Summary of Scope 1 and 2 Emissions from EAF Steel Plants, 2021

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This document summarizes the key trends and findings from the Annual 2021 emissions calculated for each Electric Arc Furnace Steel Plant.

```
Linking to GEOS 3.10.2, GDAL 3.4.2, PROJ 8.2.1; sf_use_s2() is TRUE
```

```
here() starts at /Users/ericabishop/Documents/MEDSspring/steeltracker/carbon-analysis
```

```
Attaching package: 'janitor'
```

```
The following objects are masked from 'package:stats':

    chisq.test, fisher.test
```

```
-- Attaching packages --------------------------------------- tidyverse 1.3.2 --
v ggplot2 3.4.1     v purrr   1.0.1
v tibble  3.2.1     v dplyr   1.1.0
v tidyr   1.3.0     v stringr 1.5.0
v readr   2.1.2     v forcats 0.5.1
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
```

```
Attaching package: 'plotly'
```

```
The following object is masked from 'package:ggplot2':
```

```
    last_plot


The following object is masked from 'package:stats':

    filter


The following object is masked from 'package:graphics':

    layout

Rows: 57 Columns: 25
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (11): plant_id, plant_name, owner, state, municipality, address, categor...
dbl (14): ghgrp_id, lat, lon, plant_age_years, co2e_tonnes_per_mwh, estimate...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

Summary by Plant: The Top 5 Highest Emitting Plants

```
Selecting by total_co2e_2021
```

Top 5 Highest Emitting EAF Steel Plants, 2021
Based on Scope 1 and Scope 2 Emissions from EAF Plants (metric tons CO2e)

Plant Name	Total CO2E Emissions
Nucor Steel Berkeley plant	1,757,626
Nucor Steel Decatur plant	1,593,875
Nucor-Yamato Steel Blytheville plant	1,741,089
Steel Dynamics Butler plant	2,075,603
Steel Dynamics Columbus plant	2,218,475

Summary by Company: Top emitters by emissions and emissions intensity

Top 5 Highest Emitting Steel Companies, 2021

Based on Scope 1 and Scope 2 Emissions from EAF Plants (metric tons)

Owner	Total Emissions	% of Total Emissiosn from Scope 2	Avg Total Emiss
Nucor Corp	7,921,002	65.4	
Steel Dynamics Inc	6,310,323	66.1	
Commercial Metals Co	2,467,058	69.5	
Gerdau Long Steel North America	1,869,985	73.1	
Nucor Yamato Steel Co	1,741,089	73.1	

Top 5 Most Emissions Intense Steel Companies, 2021

Based on Scope 1 and Scope 2 Emissions from EAF Plants (metric tons CO2e/metric tons steel)

Owner	Avg Emissions Intensity	Avg Total Emissions Across Plants
North American Stainless Inc	0.8730	857,537.6
SSAB Americas Holding AB	0.8635	793,409.9
Charter Manufacturing Company Inc	0.8585	373,798.4
Evraz North America PLC	0.8570	799,602.1
Liberty Steel	0.8410	374,337.8

Regional Analysis: Average and Total Emissions from Each AISI Region

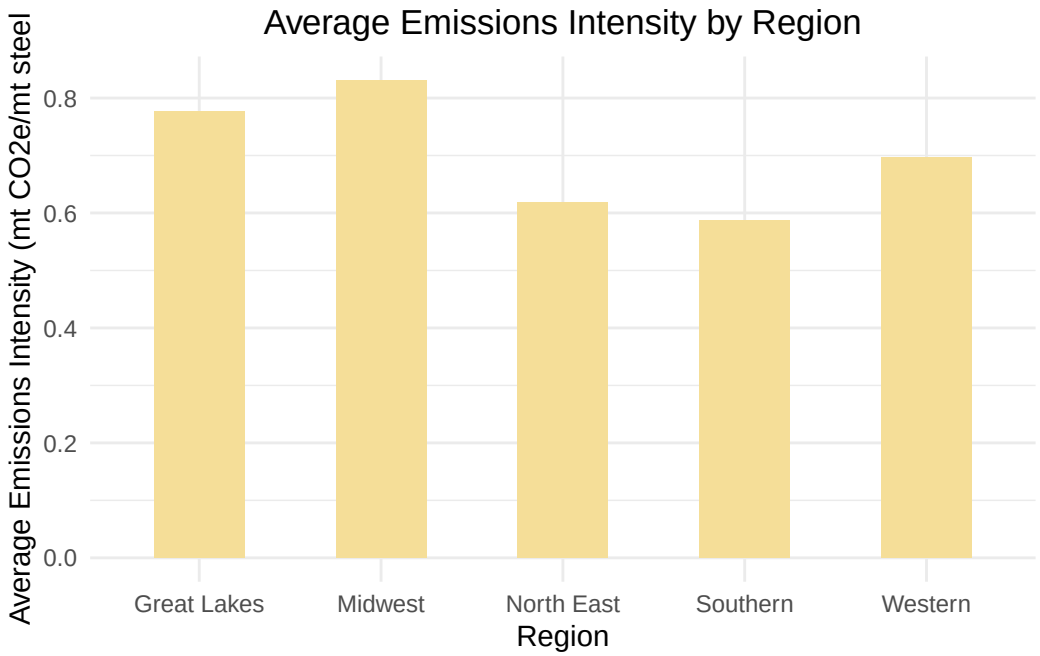
Regional Emissions from EAF Steel Production

Based on 2021 Scope 1 and Scope 2 Emissions (metric tons CO2e)

Region	Annual Emissions (mt CO2e)	Avg Total Emissions (mt CO2e)
Southern	20,152,460	806,098.4
Great Lakes	8,322,820	756,620.0
Midwest	4,624,211	578,026.3
North East	3,554,147	444,268.4
Western	2,475,415	495,083.0

