## ENVIRONMENTAL PRODUCT DECLARATION

# STEEL REINFORCING BAR AND MERCHANT BAR PRODUCTS

NUCOR CORPORATION

The Nucor Bar Mill Group produces recycled steel bar products at scrap- based mills strategically located across the United States. These mills produce a broad range of steel products, including concrete reinforcing bars (rebar), hot- rolled bars, rounds, light shapes, structural angles, channels, wire rod and highway products in carbon and alloy steels. Nucor's bar products are made with 97% recycled content, and the capacity of Nucor's rebar and merchant bar mills is estimated at approximately 7 million tons per year.

Nucor is North America's largest recycler, turning approximately 20 million net tons of scrap steel in 2019 into new steel. Nucor uses Electric Arc Furnace (EAF) technology all of its steel recycling facilities. EAFs use post-consumer scrap as its major feedstock, unlike traditional blast furnace steelmaking, which produces more than 70% of the world's steel using mined iron ore and metallurgical coal as feedstock.

Through its use of EAFs, Nucor's energy intensity is 74% lower than the global average, and its greenhouse gas intensity is less than one-third the global average, and nearly one-fifth of the average integrated (BF/BOF) steel producer.

# ENVIRONMENTAL PRODUCT DECLARATION

NUCOR®

**Steel Reinforcing Bar and Merchant Bar**
Designated Steel Construction Product

**According to ISO 14025, and ISO 21930:2017**

| | |
|---|---|
| EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE | UL ENVIRONMENT<br>333 PFINGSTEN ROAD NORTHBROOK, IL 60611 |
| GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER | GENERAL PROGRAM INSTRUCTIONS V2.7 2022 |
| MANUFACTURER NAME AND ADDRESS | Nucor Corporation, 1915 Rexford Road, Charlotte, North Carolina 28211 |
| DECLARATION NUMBER | 4790372675.101.1 |
| DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT | Steel Reinforcing Bar and Merchant Bar, 1 metric ton |
| REFERENCE PCR AND VERSION NUMBER | Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL Environment, V3.2, 12.12.2018) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 08.26.2020). |
| DESCRIPTION OF PRODUCT APPLICATION/USE | Fabricated steel reinforcing bar and merchant bar used in construction |
| PRODUCT RSL DESCRIPTION (IF APPL.) | N/A |
| MARKETS OF APPLICABILITY | North America |
| DATE OF ISSUE | June 24, 2022 |
| PERIOD OF VALIDITY | 5 Years |
| EPD TYPE | Product-Specific |
| EPD SCOPE | Cradle to Gate |
| YEAR(S) OF REPORTED PRIMARY DATA | 2019 |
| LCA SOFTWARE & VERSION NUMBER | GaBi v10.5.1.124 |
| LCI DATABASE(S) & VERSION NUMBER | GaBi 2021.2 |
| LCIA METHODOLOGY & VERSION NUMBER | TRACI 2.1, EN 15804 |

| | |
|---|---|
| The PCR review was conducted by: | UL Environment<br>PCR Review Panel<br>epd@ul.com |
| This declaration was independently verified in accordance with ISO 14025: 2006.<br>☐ INTERNAL ☒EXTERNAL | Cooper McC<br>Cooper McCollum, UL Environment |
| This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by: | **Trinity Consultants** |
| This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by: | Thomas P. Gloria, Industrial Ecology Consultants |

LIMITATIONS
The environmental impact results of steel products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the steel product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. Environmental declarations from different programs (ISO 14025) may not be comparable.

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report," v3.2 (December 2018), in conformance with ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017).

# 1. PRODUCT DEFINITION AND INFORMATION

## Description of Organization

This environmental product declaration (EPD) represents recycled bar steel products produced at Nucor Steel Auburn, Inc. (NY), Nucor Steel Birmingham Inc. (AL), Nucor Steel Connecticut, Inc.(CT), Nucor Steel Jackson, Inc. (MS), Nucor Steel Texas (TX), Nucor Steel Kankakee, Inc. (IL), Nucor Steel Kingman, LLC (AZ), Nucor Steel Marion, Inc. (OH), and Nucor Steel Utah (UT).

The rebar and merchant bar products produced at these 9 facilities are produced with nearly 100 percent pre-and-post consumer scrap steel as feedstock without the need for a pure iron source. The overall recycled steel content of Nucor's Bar Steel Products (% by Total Weight) is 97.0 percent. In addition, all of the steel produced by Nucor is 100% recyclable at the end of its useful life.

The feedstock for our recycled steel facilities is largely provided by Nucor's wholly-owned subsidiary, the David J. Joseph Company (DJJ). DJJ operates more than 60 scrap recycling facilities within close proximity to our mills that process approximately 5,000,000 tons of ferrous scrap annually and provide an abundant supply of scrap to our bar mills. By having an abundant and reliable supply of recycled scrap within close proximity not only gives Nucor's bar mills a logistical and economic advantage over their competitors, but also a carbon footprint that is a fraction of the average steel producer.

