Sources and methodology

Enerdata is an independent information and consulting firm specializing in global energy and carbon markets, providing information and advisory services on energy efficiency.

The analyses provided in Part I of this report are based on energy efficiency indicators in Enerdata's world energy data base. This database provides harmonized energy data gathered from more than 200 sources around the world. Primary energy data comes from the International Energy Agency (IEA) and are completed with data from regional organizations such as the European statistics office (Eurostat); the Latin American energy organization (Olade); the Asian Development Bank; and the Organization of Oil Exporting Countries (OPEC). Data also comes from specialized institutions such as the international association for natural gas (Cedigaz), and from national sources including national statistics agencies, ministries and utilities. These complementary data are used to correct and harmonize the primary data, and to update it rapidly. The methodology and definitions used by Enerdata are the same as those of the IEA and Eurostat.

Most of the detailed data by branch comes from the Odyssee database. Odyssee is a database dedicated to energy use and efficiency data and indicators in Europe where data from each European country's official energy agencies is gathered. Enerdata is the technical coordinator of the European program Odyssee, on behalf of all EU energy agencies, and of Intelligent Energy Europe program of the European Commission.

Energy statistics in physical units are converted into common units, ktoe or Mtoe, on the basis of the following coefficients:

- Crude oil: fixed coefficient for most countries of 1.02 toe / ton
- Oil products: fixed coefficient for all countries (same as Eurostat or IEA)
- Natural gas: national coefficients for the major countries and fixed coefficient for the other countries (0.82 toe / 1000 m3)
- Coal, lignite: fixed coefficient for coke; national coefficient for production, imports, exports for the most important producers or importers
- Electricity:
  - nuclear: 1TWh = 0.26 Mtoe
  - hydroelectricity: 1TWh = 0.086 Mtoe
  - geothermal: 1TWh = 0.86 Mtoe - total production: 1TWh = 0.086 Mtoe
  - imports, export: 1TWh = 0.086 Mtoe
  - consumption: 1TWh = 0.086 Mtoe

For more information about the methodology please contact Enerdata : assistance@enerdata.net

Key terms are defined as follows:

Energy consumption and CO_2 emissions

Primary energy consumption

The primary consumption is the indicator of the total energy consumption of a country. Total energy consumption, for each energy product, is the sum of total production, balance of trade, aviation and marine bunkers (fuel used by boats and aircraft for international transport), and stock variations.

Final energy consumption

Final consumption measures the needs of the final consumers of the country. They are broken down into several sectors: industry, transport, households, services, agriculture and non-energy uses.
Final consumption is the difference between total consumption and the consumption of the energy sector (transformations).

Final energy consumption of industry

Final consumption of industry includes the final consumption of the mining sector, manufacturing sector, construction, and water distribution and processing. Final consumption excludes the fuel consumption of all modes of transport used by industry, and also excludes energy products employed for non energy uses (eg, raw materials in petrochemicals, lubricants).

Energy consumption per capita

Energy consumption per capita corresponds to total energy consumption divided by the population.

$$totcppop = \frac{totcp}{pop} \quad p(toe/cap)$$

with:
totcp: primary consumption (Mtoe)
pop: number of inhabitants (millions)

Electricity consumption per capita

Electricity consumption per capita corresponds to electricity consumption divided by the population.

$$elecipop = \frac{eleci}{pop} \times 1000 \quad (kWh/cap)$$

with:
eleci: electricity consumption (TWh)
pop: number of inhabitants (millions)

CO_2 emissions per capita

CO_2 emissions per capita is calculated by dividing CO_2 emissions from fuel combustion by the population. CO_2 emissions cover the emissions from fossil fuels combustion (coal, oil and gas). They are calculated according to the UNFCCC methodology.

$$co2pop = \frac{co2tot}{pop} \quad (tCO_2 / cap)$$

with:
co2tot: CO_2 emissions from fuel combustion ($MtCO_2$)
pop: number of inhabitants (millions)

Transformations

Conversion losses correspond to consumption of the energy sector during the operation of the energy transformation facilities (power plants, refineries etc.).

