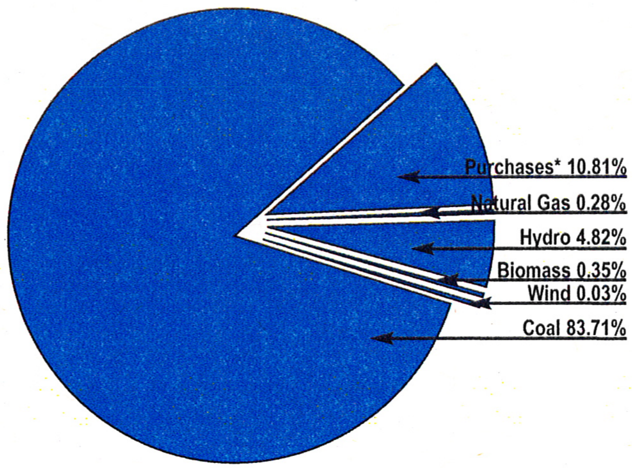
USE ELECTRICITY WISELY TO HELP THE ENVIRONMENT

Fuels used to generate electricity have different costs, reliability, and air emissions.
You can help the environment by using electricity more efficiently!

HOW ARE YOUR ELECTRICITY NEEDS MET?



Cost by fuel type

Lowest
- Hydro
- Coal
- Wind
- Purchases*
- Biomass
- Natural Gas

Highest

Reliability by fuel type

Highest
- Natural Gas
- Coal
- Purchases*
- Biomass
- Hydro
- Wind

Lowest

*Purchases come from fuel sources (nuclear, coal, natural gas, etc.) from throughout the region.

Minnesota Power

For the year ending December 31, 2005

Air Emissions by fuel type

(measured in pounds per 1,000 kWh)

	Carbon Dioxide	Nitrogen Oxides	Sulfur Dioxide	Particulate Matter	Mercury
Coal	2340	5.276	5.533	0.3490	0.00006452
Purchases*	1839	3.982	5.537	0.3257	0.00004319
Natural Gas	668	2.13	0	0	0
Biomass	1603	6.275	0	0.4119	0.00000680

Wind and solar power produce none of these air emissions. Large hydro power may alter ecosystems and cultural resources depending upon the location and design of the facility. Nuclear energy does not produce these air emissions, but does produce both high- and low-level nuclear waste.

How do air emissions affect the environment?

Carbon Dioxide is the principal greenhouse gas linked to global warming.

Nitrogen Oxides and Sulfur Dioxide contribute to acid rain; Nitrogen Oxides also contribute to smog.

Particulate matter (sometimes called soot) contributes to asthma attacks and other respiratory illnesses.

Mercury accumulates in some fish to levels exceeding current health department guidelines.

The Minnesota Pollution Control Agency is responsible for ensuring that emissions from utilities meet air quality standards for Nitrogen Oxides, Sulfur Dioxide, and smog.

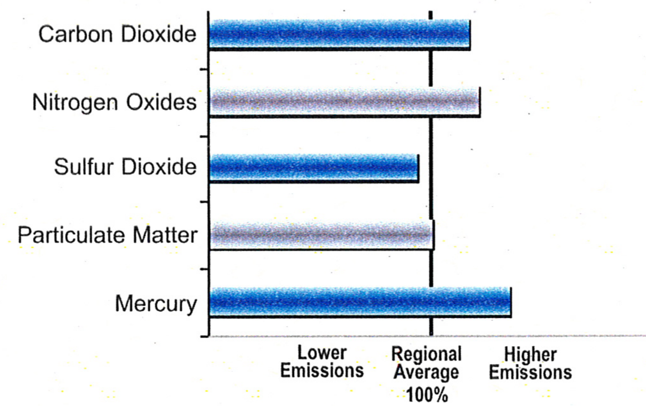
How are coal-fired power plants doing?

Statewide, coal-fired power plants in Minnesota generate: 50% of all Sulfur Dioxide pollution, 35% of all Carbon Dioxide pollution, 43% of all Mercury pollution and 16% of all Nitrogen Oxides pollution.** All other generation sources contribute a small amount of pollution.

***Pollution is emitted from many places, such as industrial and commercial sources, cars, trucks, and home heating.*

How is Minnesota Power doing?

(compared to the regional average)



How does customer conservation help?