```
# A tibble: 5 x 3
  region      avg_emissions_intensity_per_region_co2e avg_emissions_per_region
  <chr>                                        <dbl>                    <dbl>
1 Midwest                                      0.831                  578026.
2 Great Lakes                                  0.778                  756620.
3 Western                                      0.696                  495083.
4 North East                                   0.619                  444268.
```

```
5 Southern                    0.588                  806098.
```



State-Level Analysis: Average and total state level emissions

```r
total_state_emissions <- scope_1_and_2_emissions_2021 %>%
  group_by(state) %>%
  summarise(total_emissions_co2e = sum(total_co2e_tonnes_2021)) %>%
  arrange(desc(total_emissions_co2e))

total_state_emissions %>%
  head(10)
```

```
# A tibble: 10 x 2
   state          total_emissions_co2e
   <chr>                         <dbl>
 1 Indiana                     5332332.
 2 Arkansas                    4837545.
 3 Alabama                     4711069.
 4 Ohio                        4157446.
 5 South Carolina              2645329.
 6 Texas                       2296777.
```

```
 7 Mississippi                2218475.
 8 Illinois                   1986211.
 9 Kentucky                   1535095.
10 Pennsylvania               1011274.
```

```r
average_state_emissions <- scope_1_and_2_emissions_2021 %>%
  group_by(state) %>%
  summarise(avg_emissions_per_plant_co2e = mean(total_co2e_tonnes_2021)) %>%
  arrange(desc(avg_emissions_per_plant_co2e))

average_state_emissions %>%
  head(10)
```

```
# A tibble: 10 x 2
   state          avg_emissions_per_plant_co2e
   <chr>                                 <dbl>
 1 Mississippi                         2218475.
 2 Arkansas                            1209386.
 3 Indiana                             1066466.
 4 South Carolina                       881776.
 5 Iowa                                 830836.
 6 Colorado                             799602.
 7 Alabama                              785178.
 8 North Carolina                       784986.
 9 Kentucky                             767548.
10 Nebraska                             642458.
```

Benchmarking Calculations with Corporate Sustainability Reports

Although no plant-level scope 2 emissions data sets were publicly available prior to this project, most steel companies in the US self-report emissions information at the company level, including emission intensity and scope 2 emissions. However, there's no standard for these self-reported numbers, so it's challenging to do a comparison without know exactly what definitions and what start and end points these companies are using to define their scope 2 emissions.

We compared the self-reported emissions intensities from some of the top-emitting companies. The self-reported figures were all Scope 1 and 2 combined emissions intensities in metric tons of CO2 per metric ton of steel produced in 2021. These were the most similar metrics we could find, but its not an exact comparison. Below we explore how these reported numbers compare to our calculations.

Nucor reported an intensity of 0.43 in 2021. You can view the report at https://nucor.com/esg (p. 32).

Cleveland-Cliffs reported an intensity of 1.01 in 2021. You can view their report here (p. 62).

Commercial Metals Co reported an intensity of 0.451 in 2021. You can view their report here (p. 28).

Steel Dynamics reported an intensity of 0.42 in 2021. You can view their reports at https://stld.steeldynamics.com/sustainability-reporting/ (p. 41 of the 2021 report).

While many of our calculations are in the same ball park, its important to stress that without comparing emissions from the same manufacturing techniques and product outputs, and using the same standard definitions, its hard to use self-reported data like this for meaningful comparison. For example, Steel Dynamics reports their emissions intensity for cast steel, while Cleveland-Cliffs reports it for crude steel.

It was reassuring to the project team that our methods lead to results similar to industry reported numbers, but there is still a ways to go for full data transparency in the industry.