits for free, based on industry average performance; or ▪ More than 2,000 t CO_2e/$m of revenue, you will receive 94.5% of your permits for free, based on industry average performance. Industry has criticized the rate and timing of program implementation, and in particular in light of the global recession. To partially address those concerns, in 2009 the government amended the original program proposal under a Global

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	Recession Buffer program under which: ▪ Program implementation was deferred by one year; ▪ The original 60% free allocation was increased by 10% to 66%; and ▪ The original 90% free allocation was increased by 5% to 94.5%. In each case, this free allocation had been and will be reduced by 1.3% per annum and reflects the general rate of improvement in Australia's economy required to achieve their long term goals. Note though that the 1.3% is applied on a relative basis, i.e. if you receive 66% free allocation in one year, you receive 66%*(1.000-0.013) = 65.14% in the next year (not 64.7%). The original 60% and 90% were set based upon modeling by the Australian Treasury and following much input and debate by Australia environmentalists and industry (including the Australian Association of Mining and Exploration Companies) who offered opposing views on the level of free allocation, namely: ▪ Deeper cuts are required and fewer free allocations must be given, noting (in part) that industry overstates the economic consequences environmental regulations; and ▪ Higher level economic modeling by government doesn't adequately address competitiveness. In the end, the Australian government determined 60% and 90% free allocation was appropriate, later amended, to 66% and 94.5%. At the time they also published a list of eight sectors "likely" eligible for ETIE protection: ▪ 90% allocation – aluminum smelting, cement clinker, lime, silicon, and integrated iron and steel manufacturing ▪ 60% allocation – alumina refining, petroleum refining, and LNG production They noted that it was "also a large number of activities not listed above which are very likely to be eligible for EITE assistance", and as of March 2012 the list includes 45 separate sectors, ranging from "tissue paper manufacturing" to "iron ore pellets" that are eligible for EITE protection. The only sector singled out for special treatment, above and beyond the program described above, has been the LNG industry, which will receive supplemental allocations relative to production to ensure they receive an effective assistance rate of at least 50%. Protection of the EITE industries is administered under the transitional **Jobs and Competitiveness Program**[17], which will spend A$9.2 billion to protect and support local jobs, encourage industry to invest in cleaner technologies and avoid "carbon leakage". A further A$1.2 billion is available through the **Clean Technology Investment Program**[18], which will help directly improve energy efficiency in manufacturing industries and support research and development in low-pollution technologies (this program is targeted to all affected sectors under the system, not just the EITE eligible facilities).

[17] www.climatechange.gov.au/government/initiatives/jobs-competitiveness-program.aspx
[18] www.innovation.gov.au/INDUSTRY/CLEANENERGYFUTURE/Pages/CleanTechnologyProgram.aspx

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	The iron ore industry is also concerned about the cumulative adverse effects of the Australian government's climate change program combined with an increase in taxes on mining through the Minerals Resource Rent Tax (MRRT), which also comes into force on July 1st 2012. This tax is essentially a "super" profits tax, that is, it's a tax well above what's considered to be "normal" profits.
	
	The issues of whether or not to grant free allocation and, if to, how much, are complex:
	▪ Under full auctioning, the cost of compliance applies to all production and any production decisions, whether if to compete for a marginal sale or even run the facility, taking the cost of carbon into account;
	▪ If free permits are granted for a portion of production, then only marginal production above and beyond that free allocation bears the cost of compliance, and marginal production decisions will take that into account; while
	▪ The design details, for example the threshold under which to grant or not to grant free allocations, can create domestic competitive distortions. For example, assuming the decision is made, as in Australia's situation, at the sector level, then:
	    ▪ A highly efficiency leading-edge facility mining and pelletizing a low grade ore, could receive less support than;
	    ▪ An older low efficiency facility mining and pelletizing a high grade ore.
	
	This situation, in which lower efficiency is rewarded, can be justified on environmental grounds based on the fact that the production of lower grade ores, no matter of what economic benefit or how efficiently, isn't justified given the greater environmental impact.

Trading System Efficiency	From July 1st 2012 to July 1st 2015, the government is restricting the sale and use of fixed price permits. Thereafter, auctioning and trading will commence, with a cap and floor on pricing, the ability to bank permits and limited borrowing. It is therefore premature to conclude how efficient the trading system will be, noting that it is the government's intent that carbon permits be treated like financial instruments (including for the purposes of financial accounting and tax policy) and thus the system, outside of the reporting rules included in the Clean Energy Act 2011, function in a manner similar to existing trading systems. Consistent with the government's plan to have carbon permits treated like financial instruments, the Australian Securities Exchange, for example, anticipates that it will be able to introduce a futures market before July 1st 2015. According to the Australian Securities Exchange, a futures market, relative to unsophisticated markets, will lower transaction costs and provide price discovery.