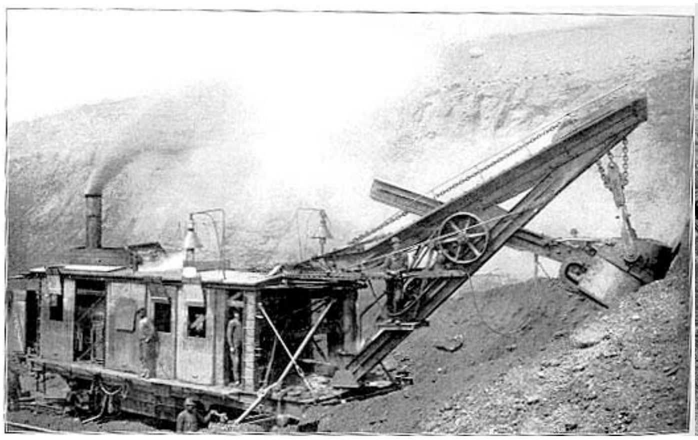
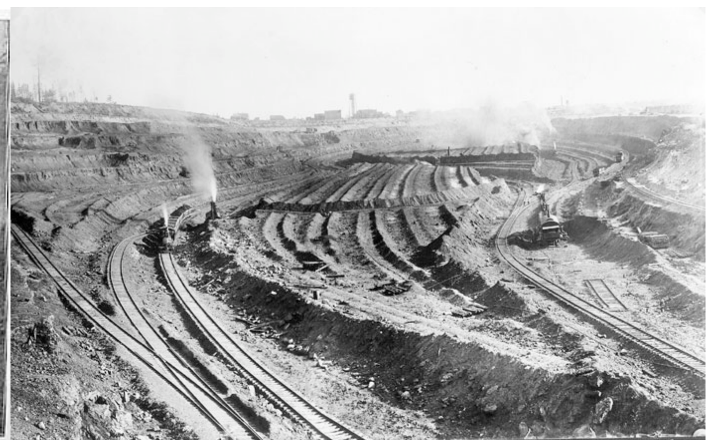
Minnesota Power's customer energy conservation programs reduced our need to generate electricity to meet your needs by 742,575,083 kWh, a 7.3% savings. These annual savings resulted from both new and ongoing customer participation in Minnesota Power's energy conservation programs. This equates to a reduction in air emissions of:

Carbon Dioxide	803,926 tons
Nitrogen Oxides	1,810 tons
Sulfur Dioxide	1,948 tons
Particulate Matter	122 tons
Mercury	0.02180 tons

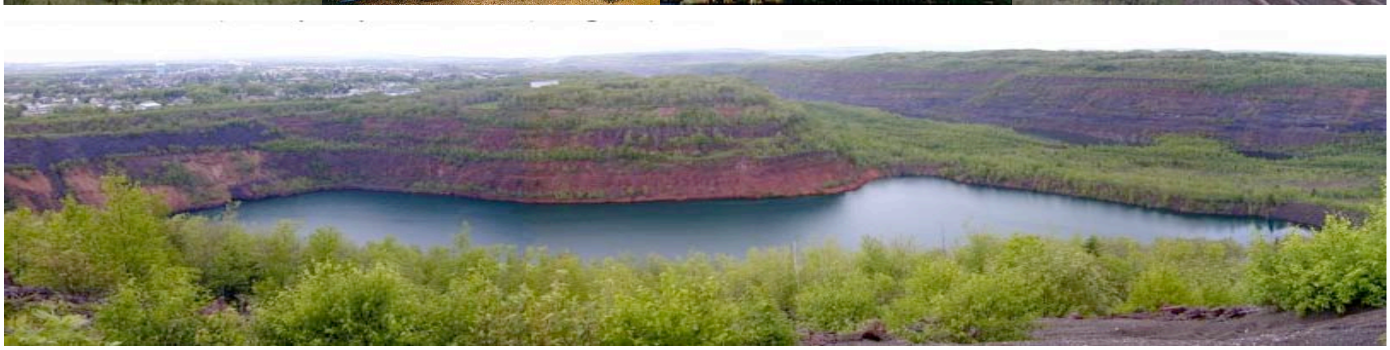
Refer to Minnesota Power's conservation programs on the reverse side.

Greenhouse Gas Emissions Inventory:

Minnesota Steel Industries' Proposed Integrated Iron Mine, DRI, Pelletizer, and 2.5 Mt/yr Steel Mill



Richard Heede

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10 July 2007

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Contents

Cover images from Minnesota Historical Society, Duluth Seaway Port Authority, Von Frese (Ohio State University), and Michael Derrick (Shortlines USA)

Greenhouse Gas Emissions Inventory: Minnesota Steel Industries' Proposed Integrated Iron Mine, DRI, Taconite, and Steel Mill

For Minnesota Center for Environmental Advocacy
By Richard Heede

This memorandum summarizes an energy and emissions analysis of an open pit taconite iron mine integrated with a steel manufacturing plant. This 2.5 million tonne per year facility is proposed for an abandoned iron mine in Minnesota's Mesabi Range by Minnesota Steel Industries LLC. The Minnesota Department of Natural Resources and the U.S. Army Corps of Engineers jointly issued a *Draft Environmental Impact Statement* in February 2007. The *Draft EIS* neither quantified emissions nor evaluated actions to mitigate emissions.

Consequently, the Minnesota Center for Environmental Advocacy (MCEA) commissioned Climate Mitigation Services (CMS) to review emissions estimates submitted by Minnesota Steel Industries' consulting company — Barr Engineering Company in Minneapolis — in April and May 2007. The Minnesota Pollution Control Agency subsequently issued its own emissions estimate in May 2007. CMS was asked to conduct an emissions estimate that analyzed the total amount of direct and indirect emissions associated with the project.

CMS estimated emissions from the power plants supplying electricity to the grid from which Minnesota Steel would acquire electricity for its energy-intensive plant. It is common practice to include indirect emissions from power plants in emissions inventories. CMS also estimated emissions from natural gas used at the plant, diesel used in mining equipment and haulers, the fuel consumed in shipping steel to market, emissions from plant employees' commuting to work, and emissions from the blasting of 13 million tonnes of ore at the mine.

This quick survey and emissions inventory is based on fuel consumption estimates supplied in the company's permit application and supporting documents required to assess non-CO_2 emissions such as particulates, SOx, and other regulated air pollutants. CMS does not have the expertise in mining, milling, and steel making required to evaluate or critique MSI's and the *Draft EIS*'s published consumption of natural gas, diesel fuel, limestone, and other resources required for this very complicated plant and its large-scale resource flows. CMS bases its emissions estimates on data published in the documents cited above; CMS uses external sources to estimate energy requirements and emissions where company data has not been provided or is deficient.