Energy and CO_2 intensities

Primary energy intensity

The primary energy intensity is calculated by dividing the total energy consumption of a country by its Gross Domestic Product (GDP). It measures the total amount of energy necessary to generate one unit of GDP.

$$eitotpcppp = \frac{totcp}{pib\$xxppa} \quad (koe / \$2005ppp)$$

with:
totcp: primary consumption (Mtoe)
gdp$xxppp: GDP at constant exchange rate and purchasing power parity of the year 2005 in dollars (US$2005bn ppp)

Final energy intensity

The final energy intensity is calculated by dividing the final energy consumption of a country by its GDP expressed at purchasing power parity. The final energy consumption is the energy consumed by end users (ie, industry, transport, households, services and agriculture) excluding uses of petroleum products and natural gas as chemical feedstocks.

$$eitotfcppp = \frac{totfc}{gdp\$xxppp} \quad (koe / \$2005ppp)$$

with:
totfc: final consumption (Mtoe)
gdp$xxppp: GDP at constant exchange rate and purchasing power parity of the year 2005 in dollar (US$2005bn ppp)

Efficiency of energy transformation

This indicator identifies how much energy is lost, during the conversion of primary energy (in the form of energy consumed by the energy sector itself and through thermal or material losses during the transformation process), before reaching the end users (ie, industry, transport, households, services and agriculture).

It is calculated by dividing the final energy consumption by the primary energy consumption. The more divergent these values are the greater the losses and the smaller the percentage value shown.

$$\text{efficiency fo energy transformation} = \frac{\text{final energy consumption}}{\text{primary energy consumption}} \times 100 \quad (\%)$$

CO_2 intensity

The CO_2 intensity indicator is calculated by dividing CO_2 emissions from fuel combustion by GDP. It describes the amount of CO_2 produced per dollar of GDP produced. GDP is expressed at purchasing power parity to reflect differences in general price levels and relate energy consumption to the real level of economic activity.

$$co2pib\$xxp = \frac{co2tot}{gdp\$xxppp} \quad (kCO_2 / \$2005ppp)$$

with:
CO_2tot: CO_2 emissions from fuel combustion ($MtCO_2$)
gdp$xxppp: GDP at constant exchange rate and purchasing power parity of the year 2005 in dollar (US$2005bn ppp)

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Power generation

Efficiency of power generation

The efficiency of power generation is calculated by dividing the total net electricity production by the energy inputs.

$$\frac{\text{elepd}}{\text{ehypd + enupd + cmsie + petie + gazie + encie + egepd + esopd + ewnpd}} \times 100 \quad (\%)$$

with:
elepd: net electricity production (Mtoe)
ehypd: electricity production from hydro (Mtoe)
enupd: nuclear electricity production (Mtoe)
cmsie, petie, gazie, encie: fuel inputs in thermal power plants (Mtoe)
egepd: geothermal electricity production (Mtoe)
esopd: electricity production from solar energy (Mtoe)
ewnpd: electricity production from wind (Mtoe)

Efficiency of thermal power plants

The efficiency of thermal power plants is calculated by dividing the net thermal electricity production by fuel inputs and is expressed as a percentage.

$$\text{efficiency of thermal power plants} = \frac{\text{electricity production of thermal power plants}}{\text{fuel inputs}} \times 100 \quad (\%)$$

Efficiency of gas-fired power plants

The efficiency of gas-fired power plants is calculated by dividing the net thermal electricity production by natural gas inputs and is expressed as a percentage.

$$\text{efficiency of gas-fired power plants} = \frac{\text{electrity of gas-fired power plants}}{\text{natural-gas inputs}} \times 100 \quad (\%)$$

Share of CCGT in thermal installed capacities

It corresponds to the share of combined cycle technology in thermal installed capacities.

$$\text{share of CCGT in thermal installed capacity} = \frac{\text{CCTG installed capacity}}{\text{thermal power capacity}} \times 100 \quad (\%)$$

Share of efficient coal power plants in thermal installed capacities

It corresponds to the share of installed capacities of efficient coal technologies, namely Supercritical, Ultra-supercritical and Integrated Gasification Combined Cycle (IGCC) technology in thermal installed capacities.