Categories	Findings
Government Revenue	The Australian government published an assessment of the income (revenue) and costs associated with implementing the program in the Australian Government's "Securing a Clean Energy Future" document. The assessment is for the fiscal 2012/15 year and is summarized below. The estimated annual program revenue is about 3% of the projected annual revenue of the Australian Government for fiscal 2012/13.[19]

	2014 – 2015 Million $ Australian	2014 – 2015 Million $ Canadian*
Government Revenue		
Sale of Permits	**$8,590**	**$9,189**
Other Carbon Revenue	**$320**	**$342**
Fuel Tax Credit Reduction	**$670**	**$717**
Total	$9,580	$10,248
Government Expenditures		
Household Assistance	**$4,825**	**$5,161**
Support for Jobs	**$3,773**	**$4,036**
Clean Energy Finance Corporation	**$455**	**$487**
Energy Security & Transformation	**$1,042**	**$1,115**
Land and Biodiversity Measures	**$489**	**$523**
Governance	**$107**	**$114**
Total	$10,691	$11,436
Net Income (Cost)	($1,110)	($1,188)

* Bank of Canada February 2012 Monthly Exchange Rate of 1.0697

The Australian government believes that by passing their climate change legislation into law, which includes specific measures to protect jobs and the competitiveness of Australian emissions intensive and trade exposed (EITE) sectors, they have removed the uncertainty companies were facing when making investment decisions. Thus their analysis has concluded that the overall impact on industrial investment, the overall economy, and government revenues will be minor.

Stakeholder Engagement	The government of Australia has consulted publically with stakeholders; meetings and materials are posted on their website, as are future consultations and necessary materials (if available).

[19] http://www.budget.gov.au/2012-13/content/overview/html/overview_36.htm

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	The Climate Change Authority is also obliged to hold public consultations including public hearings and establish a public submission process.

Lessons Learned	Australia's system, unlike the EU ETS, has yet to come into force. Thus "lessons learned" is limited to those learning's during system design, those "lessons learned" are generally written from the perspective of a particular special interest group, for example, environmentalists who seek deeper reductions, emission traders who seek a larger trading market, and large emitters who raise issues of competitiveness and cost. Taking into account these potential biases, "lessons learned" include:
	▪ Opposing views are deeply engrained, and in particular between advocates for deeper reductions, and industry, which raises competiveness and cost concerns;
	▪ Defining what an EITE sector is and how to protect raises complex policy issues, for example:
	  ▪ How to address resource quality differences among domestic and international competitors;
	  ▪ How to avoid perverse consequences, i.e. protecting "laggards" with higher emissions intensity while not protecting "leaders" and new entrants with more efficient production processes;
	  ▪ Hazards of using cost-type denominators to determine whether a sector is or is not an EITE sector given cyclical commodity process;
	▪ Broader consideration of costs and impacts, and in particular the need to amend other legislation and regulations so as to not inadvertently impose an onerous cost on industry;
	▪ Consideration of changing economic environment and the potential need for mechanisms to allow governments to rapidly amend programs in light of changing circumstances, for example, the recent recession;
	▪ The challenge of developing credible analyses to predict the impacts of specific regulatory measures on specific facilities which, among other things, impedes industry's ability to highlight specific situations or studies highlighting the adverse impact; and
	▪ The perception that governments are unable to credibly forecast future programs costs and impacts, countered by the perception that industry consistently overstates the adverse impacts of new regulations.

Sweden – European Union Emission Trading System (In force: January 1st 2005)

Categories	Findings
Executive Summary	The European Union Emissions Trading Scheme (EU ETS) is the central component of the EU's climate policy. The aim of the EU ETS is to help Member States achieve emission reductions in a cost effective way, through buying and selling permits to emit carbon dioxide (CO_2). **Sweden, being part of the EU, is obliged to adopt EU legislation into its national regulatory framework. Therefore, the description of the EU ETS rules is applicable to Swedish circumstances, noting that Sweden is the only significant producer of iron ore in the EU.** As of 2007 the EU ETS covers 27 Member States, including Sweden, the only significant iron ore mining and production member, as well as three members of the European Economic Area (Norway, Iceland and Liechtenstein). Approximately 12,000 installations in energy and industrial sectors, representing over 40% of the EU's total CO_2 emissions, are included in the system. The EU ETS is a phased scheme: 1. Phase I (January 1st 2005 – December 31st 2007) was a trial during which it appeared that several member states had significantly over allocated allowances, which, combined with the inability to carry allowances forward into phase 2, lead to a collapse in carbon prices; 2. Phase II (January 1st 2009 – December 31st 2012), in operation now and during the recession, will end at year end; and 3. Phase III (January 1st 2013 – December 31st 2020).
Scope	The EU ETS covers installations (above certain capacity or output thresholds) from selected sectors; Swedish iron ore mining and production facilities exceed this threshold and are therefore governed under the EU ETS. See further elaboration below under "Compliance".
Legislative Framework	The EU Emissions Trading Scheme (ETS) is governed by the Emissions Trading Directive adopted by the European Parliament and of the Council establishing an emissions allowance and trading within the European Union. The EU ETS Directive was implemented in Sweden under the Emissions Trading Act 2004 and the Emissions Trading Ordinance 2004. In Sweden, several authorities are tasked with the implementation of the EU ETS: ▪ Swedish Energy Agency; ▪ Swedish Environmental Protection Agency; ▪ Board of Industrial and Technical Development; and ▪ County Administrative Boards. The introduction of the EU ETS has induced changes in other climate related instruments affecting industry in Sweden. In particular, the government cut the Swedish energy tax by 50% and, to avoid "double charging", removed existing regulations on CO_2 emissions and fossil fuel use under the Swedish Environmental Code now covered by the EU ETS.

