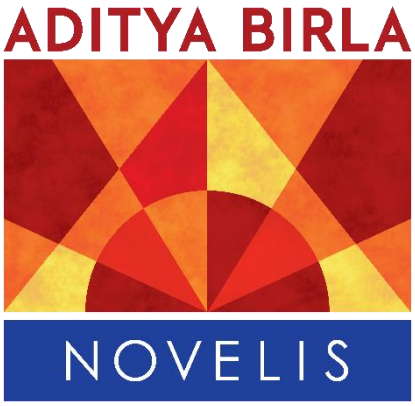

Novelis Environmental Metrics Reporting And Management Directive

Revision Date: August 14, 2019

Table of Contents

Executive Summary

This directive was designed to facilitate accurate and consistent recording and reporting of environmental metrics at all Novelis locations. This reference has been prepared to provide assistance for this process. For reporting of environmental events, please refer to EHS Incident Management Performance Standard.

The accuracy of environmental data is contingent upon a common definition of terms related to environmental metrics reporting and recordkeeping. A listing of important terms and definitions are included in the directive for all variables that are to be reported into the EtQ Sustainability Module including: Air Emissions, Material Flows, Transportation, Waste, Water, and Energy Sources.

Environmental metric charts are available through PowerBI reporting. PowerBI combines data entered into EtQ sustainability with data from the historical Performance Data Management (PDM) warehouse.

The environmental metrics data that is reported in through PowerBI must be utilized in the management review process established at the various levels in the Novelis organization. It is expected that each site will review trends in these metrics at least quarterly to identify out of control situations and assure root cause analysis and permanent corrective actions are implemented. This directive also contains an appendix that details the process for managing the sustainability data that is communicated to the external public.

1.0 Purpose, Scope, and Application

1.1 Purpose

The purpose of the Novelis Environmental Metrics Reporting and Management Directive is to promote uniformity in the management of the critical environmental metrics. This includes the consistent and accurate classification, quantification, reporting and analysis of these metrics.

1.2 Scope

The Novelis Environmental Metrics Reporting Directive covers the definitions, reporting deadlines/procedures and management review requirements necessary to maintain consistent environmental reporting and recordkeeping to allow for statistical analysis and management at all levels in the organization. It also covers the management and calculation of external environmental sustainability indicators. The Novelis Environmental Metrics Reporting Directive applies to all Novelis sites. There are however some variables discussed in this directive that are not applicable to all sites.

1.3 Roles & Responsibilities: The chart below defines the roles and responsibilities for implementation of the Directive.

	Plant Manager	Managers	Supervisory Personnel	EHS Staff
Ensure that an action plan is developed and executed to bring the plant into full compliance with the Novelis Environmental Metrics Reporting And Management Directive	AR	I	I	C
Ensure environmental data is entered into the EtQ system per this directive	A	I	I	R
Ensure that environmental metrics data that is reported in the PowerBI tool is utilized in the management review process	A	C	I	R

R	***Responsible***	*The person(s) who actually completes the task; e.g. responsible for action/implementation.*
A	***Accountable***	*The accountable person is the individual who is ultimately answerable for the activity or decision.*
C	***Consult***	*The consult role is individual(s) to be consulted prior to the final decision or action.*
I	***Inform***	*These are individuals who need to be informed after a decision or action is taken.*

2.0 Definitions

2.1 Air Emissions (Annual)

Air emissions for each operating site must quantify air emissions on an annual basis. R&D sites and offices are not required to report air emissions. Data must be reported in April for the preceding fiscal year. Unless specified otherwise, air emissions should be reported as stack or point source emissions. Fugitive emissions should not be included in the estimate unless specifically identified in this directive. Please note that actual stack testing data is the preferred source for quantifying air emissions. If they are not available, internationally recognized emissions factors such as USEPA AP-42 (or other internally recognized factor) should be used to estimate air emissions. Appendix 2A, 2B and 2C also has some process specific emissions factors that can be used in this estimation process.

Note: All air emissions will be reported for the previous fiscal year. Note: Sites may be required by local legislation to report on a calendar year basis also.

2.1.1 Particulate Matter

Include the total quantity of organic or inorganic Particulate Matter, mist or dust air emissions for the entire plant. Only include sources of stack emissions. Do not include fugitive emissions that escape from processes and are emitted through building openings. Data based on stack test results are preferred. Estimates are acceptable if measured data is not available. The most significant source of PM is scrap melting furnaces, flux boxes, holders, shredders, dross coolers, dryers, and decoaters. This variable must be reported in metric tonnes.

2.1.2 Hydrogen Chloride

Report the total quantity of hydrogen chloride air emissions from all plant processes onsite. Typically HCl emissions are associated with furnace and flux box operations where chlorine or other reactive fluxing is performed. In addition, HCl is generated during scrap or used can delaquering operations. Report stack emissions only, not fugitive emissions that fail to be captured by the ventilation system and escape into the building. Appendix 2A contains some critical emissions factors that can be used for estimating HCl emissions. Please note that site specific emission factors are preferred and should be used in lieu of the factors contained in Appendix 2A when available. This variable must be reported as HCl in metric tonnes.

2.1.3 NOx

Include the total quantity of NOx air emissions for the entire plant. Only include sources of stack emissions. Do not include fugitive emissions that escape from processes and are emitted through building openings. Data based on stack test results are preferred. Estimates are acceptable if measured data is not available. The most significant source of NOx is various natural gas or fuel oil combustion sources (i.e. building heaters, melting/holding furnaces, soaking pits, gas fired annealing furnaces, etc.). Appendix 2B contains a Novelis approved method for estimating NOx emissions from combustion sources. This variable must be reported as NO_2 in metric tonnes.

2.1.4 SO_2

Include the total quantity of SO_2 air emissions for the entire plant. Only include sources of stack emissions. Do not include fugitive emissions that escape from processes and are

emitted through building openings. The most significant source of SO_2 would be through the combustion of petroleum-based fuels such as heavy oil (#6 / Bunker C). Data based on historical stack test results are preferred. Estimates are acceptable if measured data is not available. This variable must be reported in metric tonnes. Appendix 2B contains a Novelis approved method for estimating SO_2 emissions from combustion sources.

2.1.5 VOC

Include the total quantity of VOC air emissions for the entire plant. VOC is any pollutant that can contribute to ozone formation in the lower atmosphere. It is typically measured via EPA Method 25A for US Facilities. Only include sources of stack emissions. Do not include fugitive emissions that escape from processes and are emitted through building openings. Data based on stack test results are preferred. Estimates are acceptable if measured data is not available. Typically sources of VOC are cold rolling operations, melt furnaces that process oily/coated scrap, and scrap decoating operations. Appendix 2C contains a Novelis approved method for estimating cold mill VOC emissions. This variable must be reported in terms of propane (equivalent to 1/3 of carbon equivalents) in metric tonnes.

2.1.6 MEK

Report the total quantity of MEK air emissions from all plant processes onsite. This should only include stack emissions not fugitive emissions that fail to be captured by the ventilation system and escape into the building, or are lost through volatilization from open containers. The major source of MEK is coating/painting processes onsite. This variable must be reported in metric tonnes.

2.1.7 Toluene

Report the total quantity of toluene air emissions from all plant processes onsite. Report stack emissions only, not fugitive emissions that fail to be captured by the ventilation system and escape into the building, or are lost through volatilization from open containers. The major source of toluene emissions is any coating/paint processes onsite. This variable must be reported in metric tonnes.

2.2 Direct Energy Sources (Monthly)

2.2.1 Direct Energy Sources – Natural Gas

2.2.1.1 Natural Gas

Report the total amount of natural gas consumed (cubic meters) by the site for the reporting period. This data should come from invoice / accounting records or a meter of “billing” quality, where possible.

2.2.1.2 Natural Gas Upper Calorific Value

Report the Upper Calorific value of the natural gas delivered as KWh/nm3. This data should come from invoice / accounting records or a meter of “billing” quality, where possible. If the monthly invoice is not yet received consider the average of the last 3 months.