The newest mills in the bar mill group are our rebar micro-mills in Sedalia, Missouri and Frostproof, Florida. The mill in Missouri began operating in January 2020, while the Florida mill came online in December 2020. Nucor has invested nearly half a billion dollars in these two state-of-the-art steel recycling facilities, which will each produce up to 350,000 tons of American-made rebar per year for the local Florida and Kansas City construction markets.

## Product Description

Steel reinforcing bar (steel rebar) assemblies are used in building and road/bridge projects where they are embedded in concrete. These products are rolled round deformed bars which are further detailed, cut, bent and/or tied into assemblies to prepare for installation. Additionally, merchant bar quality (MBQ) steel shapes are angles, flats, rounds, channels and others used in a variety of building, industrial and equipment products. For use in the construction market, they are detailed, cut, drilled, bolted, welded and otherwise processed at the fabricator to be prepared for installation.

Steel bar produced by Nucor's bar mill are defined by the following ASTM standards:

- **ASTM A36/A36M-19** Standard Specification for Carbon Structural Steel
- **ASTM A529/A529M-19** Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality [Grades 50, 55]
- **ASTM A709/A709M-18** Standard Specification for Structural Steel for Bridges [Grades 36, 50]
- **ASTM A572/A572M-21** Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel [Grades 50, 55]
- **ASTM A615/A615M-20** Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement [Grades 40, 60, 75, 80, 100]
- **ASTM A706/A706M-16** Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement [Grades 60, 80]
- **ASTM F1554-20** Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength [Grade 55]
- **ASTM A588/A588M-19** Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance [Grade B]
- **ASTM A29/A29M-20** Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot- Wrought [Grades 1006, 1008, 1010, 1012, 1015, 1018, 1022, 1045, 1527, 4140]
- **CSA G40.20-13/G40.21-13** General Requirements for rolled or welded structural quality steel / Structural quality steel [Grades 44W, 50W, 55W]
- **CSA G30.18M-09 (R2014)** Carbon steel bars for concrete reinforcement [Grades 400R, 500R, 400W, 500W]

## Product Average

The 2019 production data used in this EPD considers reinforcing steel bars and Merchant Bar Quality products produced by Nucor Corporation during the year. The products are manufactured at the locations listed above and in the results section. Results are weighted according to production totals at the locations based on the 2019 data. Facility-specific global warming potential results are provided in a separate table.

## Application

Reinforcing steel bars and MBQ products are used in a wide variety of applications. These products are rolled into a variety of shapes such as rebar, flats, angles, rounds, square and specialty shapes that are detailed, cut, drilled, bolted, welded, and otherwise processed at the fabricator in order to prepare them for installation.

## Declaration of Methodological Framework

The scope of the EPD is cradle-to-gate, including raw material extraction and processing, upstream transportation, and product manufacture (Modules A1, A2, and A3).

## Technical Requirement

Technical data for the studied product can be found in the table below.

**Table 1. Technical data for steel product**

| NAME | VALUE | UNIT |
|---|---|---|
| Density | 7,800 | kg/m$^3$ |
| Melting point | 1425-1450 | °C |
| Electrical conductivity at 20°C | NA | % of IAC[8] |
| Thermal conductivity | NA | W/(m-K) |
| Coefficient of thermal expansion | NA | m/m-ºC |
| Modulus of elasticity | NA | N/mm$^2$ |
| Shear modulus | NA | N/mm$^2$ |
| Specific heat capacity | NA | J/kg-ºC |
| Hardness, Brinell Number | 80-100 | HB |
| Yield strength | 250-550 | N/mm$^2$ |
| Ultimate tensile strength | 410-655 | N/mm$^2$ |
| Breaking elongation | 13-20 | % |
| Chemical composition | Varies by ASTM Specification/Grade | % by mass |

## Properties of Declared Product as Delivered

The reinforcing bar or MBQ can be fabricated (i.e., cut or otherwise modified) by a fabricator or shipped directly to a job site. This EPD addresses fabricated product.

## Material Composition

Steel bar products are manufactured entirely from carbon steel. They do not contain any materials or substances for which there exists a route to exposure that leads to humans or flora/fauna in the environment being exposed to said materials or substances

at levels exceeding safe health thresholds.

## Manufacturing

Nucor manufactures bar products from secondary steel (i.e., from steel scrap) via an electric arc furnace (EAF). Steel scrap is loaded into a refractory-lined vessel and melted via electric energy supplied through graphite electrodes. Oxy- fuel burners and other means of generating heat through chemical reactions are also employed. The chemistry of the molten steel is adjusted at this stage by adding material to attain a specific alloy composition and by removing impurities, which migrate to the slag. Once the desired chemical composition is attained, the molten steel is then cast into billets for eventual processing in the rolling mill located in the same facility.

At the rolling mill, the billets are reheated in a natural gas furnace and run through rollers to shape their profile. Any steel scrap generated is recycled internally (i.e., put back into the EAF). The finished products are packaged and loaded onto trucks or rail cars for distribution to fabricators or job sites.

Steel products are transported via rail or truck to downstream fabrication facilities. At these facilities, the steel is cut, rolled, or bent before being sold to consumers. Finished steel is also sold to distributers for consumer use.
The life cycle phases included in this study are illustrated in Figure 1.

