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Data Article

Cross border adjustment mechanism: Initial data for the assessment of hydrogen-based steel production

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ABSTRACT

Ambitious climate targets affect the competitiveness of industries in the international market. To prevent such industries from moving to other countries in the wake of increased climate protection efforts, cost adjustments may become necessary. Their design requires knowledge of country-specific production costs. Here, we present country-specific cost figures for different production routes of steel, paying particular attention to transportation costs. The data can be used in floor price models aiming to assess the competitiveness of different steel production routes in different countries [1].

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Specifications Table

Subject	Economics
Specific subject area	Energy Economics, Energy Policy
Type of data	Tables Figures
How the data were acquired	The data were acquired by conducting an intensive literature review. In addition, data provided in publicly available databases are used. The data have been processed and adjusted with regard to the research questions.
Data format	Raw Analyzed
Description of data collection	The sources [2–4] are used for providing information on the steel market and steel production routes. Data on techno-economic aspects of steel production options were extracted from [5–7]. Information focusing on the transport of commodities were derived from [8–13].
Data source location	Literature used for acquiring the data for steel production options: [2–13]
Data accessibility	Repository name: Initial Data for Assessment of Cost of Steel Production Data identification number: 10.17632/6bnj5h9w59 Direct URL to data: https://data.mendeley.com/datasets/6bnj5h9w59
Related research article	D. Rübbelke, S. Vögele, M. Grajewski, L. Zobel, Hydrogen-based Steel Production and Global Climate Protection: An Empirical Analysis of the Potential Role of the European Cross Border Adjustment Mechanism, Journal for Cleaner Production. 10.1016/j.jclepro.2022.135040, 2022.

Value of the Data

- The data can be useful for the assessment of cost gaps between green and conventional steel production routes. Thus, the data support the specification of carbon border adjustment measures.
- The data benefit researchers investigating the cost of steel production routes as well as policymakers and stakeholders who are interested in cost gaps between steel produced by using hydrogen and conventional steel production routes.
- In principle the data can be used for other studies on steel production (e.g. assessment of GHG avoidance cost and assessment of transport cost of other commodities).

1. Objective

Aiming to ensure that ambitious reduction targets on greenhouse gases can be reached without significant relocation of energy intensive industries, questions about possible cost gaps arise. Thus, reliable information on production technologies is necessary. One of the sectors which face risk of relocation is the iron and steel industry. This study provides information on cost of producing steel by taking country and production route specific aspects into consideration. Our data aid drawing conclusion on cost gaps, specific greenhouse gas (GHG) avoidance cost and on the competitiveness of different steel production routes.

Currently, the blast furnace/basic oxygen furnace (BF/BOF) and electric arc furnace (EAF) production routes dominate steel production [2]. The BF/BOF route is based on the use of coking coal as key reduction agent for reducing iron ore to pig iron. In a second step, together with ferrous scrap and other additions pig iron is processed in a basic oxygen furnace, and transformed into crude steel products like coils, plates, sections or bars. In the conventional EAF route ferrous scrap is melted using electricity. In principle, this route is less energy and less CO_2-emission intensive than the BF/BOF route [14]. In the DRI process, iron ore and gas are used to produce pig iron. More precisely, iron sponge is generated, which can be further processed into hot briquetted iron. The reducing gas consists most commonly of carbon monoxide and hydrogen and

thus the process emits CO_2 as well as water [15]. Instead of the reduction of iron ore due to a gas mixture of carbon monoxide and hydrogen, pure hydrogen could be used as a reductive to bind the oxygen from the iron ore. After the DRI process, scrap can be added to the sponge iron and processed in the EAF into crude steel. By using hydrogen, the combination of DRI/EAF offers the potential of very low CO_2 emission. However, the EAF process as well as the production of hydrogen requires a greater amount of electricity.

As a result of the different requirements in inputs, the production routes differ in cost. The data being provided in this study aims to support an assessment of competitiveness of steel production routes. An example for a competitiveness assessment using the data is presented in [1].

2. Data Description

"BASICS.pdf" provides information on the current steel market and crude steel production routes. Table 1.1 gives information on the key steel producing countries. This information can serve as starting point for the selection of countries for an assessments of cost gaps.

Technological options for crude steel producing and for reducing GHG emissions in the steel sector are presented in Fig. 1.1 in "BASICS.pdf". It shows the most important steel production routes. Hence, it contributes to better understanding on the differences between the production routes and on data requirements.

"TECH-EC.xlsx" contains information on techno-economic characteristics of the different steel production technologies: Table 2.1 provides information on the demand for inputs needed for different production routes of crude steel by country. The list of inputs includes factor demand for iron ore, scrap, coking coal, hydrogen, electricity, and labor. The cost of the inputs in the raw material suppling countries are presented in Tables 2.2 and 2.3.

Table 2.4 provides information on envisaged profit rates by steel producing country. Information of historical import quotas for different input factors and countries are listed in Table 2.5.

Tables 3.1–3.4 being presented in "TRANS.xlsx" focus on seaborne trade. Information on cost for using Capesize and Panamax vessels are present in Table 3.1. Travel times including congestion and bunkering are presented in Tables 3.2 and 3.3.

In Table 3.4 information on cost being associated with using the Suez Canal is provided (Table 1).

Table 1
Meta information on files being linked to this paper.

File	Description
BASICS.pdf	Overview steel market and crude production routes (Table 1.1, Fig. 1.1)
TECH-EC.xlsx	Techno-economic data on steel production technologies (Tables 2.1–2.5)
TRANS.xlsx	Data on transportation cost of input factors for steel production (Tables 3.1−3.4)

3. Experimental Design, Materials and Methods

Steel production routes differ in the inputs being required and therefore in their levels of production cost and GHG emissions. Since prices for inputs and efficiencies differ by country, for an assessment of technologies countries specific information is needed. This requirement frames the data acquirement for this study. In particular, we looked for country specific data on steel production routes. In addition, we looked for data on transport cost of commodities (e.g., iron ore, scrap, coking coal). The information on production cost (including transport cost) can be used, for instance, in a floor-price model [1]. Such a model can enable us to draw conclusion

on cost gaps between countries and on financial requirements to prevent green steel production from Europe [1].

Our data is extracted from well-known sources that continuously provide information on the steel sector. In particular, we use data of Steelonthenet.com. Steelonthenet.com is a steel industry news and information portal information portal being launched in 2001 [6]. As important sources for shipping we used published data of Bunker Index [8], Ship & Bunker [11] and Clarkson [9] as sources. We verified the data of these sources by comparing them with aggregated figures being published by OCED [3,16], Joint Research Center [17] and the World Steel Association [2,14], or published in reviewed papers (e.g., [5,18,19]).

Ethics Statements

The data reported in this paper do not involve any experiments on humans. Moreover, the secured data neither contain any personal information about the deceased nor any information about the hospitals where they were received or kept after the accident. Hence, no ethics approval was needed for this study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Initial Data for Assessment of Cost of Steel Production (Original data) (Mendeley Data).

CRediT Author Statement

Dirk Rübbelke: Conceptualization, Supervision, Writing – review & editing; **Stefan Vögele:** Methodology, Software, Writing – original draft; **Matthias Grajewski:** Investigation, Methodology, Software, Visualization, Writing – review & editing; **Luzy Zobel:** Data curation.

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