2.2.1.3 Liquified Propane Gas (LPG)

Report the total amount of liquified propane gas consumed (Lit.) by the site for the reporting period. This data should come from invoice / accounting records or a meter of “billing” quality, where possible. Liquified Petroleum gas (or so called "Liquified Propane gas") which is mainly propane C3H8 or butane C4H10 or a mix of both. The conversion from Kg to Liters should use : Propane = 1,98 lit/kg, Butane 1,74 lit/kg, mix of butane and propane 1,86 lit/kg

2.2.2 Direct Energy Sources – Petroleum

2.2.2.1 Heavy Fuel Oil (Number 4 or 6)

Report the total amount of heavy fuel oil consumed (kilograms) by the site for the reporting period. This data should come from invoice / accounting records or a “billing” quality meter. Fuel oil is a fraction of long hydrocarbon chains, particularly alkanes, cycloalkanes and aromatics obtained from petroleum distillation classified in six grades of fuel oil (numbered 1 through 6). Number 4 fuel oil is a commercial heating oil for burner installations not equipped with preheaters. It may be obtained from the heavy gas oil cut. Number 6 fuel oil is a high-viscosity residual oil requiring preheating to 104 - 127 °C. Residual means the material remaining after the more valuable cuts of crude oil have boiled off. The residue may contain various undesirable impurities including 2 percent water and one-half percent mineral soil. This fuel may be known as Bunker C Oil. The conversion from Lit to Kg should be 0,98 Kg/lit.

Diesel and Number 2 Fuel Oil

Report the total amount of diesel (Gasoil) and No. 2 fuel oil consumed (liters) by the site for the reporting period. This data should come from invoice / accounting records or a “billing” quality meter. Diesel (Gasoil) and No. 2 fuel oil are distillate home heating oil or for trucks and cars typically obtained from the light gas oil cut. Gas oil refers to the process of distillation. Any combustion of waste oil should be added as Diesel and Number 2 Fuel Oil.

2.2.2.2 Kerosene

Report the total amount of kerosene consumed (liters) by the site for the reporting period. This data should come from invoice / accounting records or a “billing” quality meter. Kerosene is a light oil (density 0.8 g/cm3) obtained from the fractional distillation of petroleum between 150 °C and 275 °C, resulting in a mixture of carbon chains that typically contain between six and 16 carbon atoms per molecule. The kerosene used as rolling oil should not be considered here. Kerosene to consider here is only for heating. The rolling oil recovered for heating should also be considered here.

Note: The GHG emissions associated with the direct energy consumption is calculated by using standard factors such as the fuel’s calorific value with the exception of Natural Gas. Sites enter in the specific Natural Gas Upper Calorific Value for their site.

2.3 Indirect Energy Sources (Monthly)

2.3.1 Indirect Energy Sources – Input

2.3.1.1 Electricity in from Novelis

Report the total electricity in kWh supplied from Novelis generating station to facility. This data should come from invoice / accounting records or a “billing” quality meter (Historical Data)

2.3.1.2 Electricity in from Third Party

Report the total electricity in kWh supplied from third party electricity provider to facility. This value can be calculated from supply data and converted to kWh

2.3.1.3 Hot Water in from Third Party

Report the total hot water in kWh equivalents supplied from third party to facility. This value can be calculated from supply data and converted to kWh.

2.3.2 Indirect Energy Sources – Output

2.3.2.1 Electricity out to Third Parties

Report the total electricity in kWh supplied to third parties from Novelis generating capacity. This data should come from invoice / accounting records or a "billing" quality meter.

2.3.2.2 Hot Water out to Third Parties

Report the total hot water in kWh equivalents supplied to third parties from onsite generating capacity. This value can be calculated from supply data and converted to kWh.

2.4 Process Categories -

Energy Usage and Material Flows are reported on a process level basis. The table below contains a list of processes, definition of the processes and list of equipment contained within the processes.

REMELT & DC CASTING	REMELT & CC CASTING	RECYCLING	HOT ROLLING	COLD ROLLING (sheet)	FINISHING & PACKING (sheet & foil)	Coating & Metal Treatment (sheet & foil)	FOIL ROLLING
Transform liquid metal or solid metal in various forms in a slab	Transform solid metal in various forms in a coil	Transform scrap in various forms to clean scrap	Transform a slab out of dc caster to a hot rolled coil	Transform a hot rolled coil to a cold rolled coil at final gauge	Transform a cold rolled coil at final gauge to the customer dimensions requirements	Transform the cold rolled metal at final gauge to the customer surface requirement	Transform a hot rolled coil to a cold rolled coil at final gauge <300µ
sow dryer	sow dryer	roto-grinder		cold rolling mill	slitters (with or without lubrication/waxing)	coating / painting line / Powder line	breakdown mills
melter	melter	debaler	scalper		tension levelling	litho line	intermediate mills
holder	holder	shredder	soaking pits		separating	continuous annealing and CASH Line	foil mills
sidewell melter if connected to a dc caster or supplying a DC caster with liquid metal	sidewell melter if connected to a dc caster or supplying a CC caster with liquid metal	shear	pusher furnaces		cut to length	laminating line	doubling machine
induction furnace if connected to a dc caster or supplying a DC caster with liquid metal	induction furnace if connected to a dc caster or supplying a CC caster with liquid metal	belt decoater	reversing / breakdown mill		laser	level clean line	
dc caster	cc caster		finishing/tandem mill			extrusion/coating line	
dross press/processing/tumbler	dross press/processing/tumbler		cropping shears		packing	batch annealing (cold rolling)	
baghouse	baghouse		cladding		unwinders / dr machines	metaliser	
sawing			HM waste / emulsion treatment		Alu Core line	roll forming/bright mill/embosser	
					Presses	printing	
support equipment	support equipment	support equipment	support equipment	support equipment	support equipment	support equipment	support equipment

In addition to reporting energy usage by the process categories above, facilities shall also report Total Plant energy use by source. Total Plant includes the above processes plus Production Support usage (i.e. – general production, other support equipment, central maintenance, roll-grinding shop, shipping, stores, truck maintenance, warehousing, and material handling and transfer).

2.5 Material Flows (Monthly) -

Material Flows are reported on a process level basis. Materials flows are reported by process using the categories provided below:

REMELT & DC CASTING	REMELT & CC CASTING	RECYCLING	HOT ROLLING	COLD ROLLING (sheet)	FINISHING & PACKING (sheet & foil)	Coating & Metal Treatment (sheet & foil)	FOIL ROLLING
Good tons out of DC caster	Good tons out of CC caster	Good tons out of the Recycling operation	Good tons out of the Hot mill	Good tons out of the Cold mills at final gauge	Good tons out of Final operation	Good tons out of Final operation	Good tons out of the Foil mills at final gauge
Input Solid tons in Melter & Induction furnace.	Input solid tons in melters			Cold Rolling passed tons		Treatment passed squared meters	Cold Rolling passed tons

Material flows shall also be reported for:

- Tons “ready to ship”
- Normalized Tons = Remelt & DC Casting + Remelt & CC Casting + Recycling + Hot Rolling + Cold Rolling (sheet or foil) + Finishing & Packing

Directive

2.6 Transportation (Quarterly)

2.6.1 Average Distance to Customer

The data should reflect the calculated average distance in kilometers, per mode of transport, that is traveled to deliver product to the internal and/or external customer offsite (not part of production facility).

Example:

Customer #1	Customer #2	Customer #3
50 kilometers	75 kilometers	100 kilometers
20 shipments	10 shipments	30 shipments

$$= \frac{(50\text{ km} * 20\text{ shipments}) + (75\text{ km} * 10\text{ shipments}) + (100\text{ km} * 30\text{ shipments})}{60\text{ (Total \# Shipments)}} = 79\text{ kilometers}$$

2.6.1.1 Air Cargo
2.6.1.2 Barge
2.6.1.3 Coaster
2.6.1.4 Train
2.6.1.5 Ferry
2.6.1.6 Heavy Truck (28 Tonnes)
2.6.1.7 Heavy Truck (18 Tonnes)
2.6.1.8 Ocean Vessel

2.6.2 Total Tonnes Shipped

Include total tonnes of good product shipped, per mode of transport, to the internal or external customer offsite (not part of production facility). The sum of production shipped via all modes of transport should equal the tons shipped from the facility

2.6.2.1 Air Cargo
2.6.2.2 Barge
2.6.2.3 Coaster
2.6.2.4 Diesel Train
2.6.2.5 Ferry

2.6.2.6 Heavy Truck (28 Tonnes)
2.6.2.7 Heavy Truck (18 Tonnes)
2.6.2.8 Ocean Vessel

2.7 Waste (Quarterly)

Depending on your local jurisdiction's solid waste definitions, some materials will be reported in different manners from site to site. In particular there are significant differences in how used oils, oily wastes, dross and scrap metals are classified in the local regulations. In some regions in Novelis these materials are not defined as wastes. However, Novelis external sustainability reporting needs require that all wastes be appropriately accounted for even if a waste does not meet a local jurisdiction's solid waste definition. Appendix 2D provides a reference for waste classifications for each region. For items listed in the Table as "Not a Waste", refer to the footnote for proper PDM reporting requirements.. Note: Waste generated from large construction projects or remediation projects are to be included in the PDM entries and must be noted in the PDM comments field of the appropriate waste.