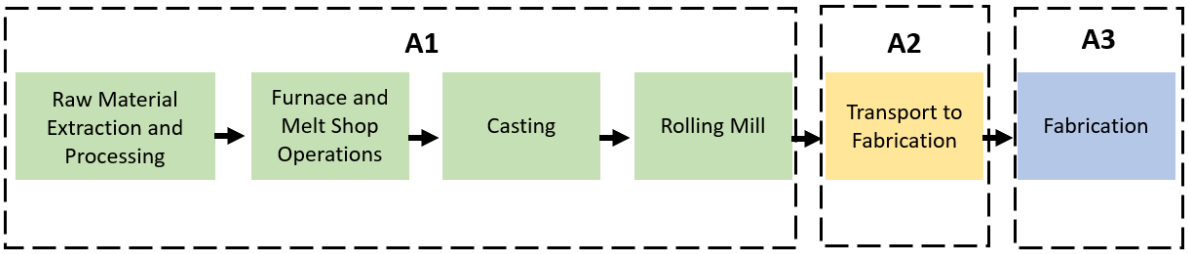


**Figure 1: Flow chart for product system**

## 2. LCA CALCULATION RULES

### Declared Unit
The declared unit is 1 metric ton of fabricated steel product. An alternative declared unit of 1 short ton is also presented.

### System Boundary
Per the PCR, this cradle-to-gate analysis provides information on the Product Stage of the steel product life cycle, including modules A1, A2, and A3. Product delivery, installation and use, and product disposal (modules A4 – A5, B1 – B7, C1 – C4, and D) have not been included.

| PRODUCT STAGE | | | CONSTRUCTION PROCESS STAGE | | USE STAGE | | | | | | | END OF LIFE STAGE | | | | BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Raw material supply | Transport | Manufacturing | Transport from gate to site | Assembly/Install | Use | Maintenance | Repair | Replacement | Refurbishment | Building Operational Energy Use During Product Use | Building Operational Water Use During Product Use | Deconstruction | Transport | Waste processing | Disposal | Reuse, Recovery, Recycling Potential |
| **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** |
| X | X | X | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND |

X = Module declared
MND = Module not declared

### Cut-off Rules
No cut-off criteria are defined for this study. The system boundary was defined based on relevance to the goals of the study. For the processes within the system boundary, all available energy and material flow data have been included in the model. In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts.

### Data Sources
The LCA model was created using the GaBi Software system for life cycle engineering, version 10.5.1.124, developed by Sphera (Sphera, 2021). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2021.2 database. Primary manufacturing data and fabrication data were provided by Nucor.

### Data Quality
A variety of tests and checks were performed by the LCA practitioner throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of project-specific LCA models as well as the background data used.

## Geographical Coverage

Primary data represents production in the United States at the following Nucor facilities:

- Nucor Steel Auburn, Inc. (NY)
- Nucor Steel Birmingham Inc. (AL)
- Nucor Steel Connecticut, Inc. (CT)
- Nucor Steel Jackson, Inc. (MS)
- Nucor Steel Texas (TX)
- Nucor Steel Kankakee, Inc. (IL)
- Nucor Steel Kingman, LLC (AZ)
- Nucor Steel Marion, Inc. (OH)
- Nucor Steel Utah (UT)

Fabrication data represents production in the United States at two downstream fabrication facilities.

Regionally specific datasets, where available, were used to represent each manufacturing location's energy consumption. Proxy datasets were used as needed for raw material inputs to address lack of data for a specific material or for a specific geographical region. These proxy datasets were chosen for their technological representativeness of the actual materials.

## Period under Review

Primary data collected represent production during the 2019 calendar year. This analysis is intended to represent production in 2019.

## Allocation

Co-products during steel mill operations are allocated using a method developed by the World Steel Association and EUROFER (Worldsteel and EUROFER, 2014) reviewed to be in line with CEN EN 15804 (CEN, 2019). The methodology takes into account the manner in which changes in inputs and outputs affect the production of co- products. The method also takes account of material flows that carry specific inherent properties.

Mill outputs such as scale and baghouse dust are handled via system expansion in line with the Worldsteel and EUROFER methodology. Recovered materials are assumed to substitute on a 1:1 mass basis. Mill scale is substituted with iron ore and baghouse dust is substituted for zinc or iron ore, depending on its specific zinc and iron contents.

## Estimates and Assumptions

The underlying study was conducted in accordance with the PCR. While this EPD has been developed by industry experts to best represent the product system, real life environmental impacts of fabricated steel products may extend beyond those defined in this document.

All of the raw materials and energy inputs have been modeled using processes and flows that closely follow actual production data on raw materials and processes. All of the reported material and energy flows have been accounted for.

Transportation distances were provided by some mills for the inbound transportation of purchased steel scrap. These distances were used to estimate scrap transport and applied to all purchased scrap, even for mills that did not provide data. Other key materials were assumed to be transported 250 miles via truck and 250 miles via rail. The average inbound transport from steel mill to fabricator was taken from the industry average EPDs created by the American Institute of Steel Construction (AISC) and the Concrete Reinforcing Steel Institute (CRSI) (AISC, 2016; CRSI, 2017). The distances were 323 miles (520 km) by rail and 174 miles (280 km) by truck.