The principal sources of emissions are from consumption of energy such as diesel fuel in mining equipment, natural gas for heating taconite and other plant uses, and electricity for the direct reduction iron plant (DRI), pelletizer, caster, and the electric arc furnaces (EAFs).

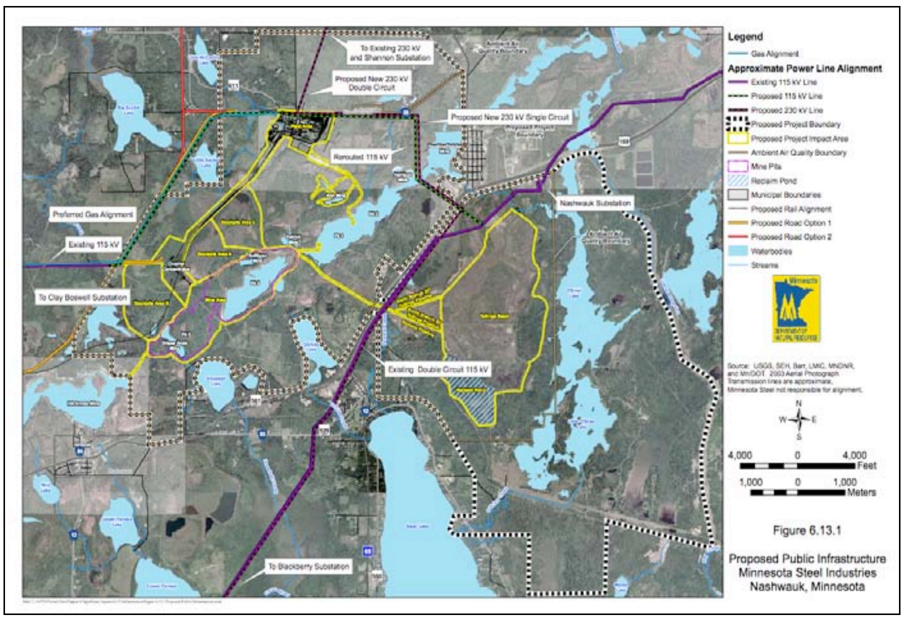
Scope and boundary definition

CMS applies the industry standard *Greenhouse Gas Protocol* guidelines to this emissions inventory.[1] CMS quantifies emissions from the Protocol's Scopes 1, 2, and 3. MSI/Barr include Scope 1 emissions (except blasting), and limited Scope 2 sources.

[1] World Business Council for Sustainable Development & World Resources Institute (2006) *Corporate Accounting and Reporting Standards*, Greenhouse Gas Protocol, Washington, DC, www.ghgprotocol.org

- Scope 1: direct emissions from fuel combustion and industrial processes within the physical boundary of Minnesota Steel's proposed facility;
- Scope 2: indirect emissions from the mining operation's consumption of purchased electricity produced by offsite electric utilities;
- Scope 3: other indirect emissions attributed to the proposed project, such as transportation of finished steel.

Specifically, CMS includes all Scope 1 emissions: direct emissions from onsite combustion of diesel fuel in mining equipment (haul trucks, mining shovels, front end loaders, etc), natural gas for process heat and other onsite uses, process emissions from the use of soda ash, limestone, anthracite coal (minor quantities), and other direct onsite emissions such as from the use of explosives at the mine. CMS also includes Scope 2 (electricity) emissions and from selected Scope 3 sources, such as fuel and emissions from commuting by 700 workers and, more significantly, the transportation of finished steel from the plant to market.



Minnesota Steel Industries LLC location, boundary, and infrastructure map, *Draft EIS* Figure 6.13.1.

CMS has not quantified and attributed emissions upstream of the direct onsite combustion of fuel, such as the energy and emissions from producing diesel fuel and natural gas, refining and processing, and transporting the fuel to MSI's plant. Such emissions, which can add 20 to 30 percent to indirect Scope 3 fuel cycle emissions, would be included in comprehensive inventories that measure the full impact of a proposed project for emissions traceable to new demand for fuel. CMS also excludes emissions from the manufacture and transportation of the MSI plant's major inputs, such as soda, limestone, anthracite coal, etc. Their onsite Scope 1 direct emissions are included, however.

While CMS includes upstream emissions, in line with conventional practice, from carbon-fired power plants supplying the MSI plant, we *exclude* CO_2 and CH_4 emissions from the mining and transportation of coal to the power plants or natural gas and diesel to the MSI facility. A comprehensive inventory of the "cradle-to-grave" emissions from MSI's proposed plant would also include emissions from the thousands of tonnes of steel, concrete, and other materials built into the plant, as well as from the fabrication of the vast scope of equipment that goes into the construction and operation of a very large and complex integrated steel mill built to mine 13 million tonnes of taconite and manufacture 2.5 million tonnes of finished steel annually. Such a comprehensive analysis would require more time and resources than were available for CMS's inquiry into GHG emissions from Minnesota Steel.

CMS adopts a broader boundary definition than that adopted by the Minnesota Pollution Control Agency and MSI/Barr Engineering's narrow definition of emissions attributable to the proposed facility. While CMS does not supply a comprehensive "cradle to grave" analysis, the CMS inventory includes a tentative estimate of emissions from the use of explosives (Scope 1), and emissions from employee commuting to work (Scope 3) and from the transportation of finished steel to market using an assumed shipping distance of 500 miles (Scope 3).