2.7.1 Hazardous

2.7.1.1 Hazardous Waste Incinerated

List the total quantity (kilograms) of all hazardous waste (as defined by your local government jurisdiction) incinerated by the plant. You should include the quantity of all hazardous waste incinerated onsite or offsite. Incineration is defined as the destruction of wastes that have a low BTU content. A low BTU content waste is defined as a waste that requires additional fuel to effectively destroy. This is not a self-sustaining process. This estimate should be all inclusive. Therefore the estimate of Total Hazardous Waste Incinerated should include the quantity of any incinerated Specific Material (Section 2.7.3) that is classified as hazardous waste by local government regulations.

2.7.1.2 Hazardous Waste Recycled

List the quantity (kilograms) of all hazardous waste (as defined by your local government jurisdiction) recycled by the plant. You should include the quantity of all hazardous waste recycled onsite or offsite. Please note that the processing of high BTU content materials which allow for a self sustaining process is an alternative fuel and should be included in this figure (as a recycling activity). This estimate should be all inclusive. Therefore the estimate of Total Hazardous Waste Recycled should include the quantity of any recycled Specific Material (Section 2.7.3) that is classified as hazardous waste by local government regulations.

2.7.1.3 Hazardous Waste Landfilled (Routine Landfilled)

Please note that this figure must include the quantity (kilograms) of all relevant landfilled hazardous wastes (as defined by your local government jurisdiction) that were generated from routine production and maintenance operations. Routine maintenance wastes include items such as pit/tank cleanings, furnace rebuilds and flooring repairs. This figure should include all hazardous industrial wastes that are landfilled onsite and offsite. The estimate should be all inclusive. Therefore the estimate of Total Hazardous Waste Landfilled should include the quantity of any landfilled Specific Material (Section 2.7.3) that is classified as hazardous waste by local government regulations.

2.7.1.4 Hazardous Waste Landfilled (Non-Routine Landfilled)

Please note that this figure must include the quantity (kilograms) of all relevant landfilled hazardous wastes (as defined by your local government jurisdiction) that

were not generated from routine production and maintenance operations. Non-routine production and maintenance wastes include “one-time” wastes such as non-routine construction, demolition and remediation wastes. This figure should include all hazardous industrial wastes that are landfilled onsite and offsite. The estimate should be all inclusive. Therefore the estimate of Total Hazardous Waste Landfilled should include the quantity of any landfilled Specific Material (Section 2.7.3) that is classified as hazardous waste by local government regulations.

2.7.2 Non-Hazardous

2.7.2.1 Non-Hazardous Waste Incinerated

List the quantity (kilograms) of all non-hazardous waste (as defined by your local government jurisdiction) incinerated by the plant. You should include the quantity of all waste incinerated onsite or offsite. Incineration is defined as the destruction of wastes that have a low BTU content. A low BTU content waste is defined as a waste that requires additional fuel to effectively destroy. This is not a self-sustaining process. This estimate should be all inclusive. Therefore the estimate of Total Non-Hazardous Waste Incinerated should include the quantity of any incinerated Specific Material (Section 2.7.3) that is classified as non-hazardous waste by local government regulations.

2.7.2.2 Non-Hazardous Waste Recycled

List the quantity (kilograms) of all non-hazardous waste (as defined by your local government jurisdiction) recycled by the plant. You should include the quantity of all non-hazardous waste recycled onsite or offsite. The processing of high BTU content materials which allow for a self sustaining process is an alternative fuel and should be included in this figure (as a recycling activity). This estimate should be all inclusive. Therefore the estimate of Total Non-Hazardous Waste Recycled should include the quantity of any recycled Specific Material (Section 2.7.3) that is classified as non-hazardous waste by local government regulations (also report any materials defined in Appendix 2D as “Not a Waste” if indicated that reporting is required in the appropriate footnote.)

2.7.2.3 Non-Hazardous Waste Landfilled (Routine Landfilled)

Please note that this figure must include the quantity (kilograms) of all relevant landfilled non-hazardous wastes (as defined by your local government jurisdiction) that were generated from routine production and maintenance operations. Routine maintenance wastes include items such as pit/tank cleanings, furnace rebuilds and flooring repairs. This figure should include all industrial wastes and general trash items that are landfilled**.** This estimate should be all inclusive. Therefore the estimate of Total Non-Hazardous Waste Landfilled should include the quantity of any landfilled Specific Material (Section 2.7.3) that is classified as non-hazardous waste by local government regulations.

2.7.2.4 Non-Hazardous Waste Landfilled (Non-Routine Landfilled)

Please note that this figure must include the quantity (kilograms) of all relevant landfilled non-hazardous wastes (as defined by your local government jurisdiction) that were not generated from non-routine production and maintenance operations. Non-routine production and maintenance wastes include “one-time” wastes such as non-routine construction, demolition and remediation wastes. This figure should include all non-hazardous industrial wastes that are landfilled onsite and

offsite. The estimate should be all inclusive. Therefore the estimate of Total Non-Hazardous Waste Landfilled should include the quantity of any landfilled Specific Material (Section 2.7.3) that is classified as non-hazardous waste by local government regulations.

2.7.3 Specific Materials

2.7.3.1 Dross

Report the total quantity (kilograms) of dross generated by all primary and secondary aluminum processes such as Recycling furnaces, DC Casting Centers, and flux boxes and shipped offsite during the quarter. If any facilities recycle dross onsite during a quarter, the amount of dross recycled must be reported in the PDM comment field (not as shipped). Dross is defined as the metallic oxide and salt slag that collects on the surface of molten metal during refining operations. This should include all gray (i.e. holder and round top melter dross) and black drosses (i.e. side well furnace dross) of varying aluminum content. The generation of salt cake from dross and scrap recycling operations (rotary salt furnaces) should not be included in this figure.

2.7.3.2 Recycle Baghouse Dust

Insert the quantity (kilograms) of baghouse dust waste generated. The amount of "baghouse dust reported should equal the waste generated from the cyclones, spark arrestors and filter baghouses associated with all melting furnaces, holding furnaces, filter boxes, shredders, and decoaters/delaquerers. This figure should include the total waste generated (including the dust collected from the process as well as acid scrubbing reagents injected into the baghouse for acid gas control).

2.7.3.3 Hot Mill Used Emulsion

Insert the quantity (kilograms) of all hot mill (both reversing and tandem mill designs) used oil emulsion generated by the process. You should report the total quantity of used emulsion as generated (prior to any treatment) by the process. Do not report the quantity of the treated waste oil concentrate or used oil fuel produced from the treatment of the used emulsion. Please report the actual quantity of used oil emulsion generated by the actual process in its original form and concentration.

2.7.3.4 Cold Mill Used Oil

Report the total quantity (kilograms) of cold mill used roll coolant generated at the plant. The quantity of oil reported should not include the amount of oil sent to a VDU process for recycling, only the amount of oil or VDU bottoms removed from the cold rolling process.

2.7.3.5 Cold Mill Filter Media

Report the total quantity (kilograms) of waste cold mill filter media. The definition of cold mill filter media includes the media itself as well as any filter papers utilized in the process. The amount of the wastes such as roll grindings from the reconditioning of hot or cold mill rolls should not be included in this figure. This would include all types of cold mill oil filter media including DE/FE and ActiCel/wood pulp filter medias.

2.7.3.6 Coating Line Related Waste Paint/Solvent

Report the total quantity (kilograms) of the used paint waste, coating wastes and all clean up solvents used in all coating line processes. The amount of gloves and rags used and disposed of in the waste paint/solvent should be included as well.

2.8 Water (Quarterly)

2.8.1 Water-Input (Quarterly)

2.8.1.1 Groundwater
Report the quantity (cubic meters) of water used from a source of water such as an onsite groundwater well.

2.8.1.2 Surface Water
Report the quantity (cubic meters) of water used from an untreated (with the exception of crude filtration) source of water such as a river or lake.

2.8.1.3 Sea Water
Report the quantity (cubic meters) of sea or ocean water used onsite.

2.8.1.4 Water from Public Net
Report the quantity (cubic meters) of water used from a treated (including filtration and disinfection) source of water such as a public/municipal water supply.