# 3. LCA RESULTS

LCIA results are relative expressions and do not predict actual impacts, the exceeding of thresholds, safety margins or risks.

## Unfabricated Bar Results

Legislation, such as the Buy Clean California Act (BCCA)[1], allows for the exclusion of emissions that occur during the fabrication stages in reporting total Global Warming Potential (GWP) results. Therefore, this LCA report provides separate, pre-fabrication GWP results for Buy Clean legislation compliance.

**Table 2. LCIA results, per 1 metric ton (unfabricated)**

| GWP [MT $CO_2$ eq.] | A1 | A2 | A3 | TOTAL |
|---|---|---|---|---|
| Auburn | 2.18E-01 | 1.02E-02 | 3.46E-01 | 5.75E-01 |
| Birmingham | 2.27E-01 | 2.23E-02 | 4.10E-01 | 6.59E-01 |
| Connecticut | 6.94E-01 | 9.54E-02 | 1.18E-01 | 9.07E-01 |
| Jackson | 2.08E-01 | 4.22E-02 | 5.32E-01 | 7.82E-01 |
| Kankakee | 2.16E-01 | 3.52E-02 | 4.66E-01 | 7.18E-01 |
| Kingman | 4.06E-01 | 1.53E-01 | 2.58E-01 | 8.17E-01 |
| Marion | 2.15E-01 | 1.54E-02 | 6.08E-01 | 8.38E-01 |
| Texas | 2.54E-01 | 2.51E-02 | 4.33E-01 | 7.13E-01 |
| Utah | 2.07E-01 | 3.73E-02 | 4.01E-01 | 6.45E-01 |

## Fabricated Bar Results

Fabrication requires 1.08 metric tons of bar per 1 metric ton of fabricated product. A1 includes production of all 1.08 metric tons of bar.

**Table 3. LCIA results, per 1 metric ton (fabricated)**

| PARAMETER | UNIT | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| GWP 100 | kg CO2 eq. | 7.60E+02 | 2.39E+01 | 8.96E+00 | 7.93E+02 |
| ODP | kg CFC 11 eq. | 2.46E-12 | 5.76E-15 | 2.02E-10 | 2.05E-10 |
| AP | kg SO2 eq. | 1.69E+00 | 6.82E-02 | 2.70E-01 | 2.03E+00 |
| EP | kg N eq. | 8.09E-02 | 7.84E-03 | 1.70E-02 | 1.06E-01 |
| SFP | kg O3 eq. | 2.88E+01 | 1.56E+00 | 8.15E+00 | 3.85E+01 |
| ADPfossil | MJ surplus | 8.89E+02 | 4.47E+01 | 3.76E+01 | 9.72E+02 |

[1] Per the Buy Clean California Act Legislative Report, fabrication refers to the processing of materials in preparation for use at the construction jobsite (e.g., bending, cutting, drilling, and painting). DGS General Services. “Buy Clean California Act – Legislative Report”. January 1, 2022. https://www.dgs.ca.gov/Resources/Legislative-Reports

**Table 4. LCIA results, per 1 short ton (fabricated)**

| PARAMETER | UNIT | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| GWP 100 | kg CO2 eq. | 6.90E+02 | 2.17E+01 | 8.13E+00 | 7.19E+02 |
| ODP | kg CFC 11 eq. | 2.23E-12 | 5.23E-15 | 1.83E-10 | 1.86E-10 |
| AP | kg SO2 eq. | 1.53E+00 | 6.18E-02 | 2.45E-01 | 1.84E+00 |
| EP | kg N eq. | 7.34E-02 | 7.12E-03 | 1.54E-02 | 9.59E-02 |
| SFP | kg O3 eq. | 2.61E+01 | 1.41E+00 | 7.39E+00 | 3.49E+01 |
| ADPfossil | MJ surplus | 8.07E+02 | 4.06E+01 | 3.41E+01 | 8.81E+02 |

**Table 5. Resource use results, per 1 metric ton (fabricated)**

| PARAMETER | UNIT | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| RPRE | MJ LHV | 1.37E+03 | 1.48E+01 | 1.21E+02 | 1.50E+03 |
| $RPR_M$ | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRPRE | MJ LHV | 1.01E+04 | 3.38E+02 | 4.20E+02 | 1.08E+04 |
| $NRPR_M$ | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| SM | kg | 1.04E+03 | 0.00E+00 | 0.00E+00 | 1.04E+03 |
| RSF | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRSF | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| RE | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| FW | $m^3$ | 4.48E+00 | 6.22E-02 | 8.23E-02 | 4.62E+00 |

**Table 6. Resource use results, per 1 short ton (fabricated)**

| PARAMETER | UNIT | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| RPRE | MJ LHV | 1.24E+03 | 1.34E+01 | 1.10E+02 | 1.36E+03 |
| $RPR_M$ | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRPRE | MJ LHV | 9.13E+03 | 3.07E+02 | 3.81E+02 | 9.82E+03 |
| NRPRM | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| SM | kg | 9.40E+02 | 0.00E+00 | 0.00E+00 | 9.40E+02 |
| RSF | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRSF | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| RE | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| FW | $m^3$ | 4.06E+00 | 5.64E-02 | 7.46E-02 | 4.19E+00 |

