Coming Clean on Industrial Emissions

Legislative Briefings on Cleaning Up Heavy Industry

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Agenda

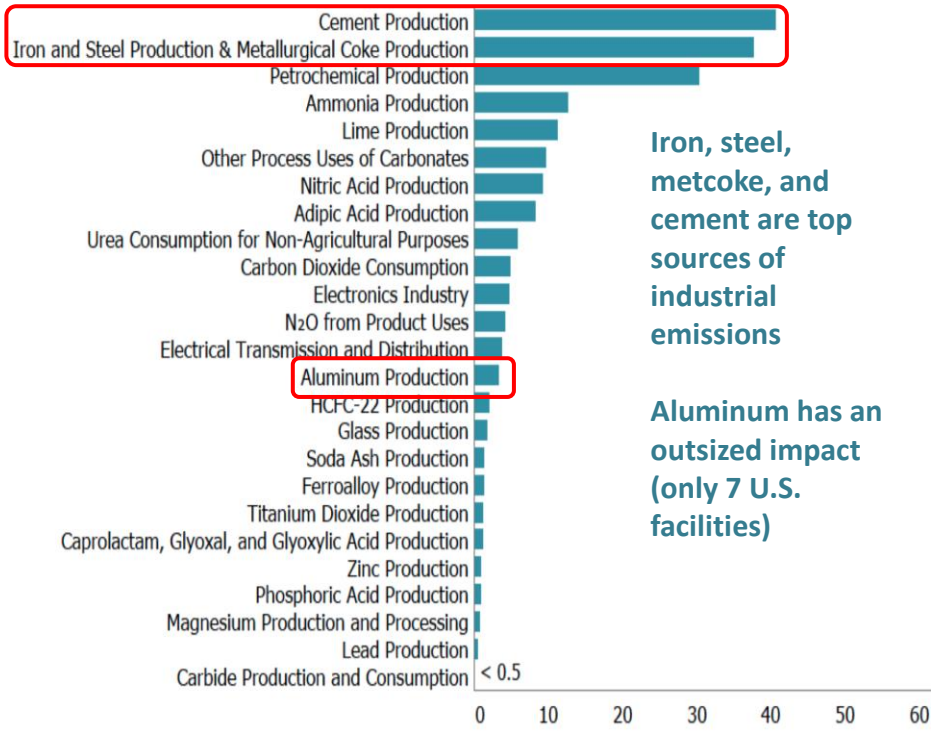
1. Overview: background, policy context, study objective
2. High-level findings
3. Facility-level data and results
   - Production
   - Greenhouse gas emissions and Buy Clean
   - Toxic releases and health impacts
   - Uncertainty in industry-reported data
   - Employment
   - Environmental justice assessment
4. Technology and policy solutions
5. Demonstration of public study materials
6. Q&A

Overview

Background

- Industrial manufacturing is vital to the U.S. economy
  - 12.8 million domestic jobs (9% of U.S. total)
  - $7.2 trillion gross economic output (16% of U.S. total)
- Major source of pollutants
  - 26.3% of U.S. greenhouse gas emissions
  - Hundreds of different air, land, and water toxics

Greenhouse Gas Emissions, 2020: Industrial Processes and Product Use



Iron, steel, metcoke, and cement are top sources of industrial emissions

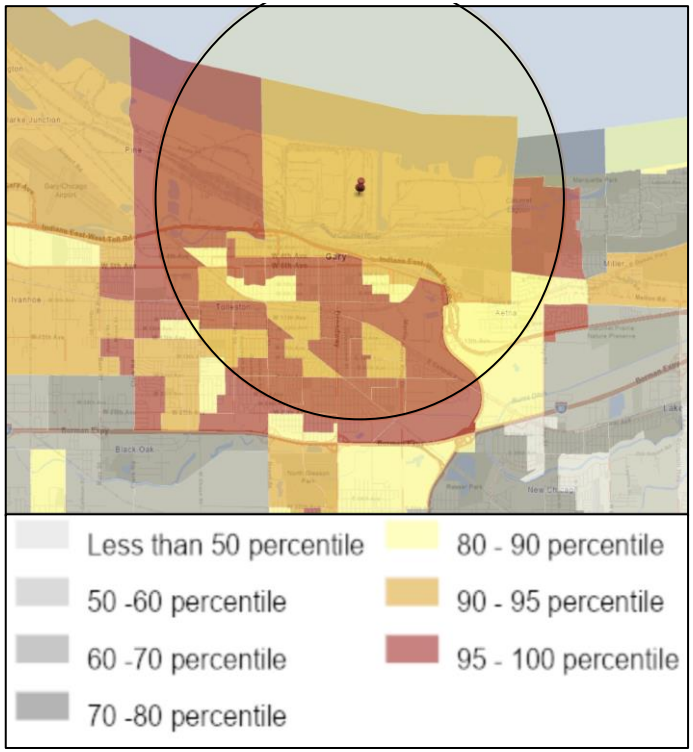
Aluminum has an outsized impact (only 7 U.S. facilities)