2.9 Water (Annually)

2.9.1 Water- Discharge (Annually) Identify planned and unplanned water discharges by destination. Do not include storm-water discharges. If the facility does not have a meter to measure water discharges, this figure needs to be estimated by subtracting the approximate volume consumed on-site from the volume withdrawn (or other valid estimating means). Report the total volume of water discharged in cubic meters per year. Report by destination below:

2.9.1.1 Groundwater
Water discharged beneath the earth's surface.

2.9.1.2 Surface Water
Water discharged to the atmosphere.

2.9.1.3 Water discharged to off-site treatment facilities
Water that is discharged to an offsite third party facility for subsequent treatment. Include water that is discharged to a sewer system or trucked.

2.9.2 Water/Wastewater- Recycle/Reused(Annually) – Definition: Recycled water is worked water that is treated before it is used in a task. Reused water is worked water that is used in a task without treatment beforehand.

2.9.2.1 Recycled Water Used in the Same Process
Report water recycled back in the same or a higher use process. An example of recycled water includes cooling water cooled by a cooling tower prior recirculation back into the cooling loop. Recycled cooling water volumes can be estimated by; multiplying the average recirculation flow rate (i.e. from cooling tower pumps) by the hours of operations (less input water); or multiplying cooling water input volume by the cooling tower cycles of concentration. Report the total volume of water recycled in cubic meters per year.

2.9.2.2 Recycled/Reused Water used in a Different Process
Report water recycled/reused in a different process. An example includes reverse osmosis concentrate water reused in an air pollution control scrubber. Grey water (i.e., collected rainwater and wastewater generated by household processes such

as washing dishes, laundry, and bathing) is included. Report the total volume of water recycled in cubic meters per year.

3.0 Data Quality

It is important to have an understanding of the data quality related to some of the environmental performance indicators. It is expected that everyone to provide the highest data quality possible. Where actual data is not available through calculations or direct measurements, estimates are acceptable. .

3.1 Calculated

Any data based on measured values that have been modified to reflect calculations by process engineers

3.2 Estimated

Any secondary data or theoretical calculation

3.3 Measured

Any primary data that reflects actual measurements (direct sampling) performed during the subject time period

Data is collected and reported by each site on a monthly, quarterly or annual basis depending on type. Depending on the site, there may be one or more people responsible for data collection (i.e. environmental resource, energy manager, transportation manager). Where data is significantly different from subsequent quarters, the sites are required to insert comments explaining the variance. Once data is entered and saved in EtQ by the site, changes will need to be made by users with “manager” level access.

The site has 10 days after the end of the quarter to enter energy data and 15 days to enter all other data. Once all data is submitted, the Novelis Inc Data Validator reviews the data to assure data is complete and accurate. If inconsistencies are identified, the plant is notified and a validation process is initiated. Once the data is deemed accurate by the Data Validator, a quarterly performance report is developed and distributed to the various operational leaders.

Data Collection Process – Quality Assurance

Each site is required to validate their data. Plants have access to emissions data for their site through EtQ and PowerBI reporting. Once the site deems it accurate, the data is saved by the site. A second data validation is performed monthly by the Novelis Inc Data Validator. PowerBI has several standard reports that will facilitate this validation. In addition, the Data Validator performs a query of all data reported each month/ quarter and reviews it for variation between historical data (i.e. prior quarter and same quarter from prior year). Uncertainties identified by the Data Validator are identified and reported back to the site. The site is responsible for correcting errors or identifying explanations for the variations.
A periodic audit is performed at each site to assure the representative responsible for reporting metrics is providing accurate data and fully understands the Novelis environmental metrics reporting requirements.

Data Collection System Security

All data input into EtQ is backed up daily so data is not lost due to IT failures. EtQ is maintained on an internal Novelis server and is accessible only through the internal intranet. Access to EtQ is controlled by access control software whereby reader, writer, manager, and super user rights are controlled depending on reporting responsibility. These access rights are controlled by the Novelis Inc EtQ Data Coordinator. Once data is entered into EtQ and saved as final data by the site, the data should be locked. The rights to unlock data are controlled by the EtQ managers. Based on EtQ’s access control features, the data reported is considered secure and well controlled.

Internal Auditing

Auditing of the Environmental metrics reporting system is performed periodically at all sites. At a minimum, the audit covers the review of the sites knowledge of the reporting definitions as well as the data collection process and calculation method to assure data is accurately and consistently reported. Calibration of key

measurement devices and meters are also checked if the site considers those meters related to a significant aspect.

The audits are performed in accordance with the Novelis EHS Auditing Directive which is a controlled document. Auditors are trained to assure competency. Findings from the audit must be corrected using the sites ISO 14001 certified corrective action process.

Corrective Action

Any findings identified at the site level are identified as corrective actions and managed in accordance with the site's corrective action process as defined in their ISO 14001 Management System.

4.0 Environmental Metrics Reports

A number of standard reports are automatically generated by the PowerBI for use by the plants so they can analyze their site's past performance. These reports will be issued monthly for Energy and quarterly for other Sustainability data. PowerBI Sustainability combines historical data from PDM and current data from EtQ to create reports. Data can be reported by plant, region and facility and by date range. Reports available from PowerBI include:

4.1 Waste to landfill

- Total volume of routine hazardous and non-hazardous waste to landfill (kg)
- Internal Reporting Intensity - Waste to landfill/ normalized tonne (kg/tonne) – can report to site level.
- External Reporting Intensity - Waste to landfill/ tonne FRP sales (kg/tonne) – can report to region level.

4.2 Water Efficiency

- Total volume of water input (cubic meters)
- Internal Reporting Intensity – Water Input/ normalized tonne (m3/tonne) – can report to site level.
- External Reporting Intensity – Water Input/ tonne FRP sales (m3/tonne) – can report to region level.

4.3 Energy Efficiency

- Total energy consumed (energy in Gigajoules or MWh)
- Internal Reporting Intensities – Energy/ normalized tonne (GJ or MWh/tonne), Energy/ shipped tonne (GJ or MWh/ tonne), Cost/ unit Energy (USD $/ MWh) – can report to site level, can report to process level.
- External Reporting Intensity – Energy/ tonne FRP sales (GJ or MWh/tonne) – can report to region level.

5.0 Management Review Process Requirements

The environmental metrics data that is reported in the PowerBI tool must be utilized in the management review process established at the various levels in the Novelis organization. It is expected that each site will review trends in these metrics at least quarterly to identify out of control situations and assure root cause analysis and permanent corrective actions are implemented.

Definitions: • Above
Related Documents: • None
References: • None

Appendix 2A
HCl Emission Factors

Process-specific HCl emissions factors generated from actual stack testing data should be used where possible. Local regional factors should be used where process-specific data is not available. If the site does not have any HCl emissions factors available, the below factors can be used.

Can Decoating Processes

- Uncontrolled emissions from a can decoating process will emit approximately 1.35 kg/tonne (2.7 lb/ton) of HCl.
- Therefore an estimate of HCl emissions can be calculated if you know your pollution control's HCl removal efficiency.
- A well designed acid gas dry or wet scrubbing baghouse should achieve approximately 85% removal. Therefore overall can decoating HCl emissions can be estimated using the below equation:

HCl Emissions (kg/year) = 1.35 kg/tonne x .85 x Prod. Rate (tonne/year)

Remelt Molten Metal Fluxing

1) Chlorine Gas Fluxing

Based on past stack testing performed, approximately 8% of the chlorine gas utilized for fluxing operations is converted into HCl. Therefore the below equation can be utilized for estimating HCl from chlorine gas fluxing in a typical Holding Furnace operation.

HCl Emissions (kg/year) = Chlorine Used (kg/year) (.08)

2) Rotary Flux Injection Utilizing Magnesium Chloride Solid Salt Flux

75% of MgCl salt flux is elemental chlorine. Based on past stack test approximately 6% of this chlorine is converted into HCl when injected utilizing good furnace practices. Therefore the HCl emissions for rotary salt injection systems can be estimated utilizing the below equation.

HCl Emissions (kg/year) = Total Salt Flux Used (kg/year) x .75 x .06

3) In Line Flux Box Emissions

The use of chlorine gas in Flux Boxes creates HCl. Based on past stack testing, typical flux box operations utilizing chlorine gas will generate approximately .04 kg HCl per tonne of molten metal processed. Therefore the equation below can be utilized to estimate HCl emissions from a flux box.