Diesel fuel emissions

Consumption of diesel fuel by mining equipment, shovels, haulers, locomotives, engines, and other combustion sources at the Minnesota Steel Industries' proposed plant is well documented in the *Draft EIS* and in Barr Engineering Company's *Air Emissions Inventory*. Diesel fuel consumption is estimated to total 4.34 million gallons per year. CMS applies a standard emissions factor of 22.384 lb CO_2 per gallon (EIA carbon coefficient), slightly higher than that used by the MN Pollution Control Agency (22.128 lb CO_2/gal) and slightly lower than MSI (22.91 lb CO_2/gal). CMS estimates emissions from diesel fuel totaling 0.044 million tonnes CO_2.

CMS excludes emissions from offsite consumption of diesel and gasoline fuels (other than from commuting by the plant's 700 employees and transportation of finished steel, discussed below), such as for rail transport of soda ash, limestone, anthracite coal, construction materials (cement & steel), vehicles, equipment, and thousands of tonnes of materiel built into the plant or required for its annual operation. CMS also excludes emissions of CO_2 and methane associated with the production, refining, transportation, and onsite storage of diesel fuel used in MSI's operations. A comprehensive inventory could trace and attribute such emissions to the project, but CMS elects to place them outside the defined emissions boundary.

Hauling mined materials in the tar sands region of Alberta; haulers.

Natural gas emissions

MSI projects, based on vendor-data and MSI models, annual natural gas demand of ~40 billion cubic feet per year (Bcf/yr) for process heat in the DRI plant (37.2 Bcf/yr), pellet plant (1.2 Bcf/yr), the rolling mill (0.8 Bcf/yr), and related smaller uses. On that basis, CMS estimates natural gas-related emissions of 2.04 million tonnes CO_2 per year (MtCO_2/yr), which is slightly higher than MSI's estimate of 2.00 MtCO_2/yr and somewhat lower than the Minnesota Pollution Control Agency's estimate of 2.33 MtCO_2/yr.[2]

[2] CMS applies a carbon coefficient of 51.48 grams CO_2 per cubic foot (gCO_2/cf) and the standard 99.5 percent combustion factor used by the US EPA and the IPCC for natural gas, with a final emissions factor of 51.22 gCO_2/cf

CMS excludes from its estimate emissions beyond onsite combustion of natural gas, such as emissions of CO_2 and methane from upstream gas production, processing, and distribution.

Midrex Corporation Direct Reduction Plant at IMEXSA steelworks in Mexico.

Blasting emissions

Neither the company's air emissions inventory nor the *Draft EIS* quantifies the amount of explosives required for blasting, nor do they estimate emissions of CO_2 and other contaminants, except to mention that blasting activity would "occur roughly once per week."[3] CMS, lacking quantitative data on ANFO (ammonium nitrate and fuel oil) requirements, bases its estimate on proxy data from blasting activity at an open pit coal mine in New South Wales, Australia.[4] CMS calculates CO_2 emissions from the use of ANFO at the Anvil Hill Project per tonne of coal mined — 0.167 tonne CO_2 per tonne ANFO, which, at that mine's use of ANFO per tonne mined, converts to 0.361 kg CO_2 per tonne of coal mined — and applies this factor to Minnesota Steel's projected taconite production of 13 million tonnes per year. The preliminary result, certain to be revised when the company provides quantitative data, is 4,735 tonnes of CO_2 per year. CMS does not estimate NOx or possible N_2O emissions.

Blasting iron ore at a mine in Atlantic City, Wyoming. Von Frese, Ohio State University.

(or 0.1129 lb CO_2/cf). The MN PCA and MSI estimates vary on the basis of applying different emissions factors: MSI (0.1100 lb CO_2/cf), and MN PCA (0.1171 lb CO_2/cf). CMS and PCA apply a combustion factor, MSI does not. PCA uses a factor for the heat content of natural of 1,009 Btu/cf, whereas CMS uses 1,030 (data from EIA, 2005).

[3] *DEIS*, p. 4-164: "Blasting techniques/procedures are designed to break and fragment rock into a desired size so that it can be readily transported, crushed and processed efficiently. Blasting activity at the Minnesota Steel mine would occur roughly once per week and would use the same blasting agents as other taconite mines: a mixture of about 94 percent ammonium nitrate (AN) and 6 percent fuel oil (FO), commonly referred to as ANFO." ... "Impacts due to blasting in surface mines include; ground vibrations, air blast, flyrock, dust, and fumes. Dust and gases are usually not a major problem outside the immediate blasting area. As with air blast, wind direction is important. When necessary, dust and gas production can be reduced by wetting the area to be blasted. Excessive fumes can be avoided by utilizing good explosive design techniques. Therefore, the remainder of the blasting impacts assessment focused on ground vibration and air blast (overpressure)."

[4] Centennial Coal Company (2006) Final Greenhouse Gas and Energy Assessment for Anvil Hill Project, New South Wales, Australia, by See Sustainability Consulting, Toronto NSW; Australian Greenhouse Office (2006) AGO Factors and Methods Workbook.