Source: EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020

Background

- Impetus for cleaning up U.S. industry
  - Climate change
  - Contamination of natural resources
  - Premature deaths and other health impacts
  - Disproportionate impacts on EJ communities
- Data limitations inhibit effective policy, decision-making, and action
  - Sources of facility-level data are disparate
  - High uncertainty: estimated vs. measured
  - Missing data: confidential or not required to report

EJ Demographic Index:
US Steel Corp - Gary Works



Policy Context

Industrial policy is gaining renewed attention in the United States and abroad

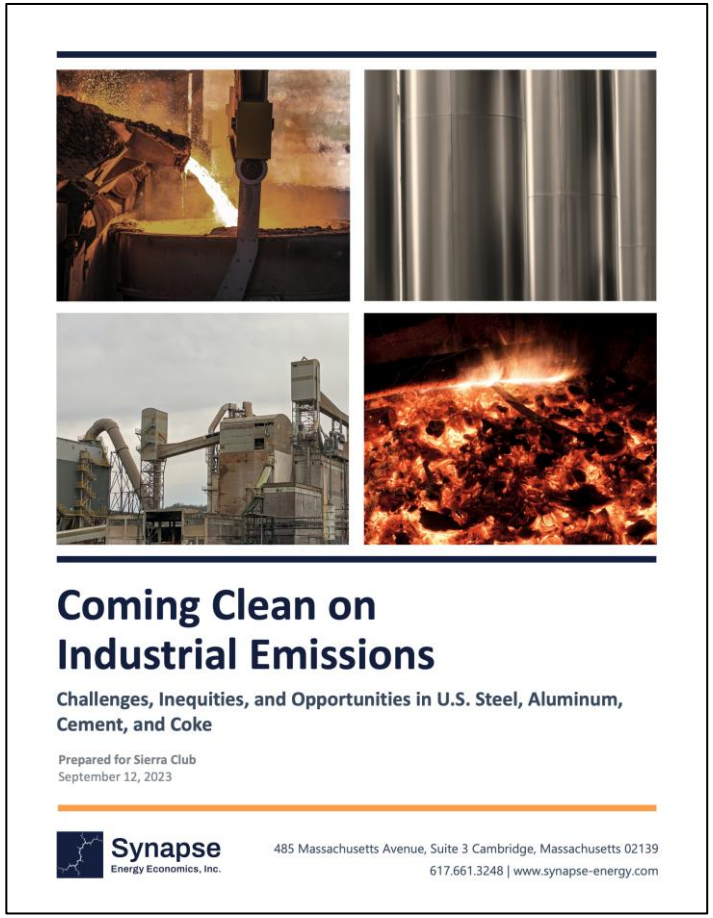
Photo credits: Climateworks Foundation, EU Commission, blue_chi, The White House

Coming Clean on Industrial Emissions Study

Provides integrated, accessible facility-level data to support public-interest initiatives

Approach

- Reviewed literature
- Collected and compiled publicly-available facility-level data
  → Facility identification, ownership, address
  → Equipment type
  → Production process
  → End products
  → GHG emissions
  → Air, land, and water pollutants
- Estimated missing facility-level data from industry sources
  → Production
  → Employment
- Quantified **GHG emissions intensity** (GHG per ton produced)
- Evaluated Buy Clean emission reduction potential
- Analyzed health impacts and environmental justice indicators
- Characterized data uncertainty
- Disseminated results: report, interactive webtool, database



High-Level Findings

Findings

Pollutants

- Iron, steel, aluminum, and cement facilities emit a wide range of pollutants
- Reported data can be hard to find – we made a central database to help

Emission intensity

- Emissions per ton vary substantially within each industry
- Leaders provide lessons for laggards

Policy opportunities

- Industrial buy-clean policies and emission standards are useful to incentivize or require materials with low GHG emission intensities

Findings

Data gaps and uncertainty

- Key data (e.g., production) are not publicly available and must be estimated
- The accuracy of reported emissions data is uncertain, largely due to the range of reporting methods available to facilities

Health impacts

- Industrial pollutants are responsible for alarming rates of adverse outcomes
- Iron and steel facilities have the largest impact of the industries we study