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	For industries participating in the EU ETS, the tax is currently 157.5 Swedish Krona per tonne (approximately CAN$ 23.56[20]/tonne) and for industries outside the EU ETS 220.5 SEK/ton (approximately CAN$ 32.99/tonne).
GHG Emission Reduction Goals and Allocations	Initially, the EU ETS was introduced as a tool to help EU Member States meet their targets under the Kyoto Protocol. The EU ETS is now a cornerstone of the EU climate change policy and its application has been extended beyond the first Kyoto compliance period ending in 2012. The EU has indicated it will take on a second Kyoto commitment period to at least 2017. In 2009, the EU approved an amendment to the EU ETS, in which it agreed to set an overarching EU-wide GHG reduction target, which would decrease linearly to 21% below 2005 levels by 2020 in regulated facilities. The cap for 2013 has been determined to be 2,039 million tonnes. This volume will be reduced annually by 1.74% of the average annual total quantity of allowances issued by the Member States in 2008-2012. In absolute terms, this means the number of allowances will be reduced annually by 37.4 million tonnes and will continue beyond 2020, unless amended by the Community not later than 2025. In the first two phases (2005-2012), allocation of allowances was done at the Member State level via National Allocation Plans (NAPs). In the NAPS, Member States had to decide how many allowances to allocate in total for a trading period and how many each installation covered by the Emissions Trading System would receive. Each country determined total quantity of allowances that was in line with its target within the framework of the Kyoto Protocol. A Member State had to ensure that the allocations granted to its installations would enable it to meet its Kyoto target. The NAPs were required to follow a set of criteria, listed in the Annex III of the EU ETS Directive, which include that quantities of allowances to be allocated should be consistent with the potential to reduce emissions. NAPs had to be approved by the European Commission before each phase and before any allowances were granted to installations. Most of allowances the free allocations. Member States were allowed to auction up to 5% of allowances in Phase I and up to 10% of allowances in Phase II. The European Commission adopted its decision on the Swedish national allocation plan for Phase II in November 2007. The total number of emission allowances to be allocated was set at 22.5 million tonnes per year. Out of this total, about 19.8 million allowances were granted, and 2.6 million were put aside for new entrants (i.e. new facilities) in Phase II. There has been no EUA auctioning by the Swedish government. In Sweden, allocation in Phase II of the EU ETS has been achieved by: ▪ Allocating to existing installations (with the exception of ore-based steel production) calculated in proportion to each installation's average emissions during a historical period, taking into account the installation's projected increase of raw-material related emissions between the allocation based period and an average for 2008-2012. ▪ Allocating to new entrants calculated depending on the activity on the basis either of output-based benchmarks or a comparison with the best available technology (BAT). Allocation from the reserve takes place in accordance with the principle of "first come, first serve" with respect to the date on which a valid application has been received by the authorities. If an operator applies for a free allocation at a date when the reserve of allowances is exhausted, the company is referred to the market for allowances.

[20] 1.0 Swedish Krona equivalent to CAN $0.1496 (Bank of Canada February 2012).

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	From Phase III (2013-2020), NAPs are replaced by the EU-wide harmonized distribution rules as follows: ▪ Full auctioning for the power sector, with the option for transitional free allocation for the modernization of electricity generation in certain countries (mainly Central and Eastern Europe); ▪ For other sectors covered by the ETS that are not deemed to be at risk of carbon leakage, including mineral and production and processing of ferrous metals, auctioning begin at 20% in 2013, with a gradual phase-in towards 70% in 2020 and 100% in 2027; and ▪ Installations in sectors or sub-sectors which are exposed to a significant risk of carbon leakage will receive 100% of allowances free of charge at the level of the benchmark of the best technology available. For the third trading period, which begins in 2013, there will no longer be any national allocation plans. Instead, the allocation will be determined directly at EU level. In Phase III, according to the EU –wide harmonized rules, allocation is based on benchmarks, as follows: Allocation = Benchmark x Historical level x carbon leakage exposure factor x Cross-sectoral correction factor OR linear factor. Different allocation methods may apply to the same installation, as the installation can be divided into sub-installations such as: i) product benchmark sub-installations; ii) heat benchmark sub-installations; iii) fuel benchmark sub-installations and iv) process emissions sub-installations. New entrants joining the EU ETS in 2013 will be able to benefit from free allocation of allowances from the new entrants reserve (with the exception of new entrants involved in power generation activities). The amended EU ETS Directive defines 'new entrants' as installations: ▪ That will receive their greenhouse gases emissions permits for the first time after 30 June 2011; or ▪ That decide to include new activities and greenhouse gases approved by the Commission into the scope of the EU ETS; or ▪ Undergoing substantial extensions after 30 June 2011, subject to terms and conditions defining what is "substantial". The new entrants reserve will contain 5% of the EU wide quantity of allowances. Any allowances left in the reserve at the end of Phase III will be auctioned by Member States. As well, up to 300 million allowances from the new entrants reserve of the EU ETS will be used to support the demonstration of carbon capture and storage (CCS) and innovative renewable technologies. Member States had to submit National Implementation Measures (NIMs), listing installations covered by the Directive

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	in their territory and any free allocation to each of those installations. A total of 634 installations, of which three are iron ore sinter pellet installations[21], are considered under the Swedish plan. According to the Swedish NIM submitted to the Commission, the number of gratis free EUAs will start at 30.2 million in 2013 and just over 216.9 million EU gratis allowances (EUAs) are planned between 2013 and 2020.