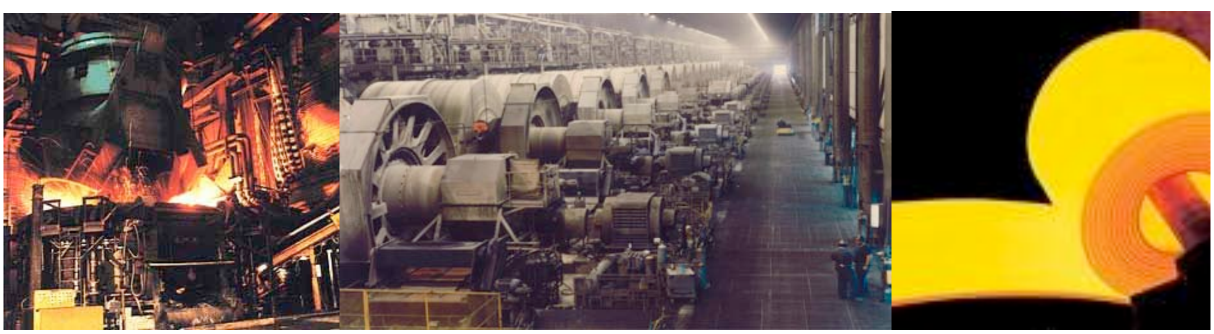
Other direct inputs and process emissions: soda ash, limestone, anthracite coal, etc.

CMS relies on company estimates of process-related emissions from the consumption of 41,800 tonnes of soda ash in the pelletizer, limestone in the pelletizer and steel mill, anthracite coal in the mill, powder coatings, electrodes, and so forth. CMS notes that the MN PCA and the Barr Engineering estimate of these source emissions are identical, likely accurate, and do not warrant re-analysis. These emissions total 0.091 million tonnes CO_2. As mentioned above, neither CMS nor MSI or the MN PCA estimate emissions related to the transportation of materiel to the plant from upstream suppliers of soda ash, limestone, anthracite, or fuel used in the plant's operation.

DMIR 406 departs the yard at Proctor, MN with 58 limestone loads for Minntac, Michael Derrick, 2003.

Electricity emissions

CMS bases its emissions estimate on stated electricity demand (450 MW) adjusted for estimated plant downtime (15.6 percent), a factor used by Minnesota Steel in the air permit application for other plant-related emissions. Thus, 450 MW times 8,760 hrs/yr x (1.0 – 0.156) = 3.326 million MWh/yr (1 million MWh = 1 TWh), plus a grid loss factor of 4 percent equals 3.464 TWh/yr.[5] This is equivalent to 0.09 percent of total U.S. electricity generation in 2005.[6]



Images of an electric arc furnace (Center for Metals Prod'n), grinding plant (Cleveland-Cliffs), and hot rolled steel.

CMS uses EIA data on the state of Minnesota's average emissions factor of 0.691 kg CO_2 per kWh (generation), which translates to electricity emissions of 2.394 million tonnes CO_2 per year. CMS adds emissions factors for power-sector-related methane (0.007 kg CH_4/kWh) and nitrous oxide (0.011 kg N_2O/kWh). Converting to CO_2-equivalent, methane emissions total 518 tonnes

[5] Richard Cordes, Minnesota Pollution Control Agency, personal communication, May 2007. CMS uses the *lower* of two pertinent operating time estimates: available or scheduled up time, and estimated operating time (7,946 and 7,390 hours per annum, or 90.6 and 84.4 percent of a full 8,760 hour-year, respectively).

[6] EIA (2006) *Annual Energy Review, 2005*, Table 8.1; MSI/US generation: 3.5 TWh / 3,883 TWh = 0.09 percent.

CO_2-e and nitrous emissions 12,031 tonnes CO_2-e, 0.02 percent and 0.50 percent, respectively. The total CMS electricity-related emissions estimate is 2.406 million tonnes CO_2-e/yr.

Barr Engineering bases its electricity emissions estimate on vendor-supplied power demand for the plant's major power loads; CMS is unable to verify that the resulting engineering estimate of total demand (1.845 TWh/yr) represents consumption by major electricity-consuming equipment only or covers *all* electricity uses at the integrated plant (lighting, electronics, process heat, and motors in conveyors, pumps, crushers, compressors, and several thousand pieces of equipment).[7] Further research will likely result in revised power consumption and emissions estimates.

The Barr estimate totals 1.539 million tonnes of CO_2 per year, 40 percent less than the CMS estimate. The chief differences between the CMS and Barr estimates are due to Barr's far lower estimate of electricity consumption and Barr's use of the carbon emission factor for the Mid-Continent Power Pool (0.834 kg CO_2/kWh) whereas CMS uses the average emissions factor for the state of Minnesota (0.691 kg CO_2/kWh; 17 percent lower than the MAPP factor used by Barr). The Minnesota Pollution Control Agency's estimate is based not on power demand but on proxy emissions per tonne of steel manufactured in the electric arc furnace (EAF) only and yields EAF emissions of 1.077 million tonnes of CO_2.

Power plant emissions.

Transporting steel to market

The *Draft EIS* (or the Minnesota Pollution Control Agency's or Barr Engineering Company's calculations) does not estimate carbon dioxide emissions resulting from the fuel consumed in transporting MSI's finished steel to market. Nor is there any published information on the likely market destinations. CMS has modeled energy and emissions for several transportation options for an assumed shipping distance of 500 miles, even though some steel may be destined for mid-Canadian or more distant markets. These scenarios are shown in the Transportation worksheet.