Pollution control

- A vast array of technologies that can reduce or eliminate pollutants from industrial facilities are available, and many more are under development
- Reducing emissions in the electricity sector is an important industrial decarbonization strategy, especially for aluminum and certain steel facilities

Findings

Jobs

- The 211 facilities in this study employ about 100,000 workers and represent an important segment of local economies throughout the United States
- Deploying pollution control strategies at industrial facilities can provide important employment opportunities
- Policies for domestic manufacturing and reducing emissions should be coupled with workforce development

Environmental justice

- Fence-line communities that support industrial facilities are socioeconomically and environmentally disadvantaged
- Metcoke and iron and steel (especially BF-BOF) communities are most affected

Facility-Level Data and Results

Master Database

- **Facility types**: iron & steel, metallurgical coke, cement, and aluminum
- **Related facilities not in scope**: ore mining and processing, ferroalloy, petcoke, secondary aluminum smelters, finishing
- **Included information**:
  1. Facility information
  2. Employment
  3. Production
  4. Emissions
     - Greenhouse gas emissions
     - Criteria air pollutants; hazardous air pollutants; air, land, and water releases
  5. Heath impact indicators
  6. Environmental justice indicators: socioeconomic and environmental

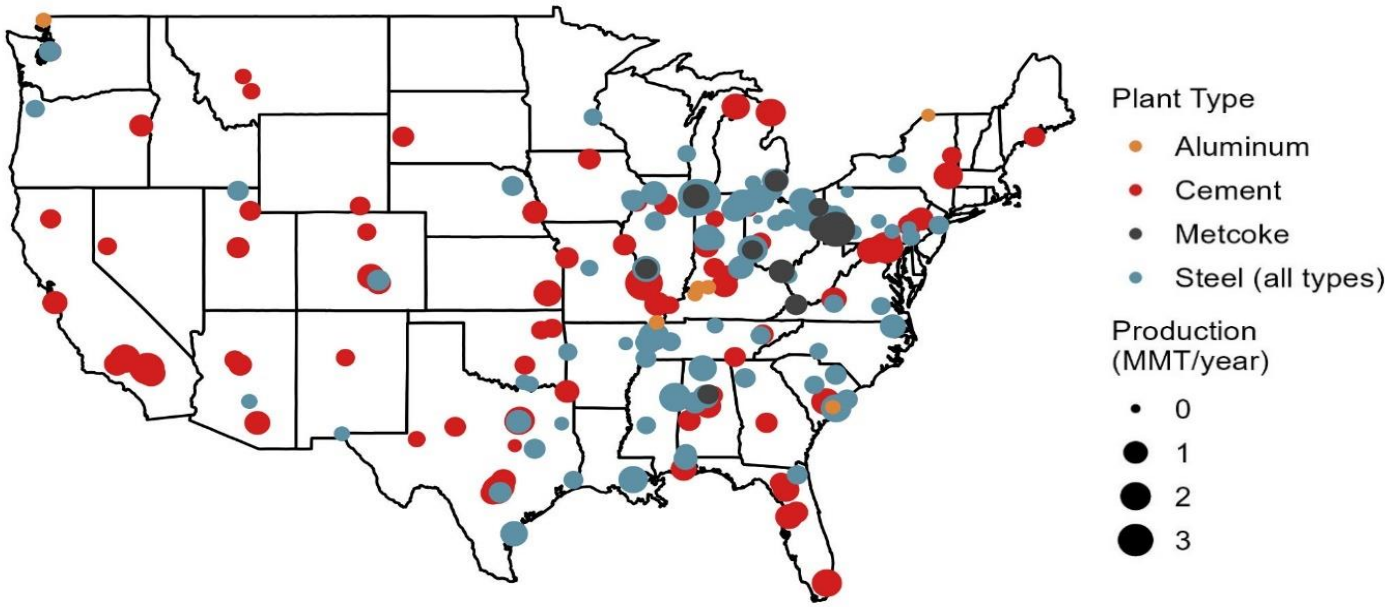
Production

- The United States is a leading producer of cement (#3 globally), iron and steel (#4), and aluminum (top 10)
- Production quantities are an important intermediate result; used to normalize emissions (i.e., GHG/ton)
- Iron and steel, metcoke, and aluminum facilities are clustered regionally; cement facilities are close to population centers

Industry-Wide Production, 2020

Industry	Production (metric tons)
Cement	85,540,748
Iron and Steel	76,745,894
Metcoke	11,412,215
Aluminum	1,012,000

