Data in Brief 36 (2021) 107046

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Industrial carbon emission intensity: A comprehensive dataset of European regions

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ARTICLE INFO

Article history:
Received 1 March 2021
Revised 30 March 2021
Accepted 6 April 2021
Available online 10 April 2021

Keywords:
Sustainability transitions
Carbon emission intensity
CO2 emissions
GDP
NUTS
Longitudinal data

ABSTRACT

The dataset has been developed within the framework of the EU EIT-Climate Kic Flagship Project "*Re*-Industrialise" and it includes data of Carbon Emission Intensity (CEI) from industrial sources for the European Regions. CEI is considered as a proxy for analysing the Industrial Sustainability Transition pathways and is calculated as the ratio between CO2 equivalent emissions ($CO2_e$) and Gross Domestic Product (GDP) of the industrial sector over a nine-year timespan, i.e. from 2008 to 2016. $CO2_e$ data at plant level have been retrieved from EU Emission Trading System (EU ETS) register and aggregated at different geographical scales, corresponding to the nested structure of NUTS (Nomenclature of Territorial Units for Statistics), proposed by EUROSTAT. Industrial GDP data have been selected from EUROSTAT database to match the industrial sectors covered by EU ETS.

DOI of original article: 10.1016/j.ecolecon.2021.106968
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https://doi.org/10.1016/j.dib.2021.107046

Specifications Table

Subject	Business, Management and decision sciences
Specific subject area	The data refers to the subject area of Sustainability Transitions Management, with particular regards to the industrial sector.
Type of data	Table
How data were acquired	Primary data have been retrieved from international, open datasets (EU ETS and EUROSTAT). The aggregation and elaboration of data have been accomplished by MS Excel.
Data format	Analyzed
Parameters for data collection	For CO2e data, all industrial sectors covered by EU ETS have been included into the data collection. Emissions from industrial plants have been considered, starting either from the beginning of the period of analysis (i.e. 2008–2016) or the moment they entered the register. GDP data have been limited to the industrial sectors corresponding to EU ETS coverage.
Description of data collection	Primary data of verified CO2 emissions have been collected from the EU-ETS registry. As the database can only be queried one installation at a time, a script has been developed for data retrieval, and substantial data consistency checks have been performed to ensure its robustness. Geographical references, in terms of NUTS, have been added manually to allow the aggregation at different geographical scales (i.e. NUTS 2–1–0). Data on Industrial GDP have been retrieved from EUROSTAT database, at current market prices by NUTS 3 regions and then aggregated for higher geographical scales.
Data source location	For CO2e emissions data: https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1 For GDP data: https://ec.europa.eu/eurostat/data/database
Data accessibility	• With the article (supplementary materials, namely "EU-ETS dataset_2008–2016" for primary data; "CEI dataset" for aggregated data) • http://dx.doi.org/10.17632/shm45fmjcx.1
Related research article	[1] Mura, M., Longo, M., Toschi, L., Zanni, S., Visani, F., Bianconcini, S. The role of geographical scales in sustainability transitions: An empirical investigation of the European industrial context. Ecol Econ. In press, DOI: https://doi.org/10.1016/j.ecolecon.2021.106968

Value of the Data

- The dataset provides a unique collection of Industrial Carbon Emission Intensity data at the European level. The primary data for CO2 emissions, collected at plant level from the EU Emission Trading System (EU-ETS) register, are aggregated at different geographical scales, based on the National Units of Territorial Statistics (NUTS) established by EUROSTAT. The multi-scalar nature of the dataset offers insights at the country-level of analysis as well as at regional and sub-regional levels.
- The data collected and aggregated represent an opportunity for academia, as they are standardised, the method applied is published and replicable and the dataset can be continuously updated, as it is based upon primary data publicly available. This represents an opportunity also for policy makers, who can benefit from the comprehensive dataset developed at different geographical scales, to deliver more effective policies, as differentiated based on the level of analysis and based on scale-specific information.
- The dataset offers opportunity for future development of studies with different scopes and perspectives. To provide a few examples, cluster analysis and focus on specific groups of regions with similar transition pathways may support the development of more targeted policies; other research may consider the integration of the dataset with additional data sources carrying either environmental or socio-economic, such as European Pollutant Release

and Transfer Register (E-PRTR) or Copernicus satellites data for the environmental data or GINI index for social ones.
- Regions and sub-regions could be grouped on the basis of economic development, specific institutional features, or other factors in order to investigate the impact of different factors on industrial sustainability transitions.