**Table 7. Output flows and waste categories results, per 1 metric ton (fabricated)**

| PARAMETER | UNIT | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| HWD | kg | 1.30E-06 | 2.83E-08 | 3.31E-08 | 1.36E-06 |
| NHWD | kg | 8.77E+00 | 3.14E-02 | 1.61E-01 | 8.96E+00 |
| HLRW | kg | 5.55E-04 | 1.19E-06 | 1.60E-05 | 5.73E-04 |
| ILLRW | kg | 5.13E-03 | 1.10E-05 | 1.49E-04 | 5.29E-03 |
| CRU | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| MR | kg | 1.82E+01 | 0.00E+00 | 0.00E+00 | 1.82E+01 |
| MER | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EE | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

**Table 8. Output flows and waste categories results, per 1 short ton (fabricated)**

| PARAMETER | UNIT | A1 | A2 | A3 | Total |
|---|---|---|---|---|---|
| HWD | kg | 1.18E-06 | 2.57E-08 | 3.00E-08 | 1.24E-06 |
| NHWD | kg | 7.96E+00 | 2.85E-02 | 1.46E-01 | 8.13E+00 |
| HLRW | kg | 5.04E-04 | 1.08E-06 | 1.45E-05 | 5.19E-04 |
| ILLRW | kg | 4.65E-03 | 9.95E-06 | 1.35E-04 | 4.80E-03 |
| CRU | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| MR | kg | 1.65E+01 | 0.00E+00 | 0.00E+00 | 1.65E+01 |
| MER | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EE | MJ LHV | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

To align with the PCR, “product specific EPDs which include averaging shall report the range of results for all TRACI indicators for products included in the average.” Transportation to fabricator represents the US average and fabrication represents average Nucor-specific data; therefore, they do not change between sites.

**Table 9. LCIA results, variation per 1 metric ton (fabricated)**

| PARAMETER | UNIT | A1 (MIN) | A1 (MAX) | A2 | A3 | Total (Min) | Total (Max) |
|---|---|---|---|---|---|---|---|
| GWP 100 | kg CO2 eq. | 6.21E+02 | 9.80E+02 | 2.39E+01 | 8.96E+00 | 6.54E+02 | 1.01E+03 |
| ODP | kg CFC 11 eq. | 7.24E-13 | 5.27E-12 | 5.76E-15 | 2.02E-10 | 2.03E-10 | 2.08E-10 |
| AP | kg SO2 eq. | 1.26E+00 | 2.67E+00 | 6.82E-02 | 2.70E-01 | 1.59E+00 | 3.00E+00 |
| EP | kg N eq. | 4.48E-02 | 1.57E-01 | 7.84E-03 | 1.70E-02 | 6.96E-02 | 1.82E-01 |
| SFP | kg O3 eq. | 1.77E+01 | 5.27E+01 | 1.56E+00 | 8.15E+00 | 2.74E+01 | 6.25E+01 |
| ADPfossil | MJ surplus | 6.84E+02 | 1.29E+03 | 4.47E+01 | 3.76E+01 | 7.66E+02 | 1.38E+03 |

**Table 10. LCIA results, variation per 1 short ton (fabricated)**

| PARAMETER | UNIT | A1 (MIN) | A1 (MAX) | A2 | A3 | Total (Min) | Total (Max) |
|---|---|---|---|---|---|---|---|
| GWP 100 | kg CO2 eq. | 5.63E+02 | 8.89E+02 | 2.17E+01 | 8.13E+00 | 5.93E+02 | 9.19E+02 |
| ODP | kg CFC 11 eq. | 6.57E-13 | 4.78E-12 | 5.23E-15 | 1.83E-10 | 1.84E-10 | 1.88E-10 |
| AP | kg SO2 eq. | 1.14E+00 | 2.42E+00 | 6.18E-02 | 2.45E-01 | 1.45E+00 | 2.73E+00 |
| EP | kg N eq. | 4.06E-02 | 1.42E-01 | 7.12E-03 | 1.54E-02 | 6.31E-02 | 1.65E-01 |
| SFP | kg O3 eq. | 1.61E+01 | 4.79E+01 | 1.41E+00 | 7.39E+00 | 2.49E+01 | 5.67E+01 |
| ADPfossil | MJ surplus | 6.21E+02 | 1.17E+03 | 4.06E+01 | 3.41E+01 | 6.95E+02 | 1.25E+03 |

# 4. LCA INTERPRETATION

The below figure presents the relative contribution of the A1, A2, and A3 modules to the total.