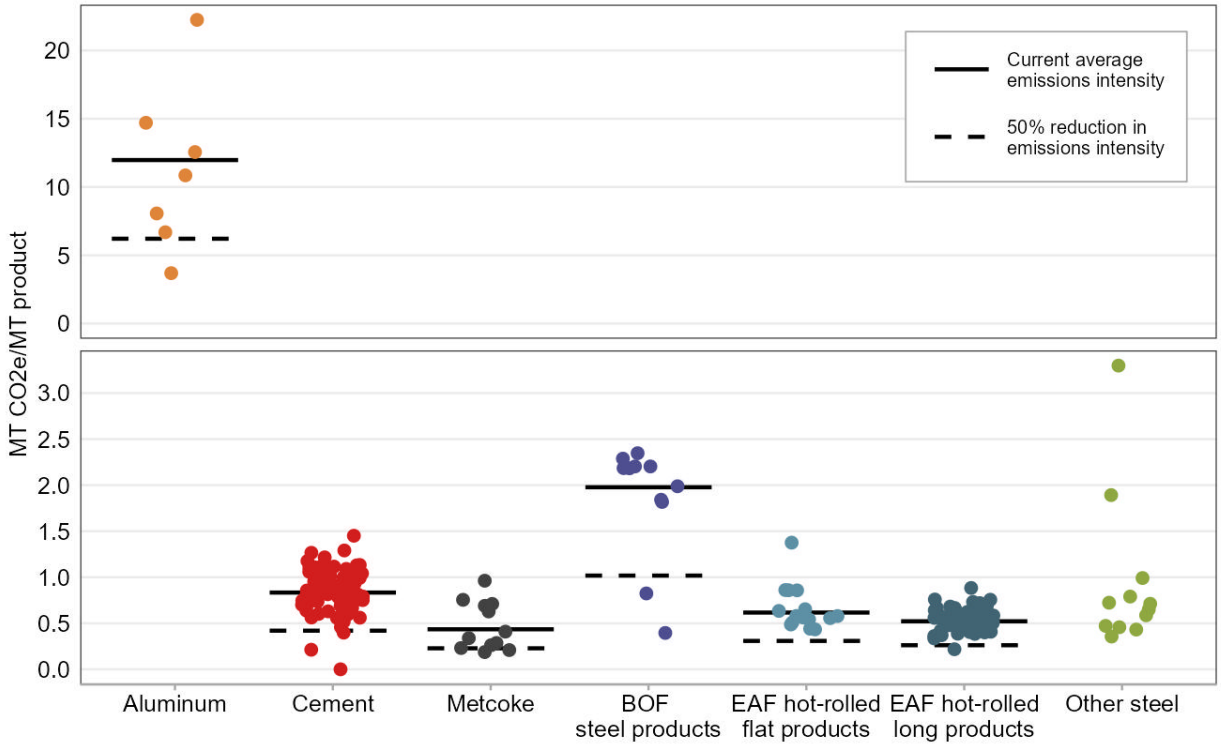
Facility-Level Production, 2020



Emissions Intensity Across Industries

- **Emission intensity varies across industries**. Aluminum emissions per ton are 12-26x higher
- **Emission intensity varies by plant within each industry.** The dirtiest plants are 4-6x dirtier than the cleanest
- The dotted lines represent the emissions intensity necessary to reduce industry emissions 50%
- A few facilities already meet this standard, but **nearly all** (201 of 211) facilities need to decrease their carbon intensity to yield a 50% overall reduction

Scope 1 & 2 Estimated Emissions Intensity



Air, Land, and Water Pollutants

- Facilities in this study release a wide array of toxics
- Facilities self-report GHG and toxic emissions using divergent methods, leading to uncertainty
- The dominant methods are "engineering calculations" (38%), periodic or random monitoring (31%), and site-specific emission factors (16%)
- Toxics data are most uncertain for cement and metcoke facilities (more engineering calculations, less monitoring)

Reported Number of Toxic Pollutants

Industry	Land	Water	Air	Total
Iron and Steel	39	51	77	81
Metcoke	-	28	40	46
Aluminum	17	21	42	42
Cement	26	17	139	140

Qualitative uncertainty assessment of toxics

Facility Type	TRI Data: Air	TRI Data: Land	TRI Data: Water
Iron and steel	B	B	A
Aluminum	B	A	A
Cement	B	B	C
Metcoke	C	D	B

Criteria Air Pollutant Health Impacts Analysis

- We estimated health benefits of reducing industrial air pollution using EPA's COBRA model
  - Estimates the impact of reducing particulate emissions only
  - Represents lower bound health benefits (vs. eliminating all pollutants)
  - COBRA is a peer-reviewed model; uses methods consistent with EPA Regulatory Impact Analyses
- Steel and iron facilities are responsible for 69% of related adverse health outcomes, cement for 15%, metcoke for 13%, and aluminum for 3%