Assuming that shipment by truck is the most likely scenario for this 500-mile haul, 2.5 million gallons of diesel fuel will be consumed (including 22 percent for the truck's return trip) and emissions of 0.234 million tonnes CO_2 for the "low" estimate; the "high" trucking emissions scenario totals 0.381 $MtCO_2$. If rail is used, CMS estimates (again for the "low" rail scenario) consumption of 4.5 million gallons of diesel fuel and emissions of 0.045 $MtCO_2$ ("high" rail totals 0.087 $MtCO_2$). CMS developed emissions estimates for shipping by inland barge, shipping on the Great Lake via "lakers," and multi-modal (e.g., 125 miles by truck plus 375 miles by rail: 0.092 $MtCO_2$). See the worksheet for details on each scenario.

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[7] Barr uses "power demand breakdown based on equipment vendor information," which are then applied to the five principal plants (EAF, LMF, Caster, DRI, and Pellet Plant). Barr Engineering Company (2007) *Minnesota Steel Industries Estimated CO_2 Emissions from Electricity Usage*, Table 1. Barr states that its electricity-related emissions estimate is a maximum, since they use coal-fired carbon coefficient, but then uses MAPP's coal-dominated carbon coefficient. In any case, CMS uses Minnesota's lower carbon coefficient but estimates much higher power demand.

Note: CMS excluded emissions from shipping materiel required for mine and/or plant operation, such as soda ash, limestone, anthracite coal, diesel fuel, natural gas, or numerous other material requirements. The only "shipping" emissions CMS has included relates to grid losses inherent in transmission and distribution of electricity and shipping finished steel to market.

Rolled steel prepared for shipment from Bethlehem Steel, image by Todd Buchanan; steel pipe on railroad car, image by Matt, St. Paul, MN.

Commuting emissions

MSI anticipates hiring 700 full-time employees, plus requiring 2,000 workers for the construction of the plant. CMS has estimated emissions from regular commuting to and from work, as is often done in corporate emissions inventories. Since the plant does not yet exist, and it is only generally known where the workers will live (Nashwauk is some 15 miles from the facility), CMS has assumed single-occupancy vehicles driven 30 miles per worker per day using a car or truck with average fuel economy of 18.6 mpg. This is conservative, since many workers are likely travel from Grand Rapids or other outlying communities. Estimated fuel consumption totals 0.37 million gallons annually, resulting in emissions of 3,308 tonnes of CO_2/yr.

CMS has not estimated emissions for staff and directors' ground or air travel. MSI has been acquired by Essar Global, a multinational steel company based in Mumbai and with steel plants in India, China, Indonesia, and Qatar and plans to build facilities in Trinidad and Tobago and Vietnam.[8] One million miles of international air travel per year (assumed for indicative purposes) — at ~270 gCO_2 per passenger-kilometer flown — translates to 435 tonnes of CO_2 per year. CMS has not included this peripheral emissions estimate in total emissions attributed to MSI.

Summary

CMS has defined a reasonable emissions boundary and has estimated total emissions for the 2.5 million-tonne per year integrated iron mine, DRI, pellet plant, and steel mill proposed for the Mesabi Range by Minnesota Steel Industries. The CMS scope and boundary goes beyond that included in the Barr Engineering Company (MSI's consulting engineers) emissions inventory and that done for the State of Minnesota by the Minnesota Pollution Control Agency. Neither of the latter estimates was included in the *Draft Environmental Impact Assessment*. While the CMS scope and boundary are more comprehensive than the company's or the state's inventory, CMS has adhered to the industry-standard WRI/WBCSD *Greenhouse Gas Protocol*. This protocol is flexible and does not prescribe, in particular, which Scope 3 emissions to include, leaving those decisions to analysts.

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[8] Minnesota Steel Industries (2007) *Essar Global To Acquire Minnesota Steel; Invest USD 1.65 Billion To Build An Integrated Steel Plant*, MSI press release, 18Apr07, 2 pp.

As noted throughout, CMS's boundary definition excludes sources and emissions that could have been included in a comprehensive inventory. CMS has taken a middle line in its boundary definition, and the State of Minnesota may elect to broaden its own scope when it completes its own analysis for the Final EIS. Entities using the *Greenhouse Gas Protocol* often include commuting, employee and director air travel, and transporting commodities to market or shipping goods made in foreign factories within their boundary protocol, and it is common to exclude emissions attributable to material suppliers and transportation companies emissions for, in this case, MSI's inputs of limestone and anthracite.

In this regard, the CMS emissions inventory includes reasonable and justifiable sources of greenhouse gas emissions sources attributable to the proposed project, and uses a boundary definition that is conservative compared to a full life cycle emissions inventory that would include plant construction, resource inputs, equipment manufacturing, emissions from the production and delivery of natural gas and diesel fuel, and numerous other sources omitted from the present study.