HCl Emissions (kg/year) = .04 kg/tonne x Production Rate (tonne/year)

Appendix 2B
NO_x/SO_x Emissions Estimation Methodology for External Combustion Sources

Process-specific NO_x/SO_x emissions factors generated from actual stack testing data should be used where possible. Local regional factors should be used where process-specific data is not available. If the site does not have any NO_x/SO_x emissions factors available, the below USEPA factors can be used.

The U.S. Environmental Protection Agency has established emissions factors and emissions estimation methods for various types of External Combustion Sources utilizing a number of different types of fuel (Fuel oil, natural gas, etc).

Below is an Internet link that you can refer to for guidance on how to estimate your NOx and SO_2 emissions.

http://www.epa.gov/ttn/chief/ap42/ch01/

For information on NOx related to the combustion of natural gas in various types of furnace operations, please refer to Section 1.4 and Table 1.4 -1 in AP 42.

For information on SO_x related to the combustion of natural gas in various types of furnace operations, please refer to Section 1.4 and Table 1.4 -2 in AP 42.

Appendix 2C
Cold Mill VOC Emission Estimation Methodology

Process-specific VOC emissions factors generated from actual stack testing data should be used where possible. Local regional emissions factors should be used where process-specific data is not available. If the site does not have any VOC emission factors available, the below estimation method can be used.

The best method to estimate VOC emissions from Cold Rolling is to perform a cold mill oil mass balance.

If you can account for all oil inputs and outputs (with the exception of the air emissions) from the cold mill, you should be able to estimate the quantity of VOC air emissions (difference between the inputs and outputs).

Typical oil inputs into the cold mill include:
- Purchased base oil (do not consider the amount of reclaimed oil from the VDU)
- Purchased additive

Typical outputs include:
- Used oil removed from the mill (not including used oil sent to VDU and returned to process)
- VDU bottoms
- Cold Mill Filter Media Waste (typically contains approximately 35% oil)
- Residual oil on coils

Therefore the quantity of VOC from Cold Rolling can be estimated using the below equation:

Cold Mill VOCs (tonne/year) = Inputs (tonne/year) – Outputs (tonne/year)

- Or -

Cold Mill VOCs (tonne/year) =
Purchased Base Oil (tonne/year) + Purchased Additive (tonne/year) –
Used Oil Removed From Process (tonne/year) – VDU Bottoms (tonne/year) –
(Cold Mill Filter Media (tonne/year) x 0.35) – Residual Oil on Coils (tonne/year)

Appendix 2D
Waste and Determination

	United States			Ontario Canada			Italy		
	Non Hazardous	Hazardous	Not a Waste	Non Hazardous	Hazardous	Not a Waste	Non Hazardous	Hazardous	Not a Waste
Dross			X[1]		X			X	
Recycle Baghouse Dust	X			X					
Hot Mill Used Emulsion			X[1]	X					
Cold Mill Used Oil			X[1]	X				X	
Cold Mill Filter Media	X			X				X	
Coating Line Related Waste Paint/Solvent		X			X			X	
Scrap Metal			X[1]			X[2]			X[2]
Spent Pot Lining		X			X				

1 Not Considered a Waste if Material is Recycled or Reclaimed in USA. For PDM, report all dross, cold mill used oil, and scrap metal that is recycled or reclaimed as “non-hazardous recycled.”

2 For PDM, report all scrap metals that is recycled or reclaimed as “non-hazardous recycled”. Scrap metal includes plant generated scrap aluminum that is shipped off-site for recycling.

Appendix 2D
Waste Determination

	Germany Europe			United Kingdom Europe			Switzerland Europe		
	Non Hazardous	Hazardous	Not a Waste	Non Hazardous	Hazardous	Not a Waste	Non Hazardous	Hazardous	Not a Waste
Dross	X	X[1]			X		X	X[1]	
Recycle Baghouse Dust		X		X[2]	X[2]			X	
Hot Mill Used Emulsion		X			X			X	
Cold Mill Used Oil		X			X			X	
Cold Mill Filter Media		X			X			X	
Coating Line Related Waste Paint/Solvent	X[3]	X[3]		X[3]	X[3]			X[3]	
Scrap Metal	X[4]			X[4]			X[4]		

Spent Pot Lining	**X**	**X[5]**			**X**		**X**	**X[5]**	

1 Dross will normally be classified as non-hazardous. But if the gas formation rate upon addition of water exceeds 1 l / (kg h) it is hazardous.
2 Baghouse dust may be non-hazardous or hazardous depending upon its composition e.g. if lime injection is used, the waste is definitely hazardous.
3 Organic solvents / solvent-based paints are hazardous. Water based paints may be non-hazardous if they do not contain hazardous materials.
4 Scrap metal will normally be classed as non-hazardous unless it is contaminated by other hazardous substances.
5 Spent pot lining will normally be classed as non-hazardous unless it is contaminated by other hazardous substances.

Appendix 2D
Waste Determination

	Brazil South America			**Korea Asia**			**China Asia**		
	Non Hazardous	Hazardous	Not a Waste	Non Hazardous	Hazardous	Not a Waste	Non Hazardous	Hazardous	Not a Waste
Dross	**X**			**X**			**-**	**-**	**-**
Recycle Baghouse Dust		**X**		**X[1]**			**-**	**-**	**-**
Hot Mill Used Emulsion		**X**				**X[2]**	**-**	**-**	**-**
Cold Mill Used Oil		**X**			**X**		**-**	**-**	**-**
Cold Mill Filter Media		**X**			**X**		**-**	**-**	**-**
Coating Line Related Waste Paint/Solvent		**X**			**X**			**X**	

Scrap Metal	**X**					**X[3]**			**X[3]**
Spent Pot Lining		**X**		**-**	**-**	**-**	**-**	**-**	**-**

1 If Recycle Baghouse Dust exceeds limits for heavy metals (Pb, CN, Cd, Hg, Cr, Cu), PCBs, or Oil (5% above) etc. using specified analysis method, The waste is considered hazardous. It is hazardous waste at Ulsan and non-hazardous waste at Yeongju.

2 Hot mill coolant is not a waste, it is waste water because oil density is 5% below. But oil & waters were segregated by oil separator. Oil is Hazardous waste by Korean law.

3 For PDM, report all scrap metals in Korea and Malaysia that is recycled or reclaimed as “non-hazardous recycled”. Scrap metal includes plant generated scrap aluminum that is shipped off-site for recycling.

Appendix 2E
Environmental Metrics Reporting Frequencies and Deadlines

Variable ID	Reporting Frequency	Reporting Deadline
Energy	**Monthly**	**10 days after the end of the month**
Material Flow	**Monthly**	**10 days after the end of the month**
Water (Input)	**Quarterly**	**15 days after the end of the quarter**
Transportation	**Quarterly**	**15 days after the end of the quarter**
Waste	**Quarterly**	**15 days after the end of the quarter**
Air Emissions	**Annual**	**4 weeks (28 days) after the end of the year**
Water (Discharge/ Recycling)	**Annual**	**4 weeks (28 days) after the end of the year**

Appendix 2F
Management Plan for External Sustainability Reporting

1) Scope

Novelis collects various data for the reporting of environmental sustainability performance to external parties and shareholders. The purpose of this management plan is to document how environmental sustainability data is gathered and results calculated for reporting to external parties. Reported data includes emissions of greenhouse gases (GHGs), energy usage, wastes recycled, incinerated and landfilled, water usage and air emissions. Novelis has developed this Management Plan to:

- Define boundary conditions for our reporting of environmental sustainability data,
- Develop definitions for consistent reporting of data,
- Define types of data to be reported,
- Assure that accurate and consistent data is maintained.

The information contained in this document describes the various facets of the Novelis Environmental Sustainability Management Plan and is supplemented by other Novelis referenced documents.

2) Boundary Conditions

Organizational Boundary

The organizational boundary includes all Novelis divisions, subsidiaries and legal entities in the countries in which we are present. Novelis generally follows the Operation Control approach[1] when setting organizational boundaries (however Novelis only accounts for the portion of the operations based on the volume of product sold by Novelis). A company has operational control over an operation if the former or one of its subsidiaries has the full authority to introduce and implement its operating policies at the operation. Novelis incorporates our joint venture facilities as follows:

- Novelis reports *50%* of the Alunorf joint venture in Germany where we have 50% of plant output.
- Novelis reports *55%* of the Logan joint venture in the USA, where we own 40% of outstanding common shares, but receive 55% of plant output due to equipment investments (It should be noted that for Logan, the percentage of output depends on current year output levels and may vary with time). For FY2007 through FY2010, Logan's output was reported at *64%*. For FY2011 and beyond, Logan's output was reported as *55%*. In addition, Logan does not report energy and waste associated with the Novelis JV partner wholly owned recycle center located on the facility.
- In Korea, Novelis holds a 99% equity interest in the Yeongju plant and Novelis reports *100%* of operational data.
- In FY2019, Novelis entered into a joint venture at its Ulsan plant. Novelis reports the percentage of plant output which varies by year over time. Prior to FY2019, Novelis held a 99% equity in the Ulsan plant and reported 100% of the operational data.
- In the Aluminum Company of Malaysia Berhad(Alcom), Novelis helds a 59% equity interest and Novelis marketed 100% of the plant's output. As such, Novelis reported *100%* of Alcom operational data.This plant was sold in FY2017 and is only reported for historical purposes.