Compliance	The EU ETS Directive (Annex 1) provides the list of activities that are covered by the scheme (some have capacity or output thresholds). The amended Directive of 2009 introduces the tCO2eq threshold in the context of small emitters - which have been part of the EU ETS scope during Phase I and II - but in Phase III will be eligible for exclusion, under the following conditions: (i) an installation carries out an activity listed in Annex 1; (ii) reported emissions were lower than 25,000 tCO2eq in each of the 3 years preceding the year of application, excluding emissions from biomass; (iii) for combustion installations, an additional capacity threshold of 35MW applies; and (iv) such installation is subject to measures that will achieve an equivalent contribution to emission reductions. Installations exclusively burning biomass are not covered by the EU ETS Directive.
	
	All installations under the EU ETS need to have a permit and have the following options to comply with the regulations:
	▪ Reduce their emissions;
	▪ Acquire EU allowances through:
	  ▪ Trading on exchanges (the Nord Pool for Sweden, Finland, Denmark and Norway); or
	  ▪ Bilateral transactions;
	▪ Acquire certified emissions reductions (CERS), again through the Nord Pool or through bilateral transactions;
	▪ Acquire offset credits (CERs from CDM projects) and Emission Reduction Units (ERUs from JI projects in Phase II)
	
	In Sweden, an operator needs to apply to the Swedish Environmental Protection Agency for an allocation. A special council for allocation of allowances (RUT), (consisting of representatives from the Swedish Environmental Protection Agency, the Swedish Energy Agency, and the Swedish Agency for Economic and Regional Growth), is tasked with processing proposals for allocations to each particular installation.
	
	Any surplus allowances can be banked between trading periods. Borrowing from the following year within a trading period is also allowed.
	
	In the 2008-2012 trading period, operators have been allowed to use JI/CDM credits up to a percentage determined in the National Allocation Plans (NAPs). Under the Swedish NAP for Phase II, companies in the Swedish register may collectively use ERUs and CERs corresponding to a share of at most 20 per cent of the total quantity of allowances issued, which, on average, means 5.0 million ERUs and CERs per year. For both existing installations and new entrants, the highest permitted use need not be evenly allocated over the period in question.

[21] The three installations are the Kiruna, Malmberget and Svappavaara facilities owned and operated by the Swedish company Luossavaara-Kiirunavaara AB (LKAB)

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	Unused entitlements can be transferred to the next trading period (2013-2020). Between 2008 and 2020, the EU ETS legislation provides for use of credits up to 50% of the overall reductions below 2005 levels made under the EU ETS. The exact amount that can be transferred and used is to be determined in line with methodology outlined in EU ETS Directives. For the ETS Phase III, the Member States have to decide whether to use an EU-wide auction platform or a national auction platform. Sweden is participating in the common auction platform: the European Union Transaction Log. For Phase III (2013-2020), NAPs are replaced by the EU-wide harmonized distribution rules: ▪ Full auctioning for the power sector, with the option for transitional free allocation for the modernization of electricity generation in certain countries (mainly Central and Eastern Europe); ▪ For other sectors covered by the EU ETS, including mineral production and processing of ferrous metals (except those deemed at risk of carbon leakage), auctioning will begin at 20% in 2013, with a gradual phase-in towards 70% in 2020 and 100% in 2027; ▪ Installations in sectors or sub-sectors which are exposed to a significant risk of carbon leakage will receive 100% of allowances free of charge at the level of the benchmark of the best technology available. These are discussed in more detail in section below" Competitiveness Impacts". The allocation of free allowances is based on benchmarks based on the mathematical product of the benchmark, historical activity level (for 2005 – 2008 or 2009 – 2010, at the facility operators choice), a carbon leakage exposure factor, and a cross-sectorial correction factor (or linear factor). As a general rule, a benchmark is developed for each product on the basis of allowances/tonne of product, determined based upon the average greenhouse gas performance of the 10% best performing installations in the EU producing that product in 2007-2008. If product benchmarking is not feasible, then other methodologies should be applied based on: ▪ First, a heat benchmark of 62.3 allowances/TJ of heat consumed or exported; ▪ Second, a fuel benchmark of 56.1 allowances/TJ fuel consumption; and ▪ Third, a process emission benchmark of 0.97 allowances/t-CO_2 of process emissions. "Heat" should meet all of the following conditions in order to be covered by a heat benchmark: ▪ Measurable; ▪ Used for a purpose (production of products, mechanical energy, heating, cooling); ▪ Not used for the production of electricity; ▪ Not produced within the boundaries of a nitric acid product benchmark; ▪ Not consumed within the system boundaries of a product benchmark; and ▪ Consumed within the ETS installation's boundaries and produced by an ETS-installation; or ▪ Produced within the ETS installation's boundaries and consumed by a non-ETS installation or other entity for a purpose other than electricity production. No distinction is made between heat from different sources (e.g. produced from different fuels, produced by boilers or