Table 1: Summary of Emissions

	Tonnes CO_2-e/yr	Percent of total
Electricity	2,406,217	49.4%
Natural Gas	2,042,824	41.9%
Diesel Fuel (on-site)	44,108	0.9%
Limestone	31,789	0.7%
Soda Ash	17,374	0.4%
Other direct emissions	90,800	1.9%
Diesel fuel (steel transportation)	234,105	4.8%
Commuting	3,308	0.1%
Explosives	4,735	0.1%
Total	**4,875,032**	**100.0%**

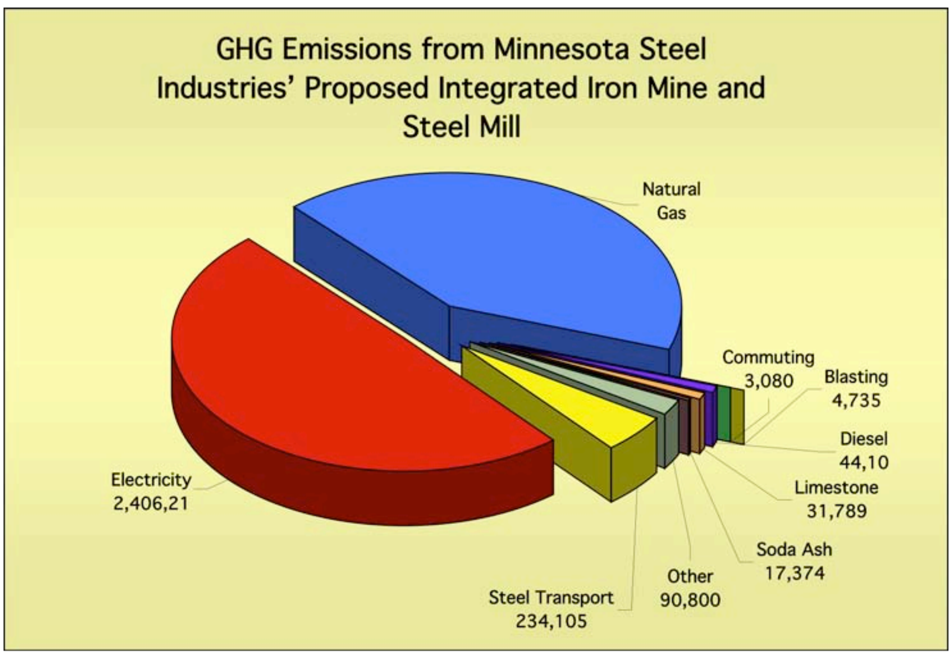
Clearly, CMS's emissions estimate is not the final word on emissions from MSI's proposed project. CMS has relied on company data when available and pertinent, and estimated emissions where quantitative data is not available or an emissions source has been ignored. Further analysis using a fuller set of engineering data will improve the estimates summarized herein.

Emissions from all sources included in the CMS inventory total 4.88 million tonnes of CO_2-e per annum, at full plant production capacity. This equals 1.95 kg of CO_2 (or 0.532 kg C) per kg of steel produced. This appears to compare poorly with best international practice of 0.44 kgC/kg steel produced.[9] But other steel-making CO_2 benchmark studies ignore iron mining and often ignore beneficiation and other elements of steelmaking included in the CMS study, hence a fair comparison is impossible to make without further analysis.

[9] Price et al (2002): China: 0.83 tC/t steel; best practice: 0.44 tC/t. BCS, Inc. (2002) *Energy and Environmental Profile of the U.S. Mining Industry*, Table 4-3 & 4-4 show energy requirements for a ~4 million ton/yr open pit mine (total 82,600 Btu/ton) and for beneficiation (11,800 Btu/ton) by equipment types and vehicles. CMS has not converted the following data to common values in order to compare our inventory results, but readers may wish to consult: US EIA *MECS 2002*, table 5b, Worrel *et al* 1999, and the UK Carbon Trust, which cites 1.75 tCO_2/tonne steel www.carbontrust.co.uk/technology/technologyaccelerator/life-cycle_energy_and_emissions.htm

Figure 1: Minnesota Steel emissions by source

Figure 2: Minnesota Steel emissions by source



Mitigation options

CMS has not investigated in any detail possible measures to reduce emissions through alternative energy options, energy-saving technology, design improvements, or heat recovery techniques. However, CMS offers a few initiatives worth further analysis.

- **Biodiesel**. Biodiesel replacement of fossil diesel fuel during the warm months, and partial bio-diesel (such as B20) replacement during cooler months (with regular diesel during cold months), can save a large proportion of emissions compared to year-round use of regular diesel. The

National Renewable Energy Laboratory suggests typical net CO_2 savings of 78.5 percent after an analysis of all relevant carbon inputs to growing, fertilizing, transporting, and processing biodiesel.[10] Assuming, tentatively, that 40 percent of MSI's projected use of 4.34 million gallons of diesel can be effectively replaced with biodiesel, MSI might be able to reduce emissions by 13,841 tonnes of CO_2, or 31 percent of the fossil-diesel emissions of 44,108 tonnes CO_2.

- **Commuting.** MSI can help reduce employee commuting emissions by creating incentives for ride-sharing or establishing a van pool for driving to and from work.
- **Alternative sources of electricity and onsite generation**. MSI can mitigate its electricity-related emissions by using combined heat and power by installing a power plant onsite and thus displace high-carbon power available from the Mid-Continent Power Pool. A combined-cycle gas turbine or other high-efficiency natural gas-fired power plant can reduce MSI's emissions significantly. CMS has not estimated the capital investment required or the CO_2 savings achievable. Since 50 percent of total emissions from MSI's integrated iron mine and steel mill is related to consumption of high-carbon electricity, substantial CO_2 mitigation is feasible. Alternatively, hydropower might be procurable from Canada. Windpower is an increasingly attractive option to reduce carbon emissions, either through commitments to purchase Renewable Energy Credits (RECs) from utilities or vendors, or direct investment in operating turbines with high availability factors and costs competitive with coal-fired power plants. CMS has not evaluated the financial feasibility or the wind resources of the Upper Midwest. WAPA and the US DOE are presently evaluating programs to facilitate the installation of *giga*watts of windpower capacity in the Dakotas.
- **EAF efficiency**: Steelmaking efficiency has improved dramatically, and many design and technology innovations have been incorporated into MSI's plant designs. CMS has not analyzed these initiatives, nor researched other technical measures to reduce energy inputs. One technology — Tetron Inc's ladle vortex inhibitor — increases the pour by 0.5 to 1.5 percent, thus decreasing slag and associated treatment and reheating.
- **Plant integration**. Integrating a DRI, pelletizer, and steel mill eliminates a great deal of heat wasted in typical steel mills often distant from iron-producing regions. MSI has indicated that large efficiency savings have been incorporated into the plant's design, and using the substantial amounts of energy in the heated pellets is an innovative feature of the proposed plant. Further analysis is likely to uncover additional ways to save money and energy.