1. Data Description

The dataset is provided in Excel format, organised into two files:

- The CEI dataset, reporting aggregations of CEI data based on different geographical scales (i.e. NUTS 3–2–1–0) per each sheet. Each NUTS is listed with the additional information of the hierarchical structure it belongs to (e.g. NUTS3 is identified also by its NUTS2, NUTS1 and NUTS0 to which it belongs; NUTS 2 by NUTS1 and NUTS0; NUTS1 by NUTS0). Each record reports both NUTS code and label, i.e. the name of the region. The CEI value calculated per each year of the observation period is reported into columns.
- The EU-ETS dataset is reported into a dedicated file (i.e. "EU-ETS dataset_2008–2016"), with information about the installation name (Column A–"InstallationName"), city (Column B–"InstallationCity"), postcode (Column C–"InstallationPostCode") and address (Column D–"InstallationAddress"), the NUTS0 (Column E–"NameNUTS0"), NUTS1 (Column F–"NameNUTS1"), NUTS2 (Column G–"NameNUTS2"), NUTS3 (Column H–"NameNUTS3"; Column I–"CodeNUTS3") of the installation, the account holder (Column J–"AccountHolder"), the NACE classification (Column K–"NACE") and description (Column L–"ClassDescription"), the reference period (Column M–"Period") and the emissions, expressed as tons of CO2 equivalent (Column N–"tCO2e").

2. Experimental Design, Materials and Methods

With the overarching aim of studying the industrial Sustainability Transition, we developed a comprehensive and innovative dataset of industrial Carbon Emission Intensity (CEI) over time for EU regions.

CEI is defined as the ratio between Carbon Dioxide equivalent emissions and Industrial Gross Domestic Product (GDP) and it is used as indicator for Sustainability Transition pathways at different levels [2–5].

Data on greenhouse gases (GHG) emissions are released at plant level on a yearly basis by the EU Emission Trading System (EU ETS). The EU-ETS register includes more than 11,000 heavy energy-demanding power stations and industrial plants and it has recently added airlines operating between EU countries, covering around 40% of the EU's GHG emissions. GHG emissions data are characterised in terms of CO2 equivalent, translating different gases into a common unit of measure based on their global warming potential. Data released at plant level have been aggregated to the nearest geographical scale, identified by NUTS 3 (Nomenclature of Territorial Units for Statistics) defined by EUROSTAT. The dataset has been developed based on the nested structure of NUTS over four geographical scales, from country to province level (i.e., NUTS 0–3), through progressive aggregation of emission data.

GDP data are retrieved from EUROSTAT open database at NUTS 3 level, considering components related to the same industrial sectors covered by EU-ETS. This allows a consistent matching between the two elements composing the industrial CEI. GDP data have been aggregated based on the same nested structure of NUTS.

The final dataset includes CEI data from 2008 to 2016 on 28 NUTS 0, 103 NUTS 1, 279 NUTS 2 and 1248 NUTS 3, for a grand total of 14,433 observations. The dataset results unbalanced, as the CEI data are not available for all NUTS over the whole period of observation. This is due to two reasons: first, the NUTS system was revised in 2015, modifying the territorial boundaries in

some countries, such as France and Poland; second, countries entered the EU-ETS with different timing, therefore time series of emissions data present different starting points.

Ethics Statement

Only primary data from datasets publicly available have been used for the development of the present dataset. All the relevant collaborations and funding sources have been mentioned.

CRediT Author Statement

Matteo Mura, Mariolina Longo and **Laura Toschi:** Conceptualization, Methodology, Writing – original draft; **Sara Zanni, Franco Visani** and **Silvia Bianconcini:** Data curation, Software, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

Acknowledgments

We would like to acknowledge EIT Climate KIC, a body of the European Union, SPS Flagship ReIndustrialise project, for providing financial support to the study within which the dataset has been developed.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.107046.

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