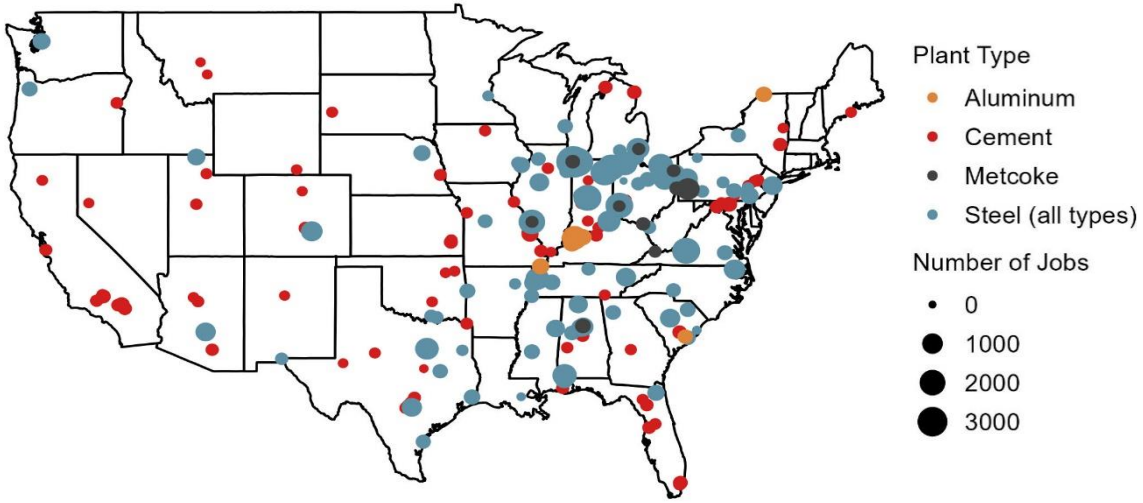
Reductions in Incidence of Health Endpoints for All Industries

Health Endpoint	Change in Incidence (cases, annual)	
	Low	High
Mortality	1,253	2,835
Nonfatal Heart Attacks	133	1,230
Infant Mortality	7	
Hospital Admits, All Respiratory	304	
Hospital Admits, Cardiovascular (except heart attacks)	310	
Acute Bronchitis	1,548	
Upper Respiratory Symptoms	28,042	
Lower Respiratory Symptoms	19,689	
Emergency Room Visits, Asthma	624	
Asthma Exacerbation	29,171	
Minor Restricted Activity Days	832,368	
Work Loss Days	140,845	

Employment

- Facilities included in this research represent nearly 100,000 workers, or about 1% of domestic manufacturing employment (12.8 million jobs)
- Since 1979, manufacturing has lost nearly 7 million jobs, from 22% of total U.S. jobs to 9%
- The loss of manufacturing roles has devastated manufacturing communities—resulting in decreased income, increased unemployment, and higher opioid addiction rates
- Newly created manufacturing positions tend to require higher levels of education
  - Barrier to entry for legacy energy workers and other disadvantaged communities
  - Need for workforce development initiatives