CMS does not have access to engineering designs and does not have expertise in mill design. Other experts can provide useful reviews and offer technical advice on efficiency improvements available for mitigation purposes. It is incumbent on the State of Minnesota to analyze the numerous opportunities to reduce emissions of greenhouse gases through enhanced efficiency, fuel substitution, and smarter design. Many opportunities can be incorporated in the project to further reduce energy intensity and emissions of greenhouse gases while fostering sustainable jobs in Minnesota and simultaneously protecting local and global environmental health.

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[10] National Renewable Energy Laboratory (1998) Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus.

References

Argonne National Laboratory (2001) *Trans-Alaska Pipeline System EIS, draft, Section 4.9: Energy Requirements and Conservation Potential*, tapseis.anl.gov/documents/docs/Section_4_9_May2.pdf

Australian Greenhouse Office (2006) *AGO Factors and Methods Workbook*, Dec06, 54pp. www.greenhouse.gov.au/woorkbook/

Barr Engineering Company (2007) *Minnesota Steel Industries CO_2 Emissions Footprint and Comparison*, Minneapolis, 6 pp. 27 April 2007.

Barr Engineering Company (2007) *Minnesota Steel Industries Estimated CO_2 Emissions from Electricity Usage,* Minneapolis, 5 pp. 17 May 2007.

Barr Engineering Company (2008) *Air Emissions Inventory*, folio of 25 Excel worksheets, for Minnesota Steel Industries.

Battles, Stephanie J., & Robert K. Adler (1999) *Production, Energy, and Carbon Emissions: A Data Profile of the Iron and Steel Industry*, ACEEE summer study paper, at eia.gov in html only; no CO2 intensity data, emailed Battles 6may

Bazari, Zabi, & Gill Reynolds (2005) *Sustainable Energy in Marine Transportation*, Lloyd's Register EMEA, IMarEST Conference, Sustainable Shipping, 1-2 February 2005, ppt, 38 slides.

BCS, Incorporated (2002) *Energy and Environmental Profile of the U.S. Mining Industry*, for U.S. DOE EERE, Chapter 4 on Iron.

Centennial Coal Company (2006) *Final Greenhouse Gas and Energy Assessment for Anvil Hill Project, New South Wales, Australia*, by See Sustainability Consulting, Toronto NSW, 10 pp.

Congressional Budget Office (1982) *Energy Use in Freight Transportation*, 80 pp., CBO Staff Working Paper, www.cbo.gov/showdoc.cfm?index=5330&sequence=0

Energy Information Administration (2006) *Annual Energy Review 2005*, US DOE.

Minnesota Department of Natural Resources (2007) *Minnesota Steel Draft Environmental Impact Statement*, Feb07, 370 pp., www.dnr.state.mn.us/input/environmentalreview/minnsteel/index.html

Minnesota Steel Industries (2007) *Essar Global To Acquire Minnesota Steel; Invest USD 1.65 Billion To Build An Integrated Steel Plant*, MSI press release, 18Apr07, 2 pp., www.minnesotasteel.com/Media/Essar%20Investment-April%2018%202007.pdf

National Renewable Energy Laboratory (1998) *Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus*, May1998, 314 pp.,

Price, L., J. Sinton, E. Worrell, D. Phylipsen, X. Huc, & J. Li (2002) Energy use and carbon dioxide emissions from steel production in China, *Energy*, 2002:429-446.

Union of Concerned Scientists (tk) *Cleaning Up Diesel Pollution Emissions from Off-Highway Engines by State*, 76 pp, error in download.

U.S. DOE Center for Transportation Analysis (2006) *Transportation Energy Data Book* Edition 25, Stacy C. Davis & Susan W. Deigel, ORNL, www-cta.ornl.gov/data/Index.html

U.S. Energy Information Administration (2006) *Annual Energy Review 2005*, US DOE, www.eia.doe.gov

U.S. Energy Information Administration (2004) *Manufacturing Energy Consumption Survey 2002*, Iron and Steel Manufacturing Energy, Table 5b, US DOE, www.eia.doe.gov

U.S. Energy Information Administration (2002) *Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation 1998-2000*, 9 pp.

World Business Council for Sustainable Development & World Resources Institute (2006) *Corporate Accounting and Reporting Standards,* Greenhouse Gas Protocol, www.ghgprotocol.org

Worrell, Ernst, Nathan Martin, & Lynn Price (1999) *Energy Efficiency and Carbon Dioxide Emissions Reduction Opportunities in the U.S. Iron and Steel Sector*, LBNL, 57 pp.

N o t e s

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For Minnesota Center for Environmental Advocacy
By Richard Heede
Climate Mitigation Services
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Folio of worksheets

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