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	CHP, heat as a by-product of a benchmarked production process, etc.).
Reporting	Since 2005, only CO_2 has been reported. Other GHG gases (CH_4, N_2O, HFCs, PFCs, and SF_6) have been introduced as opt-ins. Currently, only the Netherlands has chosen to include N_2O emissions. From 2013, reporting N_2O emissions from the production of nitric acid, adipic acid and glyocalic acid production, and PFC from the aluminum sector will be mandatory. Since 2005, there have been national registries, keeping track of allowances issued under the EU ETS and their ownership. On the 15th of May each year, each Member State is required to publish information on how its operators have fulfilled their compliance obligations. In Sweden, the registry for trading in emission allowances is maintained by the Swedish Energy Agency. All installations covered by the EU ETS are to report their emissions annually to the Swedish Environmental Protection Agency by March 31st. Emissions are reported by using the Swedish database E-CO_2 and reports have to be verified by an independent accredited verifier. The Swedish regulator actively monitors compliance and uses the data to meet their national reporting obligations under the EU ETS. Once emissions are verified, operators must surrender the equivalent number of allowances by April 30th. On May 15th statistics on fulfillment are published, showing the emissions each company has reported, and, on June 30th, the government annuls the transferred emission allowances, which are also deleted from the trading system. All industrial installations required to report their emissions are required to have an approved emission monitoring plan. The Swedish Environmental Protection Agency is the supervisory authority and reviews the reports submitted. In case of discrepancy between verified emissions and surrendered allowances, a penalty fee of $100 Euro per tonne (CAN$131.94[22] per tonne) is charged and the operator is obliged to also surrender emission allowances for its excess emissions. The Swedish Environmental Protection Agency has developed a "Measuring Technique for emission of carbon dioxide – principles and costs for monitoring within the framework of the EU Emissions Trading Scheme". This document describes different methods to monitor the variables, used to calculate the emission of carbon dioxide, within the framework of the Emissions Trading Scheme.
System Transparency	Since Phase I of the EU ETS began in 2005, national registries have been in place tracking allowances issued and ownership. In Sweden, the registry for trading in emission allowances is maintained by the Swedish Energy Agency which makes available to the public: ▪ National plans including the allowances assigned to each Member State; ▪ Accounts (held by a company or an individual) to which those allowances have been allocated; ▪ Transfers of allowances ("transactions") performed by the account holders; ▪ Annual verified CO_2 emissions from installations; and

[22] 1.0 Euro equivalent to CAN $1.3194 (Bank of Canada February 2012).

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	▪ Annual reconciliation of allowances and verified emissions, where each company must have surrendered enough allowances to cover all its emissions For the Phase III, Sweden will be participating in the common EU Transaction Log.
Competitiveness Impacts	The amended EU ETS Directive recognizes that there are sectors and sub-sectors, whose competitiveness may be put at risk due to obligation to comply with the EU ETS requirements. Specifically, a sector or sub-sector is "deemed to be exposed to a significant risk of carbon leakage" if: ▪ The extent to which the sum of direct and indirect additional costs induced by the implementation of this directive would lead to a substantial increase of production cost, calculated as a proportion of the Gross Value Added, of at least 5%; and ▪ The Non-EU Trade intensity defined as the ratio between total of value of exports to non EU + value of imports from non-EU and the total market size for the Community (annual turnover plus total imports) is above 10%. A sector or sub-sector is also deemed to be exposed to a significant risk of carbon leakage if: ▪ The sum of direct and indirect additional costs induced by the implementation of this directive would lead to a particularly high increase of production cost, calculated as a proportion of the Gross Value Added, of at least 30%; or ▪ The Non-EU Trade intensity defined as the ratio between total of value of exports to non EU + value of imports from non-EU and the total market size for the Community (annual turnover plus total imports) is above 30%. Due to the risk of carbon leakage, these sectors and sub-sectors are to receive relatively more free allowances than other sectors. Free allocation is in principle based on product-specific benchmarks. The difference in calculating formula (as given in the previous section on GHG Emissions Goals) is that, the free allocation will be multiplied by a factor 1 (100%) while for other sectors the allocation will be multiplied by a lower figure (0.80 in 2013, and reduced every year to reach 0.30 in 2020). For Phase III of the EU-ETS, facilities in sectors at risk of carbon leakage will be eligible for 100% free allowances up to a benchmark level of Best Available Technology. The Commission Decision of 24 December 2009 provides a list of sectors and sub-sectors deemed to be exposed to a significant risk of carbon leakage. The list includes *inter alia*: mining of iron ores, casting of iron, manufacture of basic iron and steel and of ferro-alloys, manufacture of cast iron tubes. Furthermore, following the latest Commission Communication "Guidelines on certain State aid measures in the context of the GHG allowance trading scheme post-2012"[23], mining of iron ore sector has been recognized as eligible for state aid measures for indirect emissions cost (i.e. compensation for higher costs incurred due to increases in electricity prices as a result of the implementation of the ETS Directive). However, currently pelletizing of iron ore is not specifically mentioned in any of the decisions or Directives; it is part of the Mining of Iron Ores Sector.