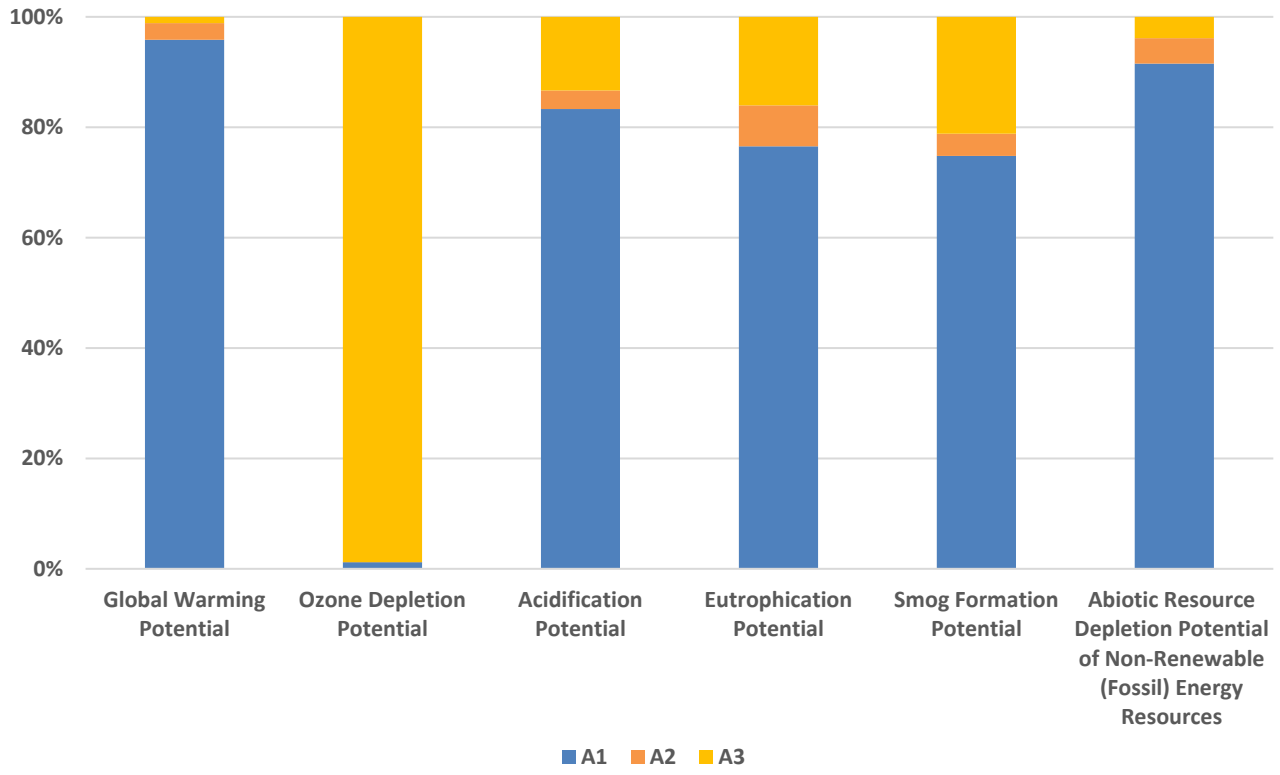


**Figure 2: Relative contributions by module, TRACI 2.1 impact categories**

The impact assessment results indicate that Module A1, i.e. raw material procurement, including the manufacturing, purchased electricity generation, on-site natural gas and diesel combustion, and facility emissions associated with the production of unfabricated steel bar, is the key contributor to the potential environmental impact for global warming potential, acidification potential, eutrophication, smog formation, and abiotic resource depletion potential of non-renewable (fossil) energy resources. Module A3, i.e. fabrication, is a key contributor to ozone depletion potential. Module A2, i.e. transport to fabricator, is not the most significant contributor to any impact category.

## Facility-Specific GWP 100 Results

Nucor bar product may be shipped from any one of Nucor's different bar mills. The results presented previously represent a production-weighted average of nine of these facilities. To understand how the Global Warming Potential (GWP) may vary between sites, facility-specific GWP100 results are presented below, per metric ton. Results are presented for bar at the mill level, which excludes impacts from the additional material requirements associated with the scrap generated during fabrication.

**Table 11: Facility-specific GWP100 results, per 1 metric ton (fabricated)**

| GWP [KG $CO_2$ EQ.] | A1 | A2 | A3 | Total |
|---|---|---|---|---|
| Auburn | 6.21E+02 | 2.39E+01 | 8.96E+00 | 6.54E+02 |
| Birmingham | 7.12E+02 | 2.39E+01 | 8.96E+00 | 7.45E+02 |
| Connecticut | 9.80E+02 | 2.39E+01 | 8.96E+00 | 1.01E+03 |
| Jackson | 8.45E+02 | 2.39E+01 | 8.96E+00 | 8.78E+02 |
| Kankakee | 7.76E+02 | 2.39E+01 | 8.96E+00 | 8.08E+02 |
| Kingman | 8.83E+02 | 2.39E+01 | 8.96E+00 | 9.16E+02 |
| Marion | 9.05E+02 | 2.39E+01 | 8.96E+00 | 9.38E+02 |
| Texas | 7.70E+02 | 2.39E+01 | 8.96E+00 | 8.03E+02 |
| Utah | 6.97E+02 | 2.39E+01 | 8.96E+00 | 7.29E+02 |