Facility-Level Employment, 2020



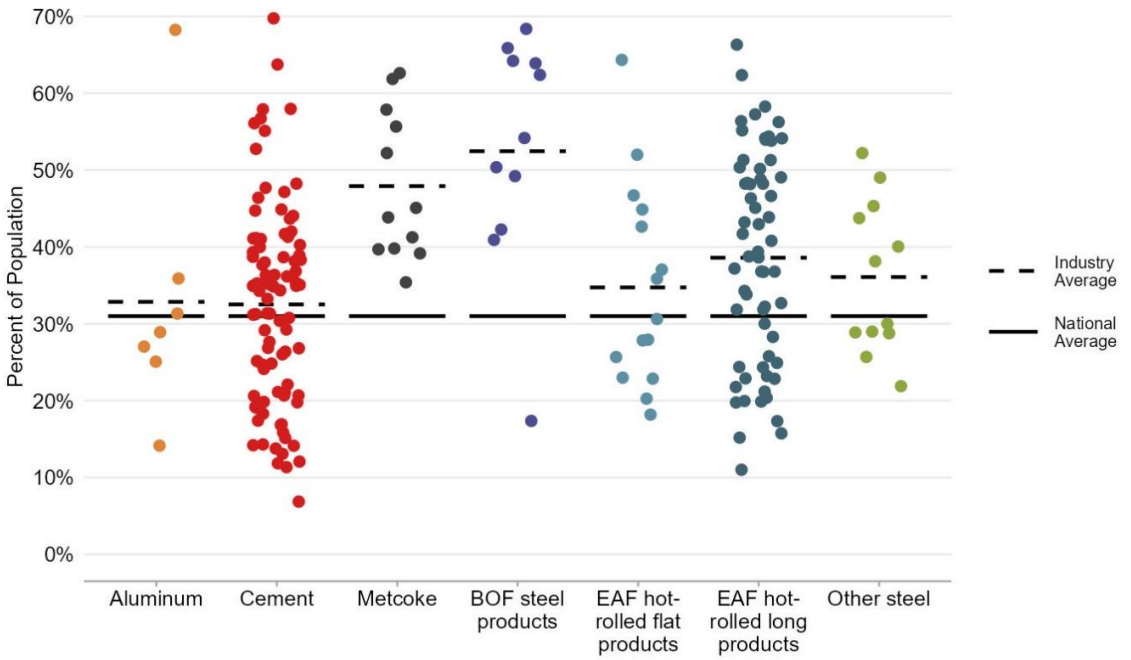
Industry-Wide Employment, 2020

Industry	Number of Jobs	Median Jobs per Facility
Aluminum	4,275	520
Cement	12,220	115
Metcoke	3,710	195
Iron and steel	74,353	388

Environmental Justice Indicators

- We rank fenceline communities along 8 socioeconomic and 12 environmental indicators
- The closer a community is to a facility, the more likely it is to be disadvantaged
  (8 of 8 demographic indicators,
  9 of 12 environmental indicators)
- Metcoke and iron/steel communities are most affected, especially integrated steel mills
  - Unemployment rates are high: 7% and 8%, respectively, vs. 5% national
  - Poor air quality: particulate matter, air toxics cancer risk

Fenceline communities (3-mile radius), percent low-income



Technology and Policy Solutions

Leading Technologies for Cleaner Industry

Industry	Technological Pathway*	Examples	Effect on Toxics, CAPs, and CO_2
Iron and Steel	Electrify production	Direct electrolysis to produce iron; electrified reheating furnaces; induction furnaces	Reduced fossil fuel pollution onsite during iron and steel production
	Shift to clean hydrogen	Direct reduction with hydrogen; SuSteel process	Reduced fossil fuel pollution onsite during iron and steel production
	Carbon capture, use, and storage	Amine-based CCS	Reduced CO_2 emissions; requires eliminating SO2 emissions
Metallurgical coke	Shift to direct reduced iron	Multiple extant facilities	Direct reduced iron can replace coke-based iron
	Carbon capture, use, and storage	Amine-based CCS	Reduced CO_2 emissions; requires eliminating SO_2 emissions
	Advanced coke making techniques	dry quenching; single-chamber-system coking; "Scope21" process	Ability to use alternative coal blends with improved efficiency and reduced pollution
Aluminum	Reduce anode reactivity	Gas anodes; inert anodes	Potential to reduce or eliminate direct CO2 and PFC emissions
	Improve electrical efficiency	Lower temperature electrolytes; wettable cathode; corrosion resistant sidewall refractory	Reduced Scope 2 emissions through greater electrical efficiency
Cement	Carbon capture, use, and storage	Amine-based CCS	Reduced CO2 emissions; requires eliminating SO2 emissions
	Electrified kiln heating	VTT Decarbonate process (Finland)	Reduced fossil fuel pollution onsite
	Alternative chemistries	New hydraulic cements; silicate & bauxite cements	Reduced process CO_2 emissions

*Note: the order of technologies is not intended to convey technological maturity, likelihood, or preference.

Leading Industrial Policy Approaches

- Emissions data collection and disclosure requirements
- Buy clean requirements for procurement
- Cement clinker substitution requirements
- Requirements for efficiency, longevity, and recycling/re-use
- Sector-specific carbon capture and storage requirements
- Clean heat standard
- Market based mechanisms (e.g., carbon pricing, cap and trade)
- Industrial efficiency or emission standards
- Industrial pilot programs
- Material-efficient building codes
- Labeling of low-carbon materials