[23] Source: http://emissions-euets.com/attachments/196_Guidelines%20on%20certain%20State%20aid%20measures%20in%20the%20context%20of%20the%20greenhouse%20gas%20emission%20allowance%20trading%20scheme%20post-2012.pdf

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	Pelletizing of iron ore is addressed in the ETS Measuring & Reporting Guidelines (MRG) on process emissions. The guidelines define process emissions as "*greenhouse gas emissions other than combustion emissions occurring as a result of intentional and unintentional reactions between substances or their transformation, including the chemical or electrolytic reduction of metal ores, the thermal decomposition of substances, and the formation of substances for use as product or feedstock*". Calculations of process emissions are discussed in the activity-specific guidelines (Annex II-IX); specifically Annex V, CO_2 emissions from metal ore roasting and sintering installations, notes that in metal ore roasting, sintering or pelletization installations, CO_2 emissions result from the following emission sources and source streams: ▪ raw materials (calcination of limestone, dolomite and carbonatic iron ores, e.g. FeCO3), ▪ conventional fuels (natural gas and coke/coke breeze), ▪ process gases (e.g. coke oven gas (COG) and blast furnace gas (BFG)), ▪ process residues used as input material including filtered dust from the sintering plant, the converter and the blast furnace, ▪ other fuels, ▪ waste gas scrubbing. As noted in the Swedish NAP for Phase II, in the allocation of allowances for Phase II, the EU-ETS made an allowance for the raw-material related emissions that cannot be reduced in the short-term other than by decreasing output at the installations. The plan referred to a prerequisite that the installation could not be a new entrant and that the increase in emissions would have to be the result of increased output within existing capacity during the period 2008-2012, relative to the period used for allocation based on historical emissions. The allowance supplement made for the projected increase of raw-material related emissions was to be evenly allocated over the years in the period. In the cases when the projection of raw-material related emissions was lower than the average of the historical emissions, the installation would have still received its basic allocation corresponding to the average of the historical emissions. There appears to be no different treatment according to production processes; except that a different emission factor applies depending on a fuel burned. Therefore, it is up to producers to decide how to make iron ore pellets, and incur least cost under the EU ETS. The EU ETS also provides for the possibility for Member States to compensate the most electro-intensive sectors for increases in electricity costs resulting from the ETS through national state aid schemes. The Commission has recently put forward Guidelines on the application of state aid rules to possible measures by Member States to support sectors exposed to a risk of carbon leakage due to costs relating to greenhouse gas emissions passed on in electricity prices in the context of the EU ETS.
Trading System Efficiency	Except for companies with obligations under the Emissions Trading Directive, individuals and organizations may also open personal holding accounts in the registry to participate in the trading of emission allowances. Spot, futures and options markets exist within the EU ETS, as well as trading allowances over-the-counter (OTC) and

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	through exchanges. The share of allowances that is required to be auctioned will increase significantly in Phase III of the EU ETS. The auction format will be a single-round, sealed bid, uniform price auction. The common auction platform will hold auctions at least weekly for EU allowances (EUAs) and at least once every two months for EU Aviation Allowances (EUAAs), given their smaller quantity. The common auction platform will determine and publish its auction calendar by 28 February of the preceding year. An early auction of 120 million Phase III allowances will take place in 2012.
Government Revenue	Auction money in Phase III: ▪ 88% of the total quantity of allowances to be auctioned will be allocated between Member States in proportion to their verified emissions in 2005; ▪ 10% of the total quantity of allowances to be auctioned will be allocated between certain Member States in the interests of solidarity and growth in the Community, thus increasing the quantity of allowances that those Member States auctioned in accordance with the previous indent by the percentages specified in Annex IIA of the proposal for an ETS Directive; and ▪ 2% of the total quantity of the allowances to be auctioned will be allocated between the Member States which had achieved in 2005 a reduction of at least 20% in greenhouse gas emissions compared with the reference year set by the Kyoto Protocol, At least 50% of the revenue, and all of the revenues from auctioning allowances in respect of aviation, is to be used to combat climate change (mainly in the EU but also in developing countries). This increase in revenue broadly offsets the reduced carbon taxes paid by corporations for their facilities captured under the EU ETS. Other sources of revenue for the government include: ▪ Penalties for surrendering fewer allowances than verified emissions; and ▪ Carbon taxes paid by the general population, which have increased approximately four-fold since introduced in 1991, are directed to the government's "General Revenue" account, which were not decreased when the EU ETS came into force.
Stakeholder Engagement	At the EU level, a discussion document, together with the list of questions on which views are sought, is being published and the consultation is open. Responses are accepted via on online survey or through completion and email of a text document. An opportunity is also provided for additional information to be submitted beyond the direct response to the consultation paper. Once the EU opens consultation, then Member States carry out their internal consultation, before they submit their standpoint. The review of the EU ETS Directive for Phase III included a series of working group discussions held between March and June 2007 on specific issues. These were attended by officials from Member States, as well as by stakeholders from industry, non-governmental organizations and academia. The Commission published a report of these discussions in the European Climate Change Program (ECCP) Working Group. Afterwards, the Commission developed a proposal for an amended Directive.

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	The European Commission holds stakeholder meetings in a group or on one-to-one basis. In 2008 and 2009, the Commission held five stakeholder meetings on the subject of carbon leakage in which Member States, industry, non-governmental organizations, and academics were given the opportunity to present their views. The consultations took place in the framework of the Working Group on the review of the EU emissions trading scheme (EU ETS), set up in the context of the European Climate Change Program. The development of a proposal for allocation principles was commissioned by the Swedish authorities. Several accompanying reports were also developed. All these documents were then circulated for comment to all stakeholders among authorities, industrial representatives and interest organizations most closely affected by the regulations. The allocation plan was also made available for the public who were invited to submit their comments. This opportunity was announced through a press release and on the Government's website (www.regeringen.se) which can also be accessed through Sweden's emission allowance trading portal (www.utslappshandel.se). Comments had to be submitted in writing to the Ministry for Sustainable Development by a specified deadline.