**Table 12: Facility-specific GWP100 results, per 1 short ton (fabricated)**

| GWP [KG $CO_2$ EQ.] | A1 | A2 | A3 | Total |
|---|---|---|---|---|
| Auburn | 5.63E+02 | 2.17E+01 | 8.13E+00 | 5.93E+02 |
| Birmingham | 6.46E+02 | 2.17E+01 | 8.13E+00 | 6.76E+02 |
| Connecticut | 8.89E+02 | 2.17E+01 | 8.13E+00 | 9.19E+02 |
| Jackson | 7.67E+02 | 2.17E+01 | 8.13E+00 | 7.96E+02 |
| Kankakee | 7.04E+02 | 2.17E+01 | 8.13E+00 | 7.33E+02 |
| Kingman | 8.01E+02 | 2.17E+01 | 8.13E+00 | 8.31E+02 |
| Marion | 8.21E+02 | 2.17E+01 | 8.13E+00 | 8.51E+02 |
| Texas | 6.99E+02 | 2.17E+01 | 8.13E+00 | 7.28E+02 |
| Utah | 6.32E+02 | 2.17E+01 | 8.13E+00 | 6.62E+02 |

# 5. ADDITIONAL ENVIRONMENTAL INFORMATION

## Health and Safety

Refer to the Nucor Bar SDS[2] for additional environmental and health protection during the product manufacturing process. Be sure to follow all recommended handling and product manufacturing guidance.

**Safety:** Since 2005, Nucor has partnered with the Occupational Safety and Health Administration (OSHA) through its Voluntary Protection Program (VPP), which recognizes companies that voluntarily go the extra mile to meet rigorous safety standards. The Voluntary Protection Program (VPP) recognizes employers and workers in private industry and federal agencies who have implemented effective safety and health management systems and maintain injury and illness rates below national Bureau of Labor Statistics averages for their respective industries. An important aspect of VPP is the Special Government Employee (SGE) Program, which allows industry employees to work alongside OSHA and of which approximately 640 Nucor employees are active participants as of September 2018.

In terms of safety, 7 of Nucor's rebar and merchant bar mills have attained their VPP certification from the federal OSHA, which is OSHA's highest level of recognition that few manufacturers achieve, and demonstrates our commitment to leading the industry by example. The seven steel recycling facilities in Nucor's Bar Mill Group that have VPP status are: Nucor Steel Auburn Inc. (NY), Nucor Steel Jackson, Inc. (MS), Nucor Steel Kankakee, Inc. (IL), Nucor Steel Kingman, LLC (AZ), Nucor Steel Marion, Inc. (OH), Nucor Steel Seattle, Inc., and Nucor Steel – Texas.

Four Nucor divisions employ the American National Standards Institute (ANSI) Z-10 Occupational Health and Safety Management System. And four others participate in the OSHA Series (OSHAS) 45001 Divisions. ANSI Z-10 is audited to best practices and in safety and health. OSHAS 45001 is an international safety and health system that provides a framework to promote better safety and health systems.

## Environmental Activities and Certifications

**ISO 14001:2015 Environmental Management System:** The environmental performance of Nucor's bar steel mills focuses on continuous improvement through internal and external training, application of new technologies and how data and results are communicated. To provide a framework for Nucor teammates to follow, Nucor utilizes ISO 14001, which is the international standard that establishes specific requirements for an effective environmental management system (EMS). All of Nucor's steelmaking operations are ISO 14001 certified. Achieving ISO 14001 certification means that each of Nucor's steel mills has put an environmental management system in place with measurable targets and objectives, such as reducing the use of oil and grease and minimizing electricity use, and has implemented site-wide recycling programs.

Many of our facilities have incorporated energy efficiency targets to reduce both cost and environmental impacts into their environmental management systems. These environmental management systems help facilitate compliance with our environmental commitment, which is every Nucor teammate's responsibility. Nucor's environmental program maintains a high level of ongoing training, commitment, outreach and visibility.

**Sustainability:** Through recycling, Nucor has made the United States the cleanest place in the world to make steel. We are producing the sustainable steel that will build our modern 21st century economy. For more than 50 years, Nucor has been making steel using an electric arc furnace (EAF) that melts recycled scrap and turns it into new steel. EAFs are far less energy intensive and more energy efficient than traditional blast furnace steel making. Electric arc furnaces allow Nucor to produce less emissions than competitors who often make steel by melting iron ore and coking coal.

By recycling scrap in EAFs, Nucor's energy intensity (average gigajoules per metric ton of steel produced) is 74% lower than the

[2] https://assets.ctfassets.net/aax1cfbwhqog/UcLHwfmcRVoyrpxb15vZl/c73a00f2a213af726e2ef74584c79517/SDS-Bar_Steel.pdf

global average, and its greenhouse gas intensity (metric tons $CO_2$ per ton of steel produced) is less than one-third the global average, and nearly one-fifth of the average integrated (BF/BOF) steel producer. Today, Nucor's greenhouse gas emissions intensity is less than one-third of the Paris Climate Agreement's most aggressive 2030 target for the global steel sector, the below 2 degrees Celsius benchmark compared to pre-industrial levels.

Today, Nucor accounts for more than 25% of the United States' steel production, but only accounts for 8% of the domestic steel industry's greenhouse gas emissions. However, Nucor realizes that being one of America's cleanest and most efficient steelmakers is not enough. That is why Nucor is committing to a 35% combined reduction in its steel mill Scope 1 and Scope 2 greenhouse gas intensity by 2030, measured against a 2015 baseline. This goal will take Nucor's steel mill CO2 emissions down to 77% less than today's global steelmaking average, and 82% less than today's integrated steelmaking average. Beyond 2030, Nucor is committed to further reducing its greenhouse emissions to a goal of net zero emission steel at scale.