When calculating the contribution of a specific environmental sustainability indicator for a joint venture facility, Novelis multiplies the contribution factor identified above in red italics by the value of the specific indicator for that site.

Leased sites, where Novelis holds no equity, have been excluded from this inventory.

Definition of Reporting Scopes

[1] The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, World Resources Institute and World Business Council for Sustainable Development, March 2004

When defining energy usage and GHG emissions, Novelis uses the concept of three scopes[2]. The three scopes are as follows:

- **Scope 1: Direct energy usage/GHG emissions -** Direct energy uses and GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment.
- **Scope 2: Electricity indirect energy usage/GHG emissions -** Scope 2 accounts for energy usage and GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
- **Scope 3: Other indirect GHG emissions -** Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Reporting of environmental sustainability metric by Scope is further explained in the following sections of the report.

Reporting Period and Baseline Years

Novelis reports all sustainability data in fiscal year format. The Novelis fiscal year begins on April 1 and ends on March 31. In establishing progress towards environmental sustainability goals, Novelis has designated the average of Fiscal Year 2007 through Fiscal Year 2009 as a baseline period.

Structural Change Adjustments - Novelis will adjust the base year sustainability metrics if structural changes occur within the company or a significant amount of change occurs due to outsourcing. Both increases and decreases in the structure will be considered a change. A change in operational control would also trigger a change. The Novelis Inc EHS Team is responsible for tracking structural change. This is performed to assure that the company can track progress in meeting all long term objectives and targets in a meaningful way. This assessment is performed on a continuous basis with physical change to the structure in PDM and associated recalculation of the baseline year performed once per year.

Methodology Changes Adjustments - Novelis will adjust the base year emissions if changes in calculation methodologies or emission factors occur. Also, discovery of errors will trigger an adjustment of the base year.

Materiality Exemptions

For reporting purposes, Novelis considers that any facility indicator that contributes less than 0.01% to the overall sustainability indicator total to be non-material and that facilities indicator may be exempt from reporting. Specific site exemptions are discussed in further sections.

Facilities List

The following table contains a list of Novelis facilities and whether they report a specific sustainability metric. Facilities designated as inactive have either been closed or sold but are part of the Novelis baseline.

[2] The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, World Resources Institute and World Business Council for Sustainable Development, March 2004

				Sustainability Metric Reported?		
FACILITY LIST	**Facility Type**	**Active**	**Inactive**	**GHG and Energy**	**Waste**	**Water**
BEREA	MFG	x		x	x	x
BUCKHEAD OFFICE	Office	x				
CHANGZHOU	MFG	x				
FAIRMONT	MFG	x		x	x	x
FLORIANOPOLIS	Collection	x				x
GÖTTINGEN	MFG	x		x	x	x
GREENSBORO	MFG	x		x	x	x
KENNESAW	Office	x		x	x	x
KINGSTON	MFG	x		x	x	x
LATCHFORD	MFG	x		x	x	x
LOGAN ALUMINUM	MFG	x		x	x	x
LUEDENSCHEID	MFG	x		x	x	x
NACHTERSTEDT	MFG	x		x	x	x
NORF	MFG	x		x	x	x
NOVELIS PAE	MFG	x		x		x
OHLE	MFG	x		x	x	x
OSWEGO	MFG	x		x	x	X
PIEVE	MFG	x		x	x	X
PINDA	MFG	x		x	x	X
PRESIDENTE PRUDENTE	Collection	x				X
RECIFE	Collection	x				X
SALVADOR	Collection	x				X
SAO PAULO COLLECTION CENTER	Collection	x				X
SEOUL OFFICES	Office	x				
SIERRE	MFG	x		x	x	X
TERRE HAUTE	MFG	x		x	x	X
ULSAN	MFG	x		x	x	X
UTINGA PLANT	MFG	x		x	x	X
WARREN	MFG	x		x	x	X
YEONGJU	MFG	x		x	x	X
ALCOM	MFG		x	x	x	X
ARATU	MFG		x	x	x	X
BERLIN	MFG		x	x	x	X
BRESSO	MFG		x	x	x	X
BRIDGNORTH	MFG		x	x	x	X
BURNABY	MFG		x	x	x	x
D.C. ITALY	R&D		x	x	x	x
DUDELANGE	MFG		x	x	x	x
LOUISVILLE	MFG		x	x	x	x
LUCE AND MARKET CENTRES	R&D		x			
NGTC	R&D		x	x		
OURO PRETO	MFG		x	x	x	x
ROGERSTONE	MFG		x	x	x	x
RUGLES	MFG		x	x	x	x
SAGUENAY	MFG		x	x	x	x
TORONTO	MFG		x	x	x	x

Intensity Metrics
Intensity measures are used for external reporting of water and energy sustainability indicators. The divisor for the intensity metric is the volume of flat rolled product (FRP) sales (as provided by the Novelis corporate finance department). FRP sales are defined as tonnes of rolled products shipped by Novelis facilities to a third party. FRP sales do not include intersegment rolled products and non-rolled products.

Quantification Method
Environmental sustainability measures are managed in the EtQ Sustainability Module. Prior to FY2020, Novelis entered data into the Performance Data Management (PDM) warehouse. The plants enter prime data into EtQ on a predetermined frequency (monthly/quarterly/annually). Data is reported using PowerBI. Utilizing calculations and emissions factors included into PowerBI, the database automatically converts the prime data into calculated emissions and provides standard performance graphs for specific energy and GHG emissions (normalized to a production metric).

Emissions Factors and Other Constants
Novelis uses the emission factor methodology for their direct emission calculations. The emission factors used for combustion and mobile sources are from the WRI/WBCSD GHG Protocol. Emission factors from IAI are used for process emissions if no site specific emission factors are available.

The emission factors use the following order of preference:

1. Emission factor from site, based on required legal factors, supplier, or local information
2. Novelis default emission factors that originate from the GHG Protocol, central laboratories, or industrial sector protocols

Novelis uses the following order of preference for indirect emissions:

1. Actual EF/grid mix transmitted by the supplier/subcontractor of energy if site has a direct supply agreement and is documented to be accurate
2. Where local supplier/subcontractor data is not available or considered inaccurate, local average EF and grid mix published for the region, state, country (eGrid) is used
3. Novelis default EF calculated based on the technical parameters of the purchased electricity

Emission factors are reviewed at the Novelis Corporation level annually for reliability, completeness, consistency, and appropriateness.

The inventory of calculations and emissions factors used in the Novelis PDM can be found in the PDM GHG Calculations Summary (Appendix 2G) attached to this manual. The various emissions factors are reviewed annually to assure they are kept up to date.

3) External Environmental Sustainability Indicators and Targets

Energy
Novelis measures and records the energy usage for Scope 1 (direct energy sources), Scope 2 (indirect energy sources) and Scope 3 (transportation energy only). For external energy reporting, only Scope 1 and Scope 2 energy usage is considered. Refer to the Novelis Environmental Metrics Reporting and Management Directive for the collection, calculation, and reporting of energy data. Energy is reported as an intensity metric with the units of GJ energy per ktonne of FRP sales.

Notes: In South America, Novelis owned hydro generation facilities. Electrical energy generated at these facilities and used at the Ouro Preto plant was counted for energy totals (Note:Ouro Preto closed in FY2013). Also, the Norf facility generates hot water that is used by the local community. The energy content of this water is not reflected as a reduction on of overall energy usage.

Novelis has established a target of reducing energy usage by 39% per ton of sales by 2020 (from FY2007-FY2009 average).

