Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Target 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

Indicator 9.4.1: CO_2 emission per unit of value added

Institutional information

Organization(s):

International Energy Agency (IEA)

United Nations Industrial Development Organization (UNIDO)

Concepts and definitions

Definition:

Carbon dioxide (here after, CO_2) emissions per unit value added is an indicator computed as ratio between CO_2 emissions from fuel combustion and the value added of associated economic activities. The indicator can be computed for the whole economy (total CO_2 emissions/GDP) or for specific sectors, notably the manufacturing sector (CO_2 emissions from manufacturing industries per manufacturing value added (MVA).

CO_2 emissions per unit of GDP are expressed in kilogrammes of CO_2 per USD constant 2010 PPP GDP. CO_2 emissions from manufacturing industries per unit of MVA are measured in kilogrammes of CO_2 equivalent per unit of MVA in constant 2015 USD.

Concepts:

Total CO_2 emissions for an economy are estimated based on energy consumption data for all sectors.

CO_2 emissions from manufacturing are based on energy data collected across the following subsectors (energy used for transport by industry is not included here but reported under transport):

- Iron and steel industry [ISIC Group 241 and Class 2431];
- Chemical and petrochemical industry [ISIC Divisions 20 and 21] excluding petrochemical feedstocks;
- Non-ferrous metals basic industries [ISIC Group 242 and Class 2432];
- Non-metallic minerals such as glass, ceramic, cement, etc. [ISIC Division 23];
- Transport equipment [ISIC Divisions 29 and 30];
- Machinery comprises fabricated metal products, machinery and equipment other than transport equipment [ISIC Divisions 25 to 28];

- Food and tobacco [ISIC Divisions 10 to 12];
- Paper, pulp and printing [ISIC Divisions 17 and 18];
- Wood and wood products (other than pulp and paper) [ISIC Division 16];
- Textile and leather [ISIC Divisions 13 to 15];
- Non-specified (any manufacturing industry not included above) [ISIC Divisions 22, 31 and 32].

Energy data are collected at a country level, based on internationally agreed standards (UN International Recommendations on Energy Statistics). CO_2 emissions need to be estimated based on energy data and on internationally agreed methodologies (IPCC Guidelines for GHG inventories).

The IEA collects national energy data, according to internationally agreed energy statistics definitions and estimates CO_2 emissions based on the IPCC Guidelines for GHG inventories Tier 1 methodology, producing internationally comparable CO_2 emissions data for over 150 countries and regions.

The gross value added measures the contribution to the economy of each individual producer, industry or sector in a country. The gross value added generated by any unit engaged in production activity can be calculated as the residual of the units' total output less intermediate consumption, goods and services used up in the process of producing the output, or as the sum of the factor incomes generated by the production process (System of National Accounts 2008). Manufacturing refers to industries belonging to the sector C defined by International Standard Industrial Classification of All Economic Activities (ISIC) Revision 4, or D defined by ISIC Revision 3.

GDP represents the sum of gross value added from all institutional units resident in the economy. For the purpose on comparability over time and across countries, GDP based on purchasing power parity (PPP) is used to calculate the total CO_2 emissions intensity of the economy. MVA is estimated in terms of constant prices in USD. The current series are given at constant prices of 2015.

Rationale:

The indicator CO2 emissions per unit of value added represents the amount of emissions from fuel combustion produced by an economic activity, per unit of economic output. When computed for the whole economy, it combines effects of the average carbon intensity of the energy mix (linked to the shares of the various fossil fuels in the total); of the structure of an economy (linked to the relative weight of more or less energy-intensive sectors); of the average efficiency in the use of energy. When computed for the manufacturing sector (CO2 emissions from fuel combustion per unit of manufacturing value added), it measures the carbon intensity of the manufacturing economic output, and its trends result from changes in the average carbon intensity of the energy mix used, in the structure of the manufacturing sector, in the energy efficiency of production technologies in each sub-sector, and in the economic value of the various output. Manufacturing industries are generally improving their emission intensity as countries move to higher levels of industrialization, but it should be noted that emission intensities can also be reduced through structural changes and product diversification in manufacturing.

CO_2 emission accounts for around 80% of all GHG emission from the manufacturing processes.

Comments and limitations:

Estimation of CO_2 emission data is not systematized in many countries, although is performed internationally based on harmonised energy data collected at national level. Energy data collection is generally well established, although in some cases national methodologies may differ from internationally agreed methodologies. National data sources include statistical offices, Energy Ministries, Environment agencies, among others. Energy consumption data and value added data are coming from different data sources which may raise some consistency issues.

Methodology

Computation method:

CO_2 emissions from fuel combustion are estimated based on energy consumption and on the IPCC Guidelines.

The total intensity of the economy is defined as the ratio of total CO_2 emissions from fuel combustion and GDP.

The sectoral intensity is defined as CO_2 emission from manufacturing (in physical measurement unit such as tonnes) divided by manufacturing value added (MVA) in constant 2015 USD.

CO2 emission per unit of value added

= CO2 emission from manufacturing (in kg)/MVA (constant USD)

Treatment of missing values:

- ***At country level:***

Boudt, Todorov, Upadhyaya (2009): Nowcasting manufacturing value added for cross-country comparison; Statistical Journal of IAOS

- ***At regional and global levels:***

No imputation is provided if values are missing for the entire country or the region. It can only be projected from the data reported for previous years.