Demonstrations

Interactive Tool Demonstration

Buy Clean Analysis of U.S. Steel, Aluminum, and Cement Facilities

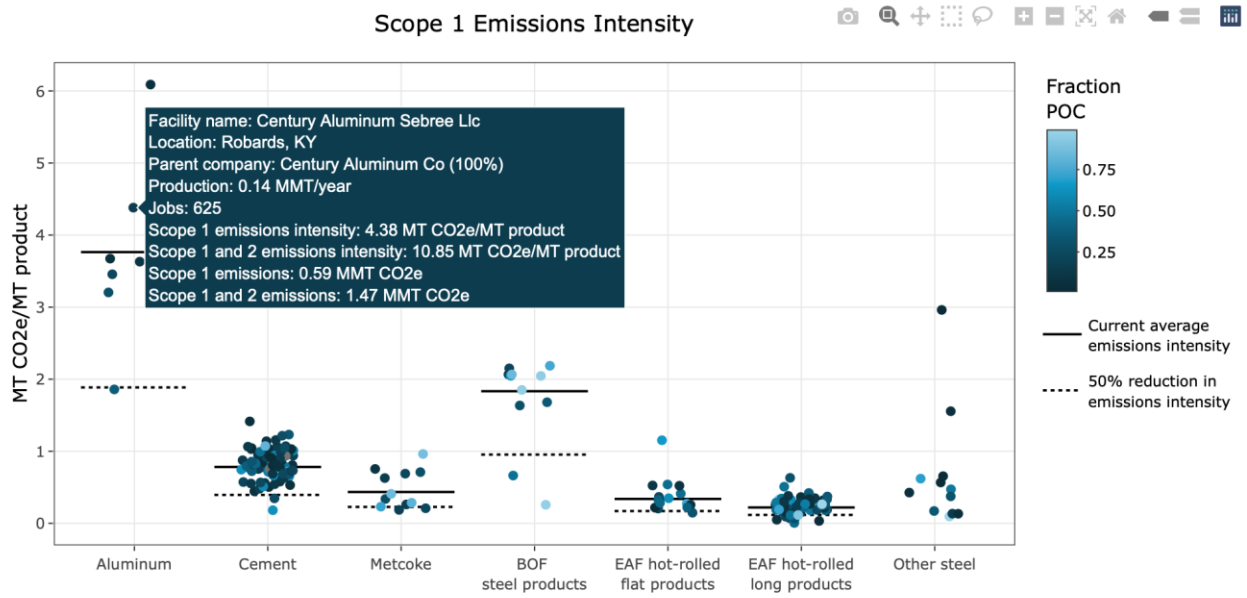
Facility Map | Distribution of Emissions Intensities | Plant Emissions Curves | EJ Analysis

People of Color | Income | Education | Language | Unemployment | Cancer Risk | Respiratory Toxics

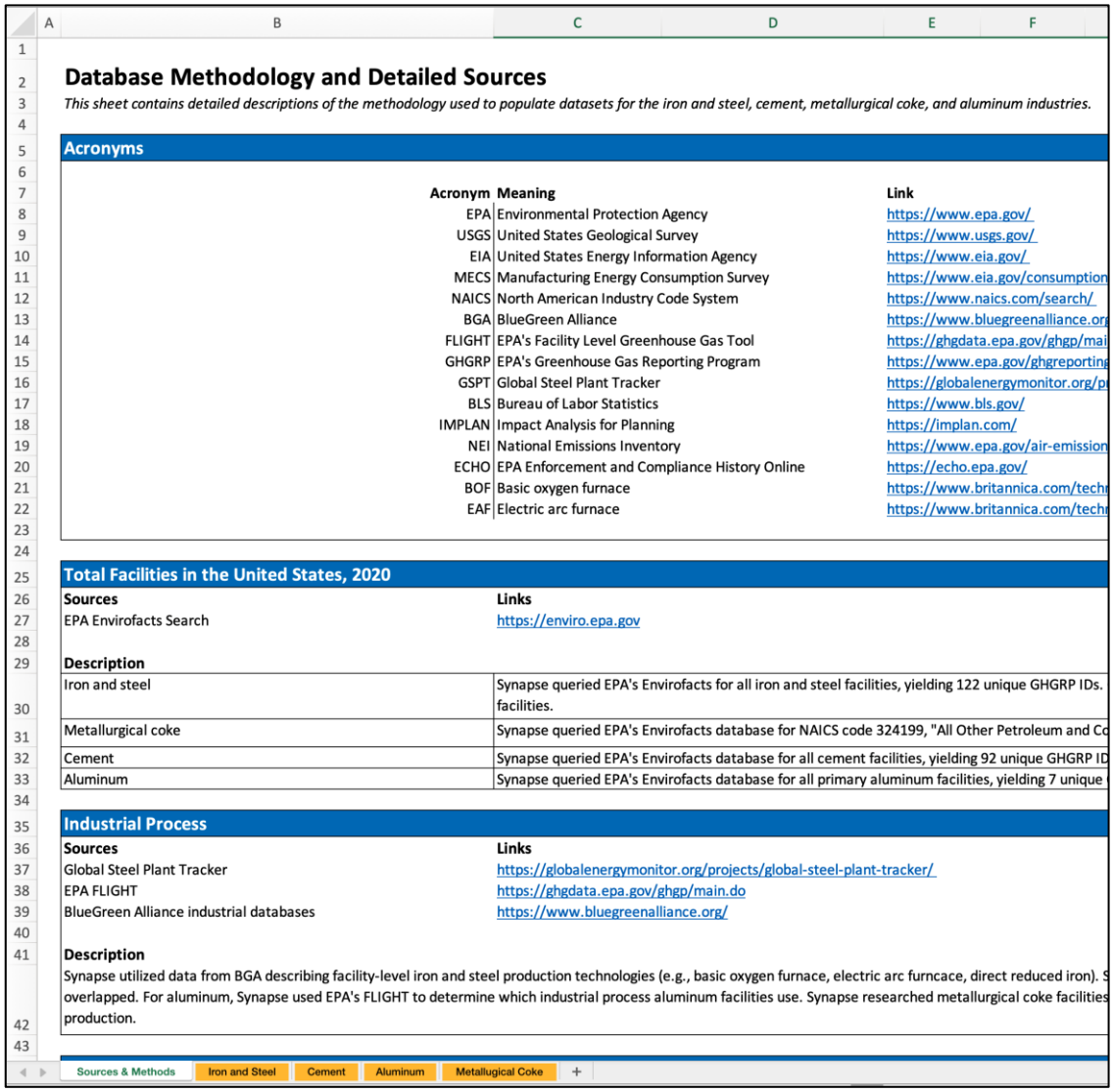
Diesel Particulates | Fine Particulates | Wastewater