Lessons Learned	The EU ETS has been in operation since 2005 and has transitioned from Phase I to Phase II. Numerous studies and reports have been issued on the subject of "lessons learned". These studies are often written from the perspective of a particular special interest group, for example, advocates for deeper reductions, emission traders who seek a larger trading market, and large emitters who raise issues of competitiveness and cost. Taking into account these potential biases, "lessons learned" include:
	▪ Initial limited coverage of gases (basically CO_2) helped ease introduction of reporting and verification requirements;
	▪ Including smaller facilities added administrative burden with limited environmental gain;
	▪ When allocating permits:
	    ▪ A solid basis for emissions caps is required to avoid "penalizing leaders and rewarding laggards";
	    ▪ Failure to consider how to treat plant shutdowns or relocations created perverse consequences;
	    ▪ Varied allocations between member states, who are often economic competitors, created "uneven playing field";
	    ▪ Auctioning versus allocation remains a divisive issue;
	▪ Inability to bank and use credits between Phase I and Phase II resulted in:
	    ▪ A price collapse at the end of Phase I; and
	    ▪ Some firms deferring investments until longer term rules were understood;
	▪ Program design placed too much reliance upon service providers and inexperienced program managers, consequently there were numerous operational issues ranging from inability to source verifiers, to a lack of promised foreign (CDM) credits;
	▪ Robust enforcement required beyond regulated entities, i.e. the EU VAT tax avoidance scheme.

Quebec – (In force: January 1st 2013)

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Executive Summary	Quebec, as a member of the Western Climate Initiative (WCI), has enacted the *Regulation respecting the cap-and-trade system for greenhouse gas emissions* under the Environmental Quality Act, making Quebec the first jurisdiction in Canada to adopt a formal cap-and-trade program based on an absolute emissions caps analogous to the EU ETS. The draft regulations were issued in 2011. The Minister of Sustainable Development, Environment and Parks will table shortly the *2013-2020 Climate Change Action Plan.* The new action plan will call for investments of nearly $2.7 billion by 2020. The final regulations for offsets are expected to be public by the end of June, 2012. Each WCI Partner jurisdiction will have an emission allowance budget under the cap-and-trade program that is consistent with its jurisdiction-specific emissions goal for 2020. Each Partner has the flexibility to decide how best to allocate its allowance budget within its jurisdiction. However, it's important to note that the WCI is only relevant to the extent on where members agree on what the rules should be within the framework of the initiative. The WCI has no enforceable powers within the provincial jurisdiction. The cap and trade system for GHG emission allowances will begin with an initial phase consisting of three compliance periods, the first of which will begin on January 1, 2013. This year is considered a transition year to allow emitters and participants to familiarize themselves with how the system works. No reduction or capping of GHG emissions will be required during this transition year. The first compliance period begins on January 1st 2013. Under the regulations, the approximately 100 industrial and power producer facilities whose GHG emissions exceed 25,000 tonnes CO_2e per year will be subject to the cap-and-trade regulations. Mining companies whose emissions exceed the 25,000 CO_2e tonnes per year threshold will be subject to the capping and reduction of their GHG emissions. In order to address concerns with respect to competition and minimize carbon leakage, the Quebec system will allocate gratis allowances to the mining sector (see below for elaboration). Since 2007, the government of Quebec has imposed a duty on fuel and fossil fuels on energy distributors. The approximately $200 million in annual revenue from the duty was fully allocated to initiatives under the 2006-2012 Action Plan. The 2012-2013 Budget stipulates that the duty will be extended until December 31, 2014 but will exempt major industrial emitters covered by the cost of the GHG emission cap-and-trade system.
Scope	The scope of the draft regulations include: ▪ Facilities that emit more than 25,000 CO_2e tonnes per year; ▪ Business-as-usual cap set in 2012 based on historic facility emissions;

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	▪ The emissions cap set by the government then decreases by an average of 4% annually; ▪ Phase 1 compliance begins on January 1st 2013; ▪ Phase 2 compliance begins on January 1, 2015, at which time businesses that distribute fuel in Quebec, or import fuel for their own consumption, and whose annual GHG emissions due to its combustion exceed the 25,000 tonnes threshold will also be subject to capping and reduction.
Legislative Framework	On December 14th 2011 the Government of Quebec passed their *Regulation respecting the cap-and-trade system for greenhouse gas emissions* under the Environmental Quality Act (R.S.Q., c. Q-2). The Minister of Sustainable Development, Environment and Parks will table shortly the *2013-2020 Climate Change Action Plan.*
GHG Emission Reduction Goals and Allocations	Quebec's overarching goal is a GHG emission reduction target is 20% below 1990 levels by 2020. As noted, the Quebec cap and trade system will begin with an initial phase consisting of three compliance periods, the first of which will begin on January 1, 2013. Initially, the cap will cover approximately 30% of Quebec's total emissions and by 2015 will cover 80% of total emissions. The annual allowance budget starts at 23.7 million tonnes in 2013. Quebec has adopted the proposed WCI design for transportation fuel GHG emissions. Effective in 2015, it will affect any fuel supplier (wholesaler or retailer) within the participating WCI Partner jurisdiction that distributes liquid transportation fuel sold or imported for consumption in the participating Partner jurisdiction. In 2015, consistent with the expanded scope of the regulations when fuel distributers and importers come under the regulations, the allowance cap increases to 63.3 million tonnes and then decreases until reaching 50.9 million tonnes by 2020. In the initial transition period, there will be gratis emissions allocations for industry, including mining, structured as 80% of combustion emissions and 100% of process emissions (As defined in the regulations, Appendix C Part II, fixed process emissions are the CO2 emissions resulting from a fixed chemical reaction process for production purposes that generates CO2, from chemically-bonded carbon in the raw material, or from the carbon used to remove an undesirable component from the raw material where there is no substitutable raw material). The allocations will be based on a 2007-10 emission intensity baseline. Thus if a facility is able to reduce its process emissions relative to its baseline, that reduction may be used towards compliance. By the 2015-2020 period, it's anticipated that the level of gratis allocation will decrease. By the 2015-2020 period, it's anticipated that the level of gratis allocation will decrease by 1-2% per year. The fact that approximately 65% of Quebec's total emissions originate from the use of transportation fuels, the free allocation of emissions represents a minor portion of total provincial emissions relative to other jurisdictions more reliant upon fossil fuels for energy. The government expects to auction emission units up to 4 times per year. The auction floor price starts at $10.00 in 2012, and increases annually by 5% plus inflation.