Nucor also recently launched its Econiq™ product line, which is the world's first net-zero steel available at scale. Econiq is not a single product; it is a net-zero certification, which can be applied to any product from Nucor's steel mills by balancing the CO2 produced by our activities by an equivalent amount being removed. We achieve net-zero on Econiq products by eliminating all remaining Scope 2 emissions (by using 100% renewable electricity certificates) and by offsetting all Scope 1 emissions (through the purchase of carbon offsets). Per the requirements of the Product Category Rule for Building-Related Products and Services in North America, Part A, Renewable Electricity Certificates are not included in this LCA. Nucor shipped its first Econiq steel to a commercial customer in January 2022.

**Recycled Materials Content**: Nucor proudly uses recycled scrap to make high-quality steel with low emissions, using one of the cleanest and most energy efficient steel-making processes available. Steel can be infinitely recycled and reused without any quality loss. Nationwide, Nucor steel products are made from an average of 75.4% recycled content, with some products containing almost 100% recycled content.

Globally, only 26.3% of the more than 2 billion net tons of steel produced in 2020 was made by recycling scrap in EAFs – and EAFs only accounted 9.2% of the 1.17 billion net tons of steel made in China. Scrap inputs for the total crude steel production globally have remained at around 35% since 2013. To effectively address the goals set by the Paris Climate Agreement, the International Energy Agency recommends that the global market share needs to reach over 40% by 2030.

**Waste and Water Recycling**: Nucor's EAFs, including the ones at its bar steel mills, emit less than 1% of the particulate matter of a traditional steel blast furnace – and the company recycles 99 percent of the EAF dust it collects in its baghouses. Nucor also recognizes that water is a critical natural resource and is essential to our business and the communities in which it operates. Nucor has worked extensively to improve water use efficiency in its processes. One hundred percent of the process water from Nucor's steelmaking operations is recycled multiple times at its bar steel mills. Currently there are no Nucor steel mill division located in a High or Extremely High Water Stress Area.

Nucor also participates in the Network for Business Innovation and Sustainability (NBIS) By-Product Synergy Group. This NBIS group brings together environmental experts from a wide variety of industries to allow them to compare waste streams and find ways to divert materials from landfills.

**Clean Energy**: As America's cleanest and most efficient steel company, Nucor is extending beyond its fence line to lower its carbon footprint by investing in the development of new clean wind and solar power generation capacity. Nucor has recently made two such investments in close proximity to its bar mills.

In November 2020 and March 2021, Nucor entered two Virtual Power Purchase Agreements (VPPAs) which support the development of more than 350 megawatts of new clean energy infrastructure, making Nucor the 7th largest corporate buyer of renewable energy in America, and the largest of any steel producer.

The VPPAs enable the construction of 250MW of new solar energy and 100MW of new wind energy in Texas. Together, these two projects are equal to the electricity usage of nearly 70,000 Texas homes and have the potential to power to the regional electric grid 24-hours a day.

**Environmental Training**: In 2015, Nucor established Nucor Environmental University (NEU), an online training platform for Nucor teammates with environmental responsibilities and others looking to expand their involvement with the environmental team. From the beginning, Nucor designed this program to help teammates develop a thorough and meaningful understanding of environmental compliance. NEU has had over 1,000 active users since its inception and Nucor teammates have completed at least 10,000 environmental training courses, passed over 6,600 training exams, and helped develop dozens of courses. Because of NEU, Nucor's teammates are better prepared to meet the demands of environmental compliance and achieve Nucor's goal of being a sustainable organization.

## 6. REFERENCES


- *CEN. (2019). EN 15804: 2019-04 Sustainability of construction works. Environmental product declarations.*
- *ISO. (2006). ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines.*
- *ISO. (2009). ISO 14040: Environmental management - Life cycle assessment - principles and frameworks.*
- *ISO. (2011). ISO 14025: Environmental labels and declarations - Type III environmental declarations - principles and procedures.*
- *ISO. (2017). ISO 21930 Sustainability in building construction - Environmental declaration of building products.*
- *Sphera. (2021). GaBi LCA Database Documentation. Retrieved from Sphera Solutions, Inc.: http://www.gabi-software.com/america/support/gabi/*
- *UL Environment. (2018). Product Category Rules for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, v3.2.*
- *UL Environment. (2020). General Program Instructions, v2.5.*
- *UL Environment. (2020). Part B: Designated Steel Construction Product EPD Requirements, v2.0.*
- *Worldsteel and EUROFER. (2014). A methodology to determine the LCI of steel industry co-products.*

## 6. CONTACT INFORMATION

### Study Commissioner

NUCOR®

**NUCOR CORPORATION**
1915 Rexford Road
Charlotte, NC 28211
Ph: 704.366.7000
www.nucor.com

### LCA Practitioner

Trinity Consultants

**TRINITY CONSULTANTS, INC.**
12700 Park Central Drive, Suite 2100
Dallas, TX 75251
https://www.trinityconsultants.com/