Each point represents an industrial facility. The y-axis position shows the facility's greenhouse gas emissions intensity (metric tons of carbon dioxide equivalent per metric ton of product). The crossbars show the current production-weighted average emissions intensity for each industry.

The color scale shows the percentage of the population within a 3-mile buffer around each facility who are people of color. Plants shown in dark blue have fewer people of color living nearby than plants shown in light blue. Those shown in gray do not have data available.



Master Database Walkthrough



Database Methodology and Detailed Sources

This sheet contains detailed descriptions of the methodology used to populate datasets for the iron and steel, cement, metallurgical coke, and aluminum industries.

Acronyms

Acronym	Meaning	Link
EPA	Environmental Protection Agency	https://www.epa.gov/
USGS	United States Geological Survey	https://www.usgs.gov/
EIA	United States Energy Information Agency	https://www.eia.gov/
MECS	Manufacturing Energy Consumption Survey	https://www.eia.gov/consumption
NAICS	North American Industry Code System	https://www.naics.com/search/
BGA	BlueGreen Alliance	https://www.bluegreenalliance.or
FLIGHT	EPA's Facility Level Greenhouse Gas Tool	https://ghgdata.epa.gov/ghgp/mai
GHGRP	EPA's Greenhouse Gas Reporting Program	https://www.epa.gov/ghgreportin
GSPT	Global Steel Plant Tracker	https://globalenergymonitor.org/p
BLS	Bureau of Labor Statistics	https://www.bls.gov/
IMPLAN	Impact Analysis for Planning	https://implan.com/
NEI	National Emissions Inventory	https://www.epa.gov/air-emission
ECHO	EPA Enforcement and Compliance History Online	https://echo.epa.gov/
BOF	Basic oxygen furnace	https://www.britannica.com/techn
EAF	Electric arc furnace	https://www.britannica.com/techn

Total Facilities in the United States, 2020

Sources	Links
EPA Envirofacts Search	https://enviro.epa.gov

Description	
Iron and steel	Synapse queried EPA's Envirofacts for all iron and steel facilities, yielding 122 unique GHGRP IDs. facilities.
Metallurgical coke	Synapse queried EPA's Envirofacts database for NAICS code 324199, "All Other Petroleum and Co
Cement	Synapse queried EPA's Envirofacts database for all cement facilities, yielding 92 unique GHGRP ID
Aluminum	Synapse queried EPA's Envirofacts database for all primary aluminum facilities, yielding 7 unique

Industrial Process

Sources	Links
Global Steel Plant Tracker	https://globalenergymonitor.org/projects/global-steel-plant-tracker/
EPA FLIGHT	https://ghgdata.epa.gov/ghgp/main.do
BlueGreen Alliance industrial databases	https://www.bluegreenalliance.org/

Description

Synapse utilized data from BGA describing facility-level iron and steel production technologies (e.g., basic oxygen furnace, electric arc furncace, direct reduced iron). S overlapped. For aluminum, Synapse used EPA's FLIGHT to determine which industrial process aluminum facilities use. Synapse researched metallurgical coke facilities production.

Sources & Methods | Iron and Steel | Cement | Aluminum | Metallugical Coke

Question and Answer

Thank you!

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