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Compliance	Under the draft regulations, an emission allowance means: i) a greenhouse gas emission unit, ii) offset credit or early reduction credit, iii) any emission allowance issued by a government other than the Government of Quebec with which an agreement has been entered into, each allowance having a value corresponding to one metric ton of greenhouse gas CO_2 equivalent. The draft regulations provide a formula for determining an affected facility's emissions unit which is determined by a formula provided in the regulations. Only emitters registered in the system, having a covered establishment in Quebec and not holding emission units in their general account are eligible for a sale of emission units by mutual agreement
	
	The compliance options include:
	- Reducing emissions;
	- Offset credits (final offset regulations due to be released by end of June);
	  - Total number of offset credits that may applied towards compliance may not exceed 8% of the registered emitters' total obligation;
	  - Opportunities to develop offsets will become more limited in Phase 2 (beginning in 2015) as the emissions cap lowers and more of the economy is captured by the regulations;
	  - The government is still considering local, Canada, North America or CDM as sources.
	- Early reduction credits:
	  - All emitters under the regulations during the initial phase are eligible for early reduction credits which are reductions that were achieved during 2008 to 2011, relative to a baseline determined during 2005 to 2007;
	  - Emissions reduction credits (i) must arise from on-site activities as a result of a capital investment, but (ii) cannot be attributed to reductions arising from on-site transportation or sequestration activities;
	  - Applications for early credits must be submitted by December 31, 2012
	- Emissions Allowances:
	  - Emissions allowances are issued without charge by the government of Quebec, or by any other government with which Quebec has entered into an agreement with consistent with the regulations;
	  - Allocation without charge is available under a prescribed allocation methodology outlined in the regulations for eligible industries according to their North American Industry Classification System (NAICS) code, including;
	    - Mining and Quarrying (NAICS 212, except oil and gas);
	  - The government will also maintain a Reserve Account of emission allowances which will hold allowances in reserve and which may be, at the Minister's discretion, allocated for free or sold. If sold, the reserve allowance price starts at $40 – 50 per tonne, and increases 5% annually plus inflation.

Reporting	Emissions of all six main greenhouse gases (CO_2, CH_4, N_2O, PFCs, HFCs and SF_6) as well as NF_3 (nitrogen trifluoride) and are to be reported in accordance with the regulations. Emissions reports are filed annually by September 1st and must be independently verified by an ISO 14065 accredited verifier.
System Transparency	Quebec regulators plan to create a "closed system", limited to emitters and registered system participants, for trading compliance instruments. The Quebec cap and trade system will also include strict transparency and disclosure

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	requirements covering: ▪ Quantity and type of carbon credit traded; ▪ Settlement price for each type of carbon credit traded; ▪ Planned date of transaction; and ▪ Name and contact information of the buyer and seller.
Competitiveness Impacts	The system includes allocation with no charge to account for the competitiveness of emission intensive trade exposed industries. To date we have not been able to determine how this will be applied.
Trading System Efficiency	It is anticipated by observers that the Quebec Securities Commission will regulate emissions trading in the province. It is therefore likely that the trading system could be as efficient as any new product introduced into the market.
Government Revenue	On March 20th 2012 the government of Quebec published revenue and expenses associated with their program in their 2012 – 2013 Budget, outlining climate change revenue and expenditures in the summary "Quebec and Climate Change – A Greener Environment". The government has indicated that revenues from the sale of allowances will be entirely allocated to funding the *2013-2020 Climate Change Action Plan.* Cumulative program revenues and expenses to 2020 are summarized here: **Revenue** — Million $ Carbon Market — **$2,445** Fuel and Fossil Fuel Duty — **$220** **Total Revenue** — $2,665 **Expenditures** — Million $ Support Individual Initiatives — **$1,645** Establish Partnerships with communities and civil society — **$158** Support Innovative enterprises — **$610** Foster adaptation by Quebec society to climate change — **$200** Partnerships, international cooperation, management and accountability — **$53** **Total Expenditures** — $2,665
Stakeholder Engagement	The draft regulation was open for public consultation from July 7th 2011 to September 4th 2011.