GHGs

Novelis measures the quantity of emissions of GHGs from Scope 1 (direct energy sources), Scope 2 (indirect energy sources, PFC emissions) and Scope 3 (transportation of Novelis products and purchases of primary aluminum). Refer to the Novelis Environmental Metrics Reporting and Management Directive for the collection, calculation, and reporting of GHG emissions resulting from energy and transportation. GHG emissions are reported as absolute tonnes of CO_{2e}.

GHG List - Novelis reports emissions for CO_{2e} (fuels combustion, VOC destruction), CH_4 (fuels combustion), and N_2O (fuels combustion). PFCs are currently and been historically been emitted by the Novelis South American smelters in Ouro Preto and Aratu (closed).

Since Novelis is not in the business of gas transport, CH_4 emissions from natural gas leaks is nonexistent. Novelis has performed an assessment of the significance of global warming impacts associated with the release associated with refrigerant systems (HFCs/CO2), fire suppression systems (CO2/FM200) and emissions associated with VOC release and destruction and have found them to be insignificant sources.

GHG emission factors have been developed from a variety of sources primarily including: the International Aluminum Institute (IAI), World Resources Institute (WRI), World Business Council for Sustainable Development (WBCSD), and US Environmental Protection Agency (USEPA). Novelis follows 1996 IPCC directives for stationary and mobile sources. The IPCC directives are consistent with the USEPA Climate Leaders methodologies. Process-specific alumina production, anode production and aluminum smelter emissions (South America only) are calculated based on emission factors and calculation methods identified in the International Aluminum Institute's (IAI), "The Aluminum Sector Greenhouse Gas Protocol". All GHG emission factors are defined in the PDM GHG and Energy Calculation guide.

Emissions Source Identification Procedure - Novelis has identified stationary and mobile combustion sources, indirect emissions, emissions from process specific operations and fugitive emissions. Site reconnaissance and visual inspections have been done at all Novelis Corp facilities to identify all emission sources at the sites. A review of energy usage records and invoices was also completed to assure completeness of the initial source inventory.

The responsibility for maintaining and identifying emissions is the responsibility of each site. Additionally GHG metrics reporting is audited each year as part of the Novelis EHS Comprehensive Audit Program. This audit program will facilitate the identification of new sources to assure the source inventory is maintained properly.

Novelis has established a target of reducing GHG emissions by 50% by 2020 (from FY2007-FY2009 average).

Water Usage

Novelis has developed external sustainability targets for water usage intensity. Water usage is defined as the volume of water intake at a facility. As described above, to obtain water usage intensity, water intake is divided by the ktonnes of FRP sales. Refer to the Novelis Environmental Metrics Reporting and Management Directive for the collection, calculation, and reporting of water data. Water is reported as an intensity metric with the units of cubic meters of water intake per ktonne of FRP sales. For external reporting, Novelis considers Scope 1 sources only and does not consider water usage from Scope 2 and Scope 3 sources.

Novelis has established a target of reducing water usage by 25% per ton of sales by 2020 (from FY2007-FY2009 baseline average).

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Waste to Landfill

Novelis has developed external sustainability targets for waste to landfill. Novelis does not consider wastes as landfilled if those wastes are land applied in such a way that they are considered a raw material for the application (i.e. – road base subgrade material, ingredient to concrete.) Novelis records all wastes to landfill. Wastes that are not considered reoccurring but are one time wastes (i.e. – remediation wastes and large construction projects) are reported externally towards goal attainment. Volumes of these type wastes are recorded in PDM. Refer to the Novelis Environmental Metrics Reporting and Management Directive for the collection, calculation, and reporting

of waste to landfill data. Waste to landfill is reported as absolute in units of ktonne. For external reporting, Novelis considers Scope 1 sources only and does not consider waste to landfill from Scope 2 and Scope 3 sources. Novelis does estimate and include landfill wastes generated from the off-site recycling of dross.

Novelis has established a target of reducing waste to landfill by 30% per ton of sales by 2020 (from FY2007-FY2009 baseline average).

Appendix 2G
PDM Greenhouse Gas and Energy Calculation Guide

A. Indirect GHG Emissions and Energy Consumption from Electricity Generation

GHG Calculation:

$$\textit{Emissions of } CO_2e \textit{ (tonne)} = \sum PE * (EF / 1000)$$

Where

PE = Electricity Consumption (kWh)
EF = Emission factor (tCO_2/MWh)
1000 = Conversion Factor (1 MWh = 1000 kWh)

Energy Calculation:

$$\textit{Energy Consumption (GJ)} = \sum PE * (3.6 / 1000)$$

Where

PE = Electricity Consumption (kWh)
3.6 = Conversion Factor (3.6 MJ = 1 kWh)
1000 = Conversion Factor (1000 MJ = 1 GJ)

Electricity Emission Factors (includes all 6 GHG Emissions)

Region	Country/ Subregion	t CO2e/ MWh (2003-2008)	t CO2e/ MWh (2009-2010)	t CO2e/ MWh 2011	t CO2e/ MWh (2012-FY2014)	t CO2e/ MWh (FY2015-current)
Asia	China	0.8572	0.7943	0.751	0.772	0.77
	India	0.948	0.9505	0.9744	0.9184	0.8624
	Malaysia	*	0.672	0.6576	0.7286	0.6896
	South Korea	**	0.4691	0.4622	0.5352	0.5472
Europe	France	0.0872	0.0853	0.0872		0.061
	Germany	0.4554	0.4062	0.4406	0.4636	0.477
	Italy	0.4564	0.4054	0.4049	0.4079	0.402
	Luxembourg	0.3343	0.3278	0.3247	0.4117	0.387
	Switzerland	0.0243	0.0257	0.028	0.027	0.03
	United Kingdom	0.4688	0.5066	0.4989	0.4589	0.441
North America	British Columbia	0.024	0.02	0.0200	0.0113	0.0140
	Ontario	0.222	0.18	0.1700	0.0980	0.0930
	Quebec	0.008	0.006	0.0020	0.0020	0.0020
	NPCC Upstate NY (Oswego)	0.3737	0.3287	0.3114	0.2269	0.2487
	RFC West (Warren, Terre Haute, Fairmont)	0.7093	0.7012	0.7075	0.6933	0.6855
	SERC South (Greensboro)	0.6796	0.6794	0.6819	0.6043	0.6173
	SERC Tennessee Valley (Logan, Berea)	0.6816	0.6888	0.7026	0.6190	0.6333
South America	Brazil	0.0856	0.0818	0.0894	0.0874	0.0684

*0.631 (2004), 0.614 (2005), 0.661 (2006), 0.684 (2007), 0.672 (2008)
**0.4363 (2005), 0.4420 (2006), 0.4633 (2007), 0.4691 (2008)

Source (refer to calculations worksheet for the most current reference.)
United States: eGRID
Canada National Inventory Report - Greenhouse gas sources and sinks in Canada
Source CO2 factors: International Energy Agency Data Services. "CO2 Emissions from Fuel Combustion (#### Edition)"
Source International CH4/N2O factors: International Electricity Emission Factors by Country,
Source Malaysia: Study on Grid Connected Electricity Baselines in Malaysia,
Source South Korea: Korea Energy Management Corporations,

Exceptions:
Saguenay buys direct from Alcan Power Plant or City of Jonquiere: 100% Hydropower.
Sierre uses 100% Hydropower.
Nachterstedt and Latchford enter their own site-specific value.

B. Indirect GHG Emissions and Energy Consumption from Steam and Hot Water Generation

GHG Calculation:

$$Emissions\ of\ CO_2e\ (tonne) = \sum PE * EF$$

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Effective Date: August 30, 2019

Where

PE = Steam/Hot Water Consumption (kWh)
EF = Emission factor for steam or hot water used (tonne CO2/kWh) = 0.00023

Note:
PDM calculation assumes Natural Gas fuel and a boiler efficiency of 80% to convert the quantity of steam or hot water reported in kWh to tonne of CO_2. The calculation that was used to derive the emissions factor is below:

$$EF = ((0.0018\ tCO_2/m^3\ gas) / (0.035\ GJ/m^3\ gas) / .80) * (0.0036\ GJ/kWh)$$
$$= 0.00023\ \text{tonne}\ CO_2\ \text{per kWh steam/hot water}$$

Energy Calculation:

$$\textit{Energy Consumption (GJ)} = \sum \textit{PE} * (3.6 / 1000)$$

Where

PE = Steam/Hot Water Consumption (kWh)
3.6 = Conversion Factor (3.6 MJ = 1 kWh)
1000 = Conversion Factor (1000 MJ = 1 GJ)

C. Direct GHG Emissions and Energy Consumption from Stationary & Mobile Combustion

GHG Calculation:

$$\textit{Emissions of } CO_2e \textit{ (tonne)} = \sum (\textit{Fuel}_i \textit{ consumption} \times \textit{Fuel}_i \textit{ EF})$$

Where:

$Fuel_i$ consumption : total fuel quantity purchased expressed in physical unit (kg or m3 or liters)

$Fuel_i$ EF : CO2 emission factor expressed in tCO2e/physical unit of fuel.