Regional aggregates:

Regional aggregates are derived from the total number of available countries in a country group.

Sources of discrepancies:

Difference may arise 1) if the country has not submitted energy consumption data adequately dis-aggregated by sector or by energy sources 2) due to conversion of value data into USD.

Methods and guidance available to countries for the compilation of the data at the national level:

It is important that energy data collection and emissions calculations are consistent with international standards. CO2 emissions need to be estimated based on energy data and on internationally agreed methodologies. Energy data are collected at a country level, based on internationally agreed standards (UN International Recommendations on Energy Statistics). The IEA collects from countries energy data, according to internationally agreed energy statistics definitions. Then, the IEA estimates CO2 emissions based on country data and on the IPCC Guidelines for GHG inventories, producing internationally comparable CO2 emissions data for over 150 countries and regions. For energy data: the IEA sends standardised energy questionnaires (by fuel) to its Members and more globally to countries willing to provide data (e.g. all EU - jointly with Eurostat- most UNECE countries, and a few others submit these questionnaires). Questionnaires are available at:

http://www.iea.org/statistics/resources/questionnaires/annual/. For other countries, national data are processed to a consistent format. Therefore, the IEA is able to provide key energy statistics. More detail on methods and sources is available at: http://wds.iea.org/wds/pdf/WORLDBAL_Documentation.pdf.

To estimate CO2 emissions, the internationally agreed reference is the 2006 IPCC Guidelines on GHG Inventories: http://www.ipcc-nggip.iges.or.jp/public/2006gl/. For the underlying energy data, the reference is the UN International Recommendations on Energy Statistics: https://unstats.un.org/unsd/energy/ires/. More information on methodologies from the IEA is available at: http://wds.iea.org/wds/pdf/Worldco2_Documentation.pdf.

Quality assurance:

The IEA has extensive data quality checks on the energy data submissions (around 30 statisticians working on it), and iterates with countries on data issues and how to address them. http://www.iea.org/statistics/resources/questionnaires/annual/. The IEA also works in cooperation with the IPCC and the UNFCCC to ensure the highest consistency between international methodologies and methodologies adopted at the IEA; the IEA validates energy data submitted to the UNFCCC by countries within their inventories. The IEA convenes international workshops among partner Agencies working on energy data to ensure consistency between energy data at global level is enhanced continuously, and methodologies are harmonised.

The IEA has an extensive data quality assurance and validation process through exchange with national data providers worldwide. It also convenes its Energy Statistics Development Group meeting to discuss energy statistics developments with its Members, and cooperates with partners worldwide to ensure coherence of data and methods.

Data sources

Description:

Data on total CO_2 emissions from fuel combustion, also disaggregated by sector, are taken from the International Energy Agency (IEA) database (IEA CO_2 Emissions from Fuel Combustion: https://www.iea.org/reports/co2-emissions-from-fuel-combustion-2019).

The IEA produces the indicator on total CO_2 emissions/GDP, based on secondary sources for GDP (OECD National Accounts and World Bank Development indicators).

UNIDO maintains MVA database. Figures for updates are obtained from national account estimates produced by UN Statistics Division (UNSD).

Collection process:

Energy data are collected at the national level according to harmonised international definitions and questionnaires, as described in the UN International Recommendations for Energy Statistics (https://unstats.un.org/unsd/energy/ires/).

The estimates of CO_2 emissions from fuel combustion are calculated by the IEA based on the IEA energy data and the default methods and emission factors from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (http://www.ipcc-nggip.iges.or.jp/public/2006gl/). More information on methodologies from the IEA is available at: http://wds.iea.org/wds/pdf/Worldco2_Documentation.pdf

The MVA and GDP country data are collected through a national accounts questionnaire (NAQ) sent by UNSD. More information on the methodology is available on https://unstats.un.org/unsd/snaama/methodology.pdf.

Data availability

Description:

Data are available for more than 130 countries.

Time series:

Data for this indicator are available as of 2000 in the UN Global SDG Database, but longer time series are available in the IEA database (IEA CO_2 Emissions from Fuel Combustion) and the UNIDO MVA database.

Disaggregation:

Data can be presented for national totals, for the manufacturing sector, and by industrial subsector.

Calendar

Data collection:

Data collection is carried out by receiving data electronically throughout the year.

Data release:

The IEA releases its World CO_2 emissions from fuel combustion statistics in Fall each year.

UNIDO MVA database is updated between March and April every year.

Data providers

Name:

UNSD, IEA

Description:

NSOs and national energy data collecting agencies provide the data to UNSD and IEA.

Data compilers

Name:

UNIDO, IEA

Description:

IEA provides data on total CO_2 emissions, CO_2 emissions/GDP, manufacturing CO_2 emissions.

UNIDO compiles the data using its source for MVA data and IEA for data on CO_2 emissions.

References

URL:

https://www.iea.org/statistics http://wds.iea.org/wds/pdf/Worldco2_Documentation.pdf

www.unido.org/statistics

https://unstats.un.org/unsd/snaama/methodology.pdf

References:

International Yearbook of Industrial Statistics; UNIDO

IEA (2019), *CO_2 Emissions from Fuel Combustio*n

System of National Accounts, 2008

IEA, *Key world energy statistics*

International Standard Industrial Classification of All Economic Activities 2008