Default Factors used in GHG Calculation:

Type	Default Factor	Factor Units
Heavy Fuel Oil (Number 4 or 6)	3.2×10^{-3}	tonne/kilogram
Diesel and Number 2 Fuel Oil	2.7×10^{-3}	tonne/liter
Kerosene	2.6×10^{-3}	tonne/liter
Gasoline	2.4×10^{-3}	tonne/liter
Natural Gas	1.8×10^{-3}	tonne/cubic meter
Liquid Natural Gas	3.1×10^{-3}	tonne/kilogram
Methane	2.8×10^{-3}	tonne/kilogram
Propane	1.6×10^{-3}	tonne/liter
Butane	1.8×10^{-3}	tonne/liter
Anthracite (86-98% carbon)	2.9×10^{-3}	tonne/kilogram
Bituminous (45-86% carbon)	2.6×10^{-3}	tonne/kilogram
Sub bituminous (35-45% carbon)	1.9×10^{-3}	tonne/kilogram
Lignite (25-35% carbon)	1.5×10^{-3}	tonne/kilogram
Petroleum Coke	3.1×10^{-3}	tonne/kilogram
Wood	0	
Biomass	0	

Source: WRI/WBCSD GHG Protocol stationary combustion calculation tool. When calculating default factors, the following global warming potentials were used: CH4 = 21 kg CO2e/GJ, N2O = 310 kg CO2e/GJ.

Energy Calculation:

$$\textit{Energy Consumption (GJ)} = \sum (\textit{Fuel}_i \textit{ consumption} \times \textit{Fuel}_i \textit{ EF})$$

Where:

$Fuel_i$ consumption = total fuel quantity purchased over the period expressed in physical unit (kg or m3 or liters)

$Fuel_i$ EF = Energy emission factor expressed in GJ/physical unit of fuel.

Default Values Used in Energy calculation:

Type	Default Factor	Factor Units
Heavy Fuel Oil (Number 4 or 6)	4.3×10^{-2}	GJ/kilogram
Diesel and Number 2 Fuel Oil	3.9×10^{-2}	GJ/liter
Kerosene	3.8×10^{-2}	GJ/liter
Gasoline	3.5×10^{-2}	GJ/liter
Natural Gas	Upper Calorific Value (variable)	KWh/cubic meter x 0.0036 GJ/KWh
Liquid Natural Gas	5.2×10^{-2}	GJ/kilogram
Methane	5.6×10^{-2}	GJ/kilogram
Propane	2.7×10^{-2}	GJ/liter
Butane	2.9×10^{-2}	GJ/liter
Anthracite (86-98% carbon)	2.9×10^{-2}	GJ/kilogram
Bituminous (45-86% carbon)	3.0×10^{-2}	GJ/kilogram
Sub bituminous (35-45% carbon)	2.1×10^{-2}	GJ/kilogram
Lignite (25-35% carbon)	1.6×10^{-2}	GJ/kilogram
Petroleum Coke	3.3×10^{-2}	GJ/kilogram
Wood	0	
Biomass	0	

Source: WRI/WBCSD GHG Protocol stationary combustion calculation tool

D. GHG Emissions and Energy Consumption from Offsite Transport of Product

GHG Calculation:

$$Emissions\ of\ CO_2e\ (tonne) = 10^{-6} \times \sum (D_i * W_i * EF_i)$$

Where:

D_i = Average distance traveled by means of transport$_i$ (km)
W_i = Total weight of transported product by means of transport$_i$ (tonnes)
EF_i = GHG emission factor for means of transport$_i$ (g/t*km)
10^{-6} = *Conversion Factor (1,000,000 g = 1 tonne)*

Default Factors used in GHG Calculation:

Type	Default Factor	Factor Units
Air Cargo	570	grams/tonne*kilometer
Barge	35	grams/tonne*kilometer
Coaster	35	grams/tonne*kilometer
Train	20	grams/tonne*kilometer
Ferry	35	grams/tonne*kilometer
Heavy Truck (28 Tonnes)	72	grams/tonne*kilometer
Heavy Truck (18 Tonnes)	72	grams/tonne*kilometer
Ocean Vessel	10	grams/tonne*kilometer

Source: The calculation of direct and indirect GHG from mobile sources are reported in accordance with "Mobile combustion Mobile Combustion CO2 Emissions Calculation Tool. June 2003. Version 1.2 WRI-WBCSD GHG Protocol Initiative". Per the tool (see "Assumption" section on the "Introduction" tab) CH4 and N2O emissions are considered but are deemed insignificant.

Energy Calculation:

$$Energy\ Consumption\ (GJ) = \sum (D_i * W_i * EF_i)$$

Where:

D_i = Average distance traveled by means of transport$_i$ (km)
W_i = Total weight of transported product by means of transport$_i$ (tonnes)
EF_i = Energy emission factor for means of transport$_i$ (GJ/t*km)

Default Factors used in Energy Calculation:

Type	Default Value	Factor Units
Air Cargo	9.0×10^{-3}	GJ/tonne*kilometer
Barge	5.3×10^{-4}	GJ/tonne*kilometer
Coaster	5.3×10^{-4}	GJ/tonne*kilometer
Train	3.0×10^{-4}	GJ/tonne*kilometer
Ferry	5.3×10^{-4}	GJ/tonne*kilometer
Heavy Truck (28 Tonnes)	1.1×10^{-3}	GJ/tonne*kilometer
Heavy Truck (18 Tonnes)	1.1×10^{-3}	GJ/tonne*kilometer
Ocean Vessel	1.5×10^{-4}	GJ/tonne*kilometer

Source: Derived from WRI/WBCSD GHG Protocol mobile combustion calculation tool

E. GHG Emissions from Purchased Primary (Scope 3)

GHG Calculation:

$$Emissions\ of\ CO_2e\ (tonne) = \sum (W_i * EF_i)$$

Where:

W_i = Total weight of purchased primary aluminum (tonnes)

EF_i = CO2 emission factor expressed in tCO2e/tonne of primary aluminum purchased.

Default Factors used in GHG Calculation:

Scope 3 emissions related to the primary metal purchased from external suppliers by Novelis has been estimated. The CO2 eq. emission factors are based on International Aluminum Institute (IAI) detailed data and they include the different process steps of the aluminum upstream production (from bauxite mining to primary ingot casting)**.**

IAI - Global Average (China included)	*1 tonne of prime*
Process	kg of CO2eq.
Bauxite Mining	26
Alumina Refining	2,931
Anode Production	269
Electrolytic Process	2,160
Electrolytic Energy	7,780
Ingot Casting	124
Primary	**13,290**

The Global average of 13.3 Tonnes of GHG eq. for one Tonne of primary metal includes the global average electricity mix, which is not representative for what Novelis utilizes due to a different energy mix during the electrolytic process (usually each smelter has a captive power plant).

The Novelis metal group assesses the electricity power used in the production of purchased metal primary when the original source of the materials is known and can provide this information (e.g. with sheet ingot from a specific smelter to a Novelis plant). For a small population, the information is not available (e.g. aluminium ingots from LME via traders), in which case the global average is applied.

kg of CO2eq.	Hydro	Nuclear	Natural Gas	Coal	Global Average	
Global Average	**6,255**	**6,255**	**12,960**	**19,366**	**13,290**	
Novelis Mix	68%	3%	1%	15%	13%	**NOVELIS**
	4,253	188	130	2,905	1,728	**9,203**

Novelis uses an average of 9.2 Tonnes of CO2eq. for each Tonne of primary that is sourced.

F. References for T&D Line Loss, % indirect energy by source (including renewable vs non-renewable)

Source T&D line loss and % indirect (except USA and Canada for % indirect energy) IEA
http://iea.org/stats/prodresult.asp?PRODUCT=Electricity/Heat

% of indirect energy for USA and Canada

Source United States: eGRID2007 Version 1.1, January 2009

Source Canada: National Inventory Report 1990-2006, Annex 9

Exceptions:
Saguenay buys direct from Alcan Power Plant or City of Jonquiere: 100% Hydropower. (Plant is now closed)

Sierre uses 100% Hydropower.