$$\text{share of efficient coal capacities} = \frac{\text{efficient coal technologies installed capacity}}{\text{thermal power capacity}} \times 100 \quad (\%)$$

Rate of electricity T&D losses

The rate of electricity T&D losses is the ratio between the quantity of energy lost during transport and distribution, and the electricity consumption.

$$\text{Rate of electricity T&D losses} = \frac{\text{electricity T&D losses}}{\text{electricity consumption}} \times 100 \quad (\%)$$

CO_2 emission factor in power generation

The CO_2 emissions per kWh generated is calculated by dividing the total CO_2 emissions from electricity generation and from the heat produced by cogeneration (CHP) plants by the total electricity and heat generation.

$$\text{efelec} = \frac{\text{co2ele + co2heatchp}}{\text{prdele + prdheatchp}} \quad (gCO_2/kWh)$$

with:
CO_2ele: CO_2 emissions from electricity generation (tCO_2)
CO_2heatchp: CO_2 emissions from heat produced from chp (tCO_2)
prdele: electricity generation (GWh)
prdheatchp: heat production from CHP (GWh)

Industry

Share of electricity in industrial consumption

It corresponds to the share of industrial energy consumption which is met by electricity.

$$\text{pcelcindcf} = \frac{\text{elccfind}}{\text{totcfind}} \times 100 \quad (\%)$$

with:
elccfind: Final consumption of electricity by industry (Mtoe)
totcfind: Final consumption of energy by industry (Mtoe)

Energy intensity of industry

The energy intensity of industry is calculated by dividing the total final energy consumption of industry by the value added of industry measured at constant purchasing power parity (ppp).

$$\text{eitotind} = \frac{\text{totfcind}}{\text{vadind\$xxppp}} \quad (kCO_2 / \$2005ppp)$$

with:
totfcind: final consumption of energy by industry (Mtoe)
vadind$xxppp: value added of industry at constant exchange rate and purchasing power parity of the year 2005 in dollar (US$2005bn ppp)

Energy intensity of non-metallic minerals industry

The non-metallic minerals industry corresponds to the manufacturing of glass and glass products (e.g. flat glass, hollow glass, fibers, technical glassware etc.), ceramic products, tiles and baked clay products, and cement and plaster, from raw materials to finished articles. The energy intensity of the branch is calculated by dividing the final energy consumption of the branch by the value added of the branch measured at constant purchasing power parity (ppp).

$$\text{eitotchi} = \frac{\text{totfcchi}}{\text{vadchi\$xxppp}} \quad (kCO_2 / \$2005ppp)$$

with:
totfcchi: final consumption of energy by non-metallic minerals industry (Mtoe)
vadchi$xxppp: value added of non-metallic minerals industry at constant ppp in dollar 2005 (US$2005bn ppp)

Energy intensity of chemicals

The chemical industry includes the transformation of organic and inorganic raw materials by a chemical process, and the manufacture of basic pharmaceutical products and pharmaceutical preparations. The energy intensity of chemicals is calculated by dividing the total final energy consumption of the chemical industry by the value added of the chemical industry measured at constant purchasing power parity (ppp).

$$\text{eitotchi} = \frac{\text{totfcchi}}{\text{vadchi\$xxppp}} \quad (kCO_2 / \$2005ppp)$$

with:
totfcchi: final consumption of chemical industry (Mtoe)
vadchi$xxppp: value added of chemical industry at constant ppp in dollar 2005 (US$2005bn ppp)

Unit consumption of steel

The unit consumption of steel is calculated by dividing the energy consumption of the steel industry by steel output measured in tons.

$$\text{uctotsteel} = \frac{\text{totfcsteel}}{\text{prdsteel}} \quad (\text{toe} / \text{t})$$

with:
totfcsteel: energy consumption of steel (Mtoe)
prdsteel: production of crude steel (Mt)

Unit consumption of paper and printing

The paper industry includes the manufacture of pulp, paper and converted paper products, and the printing of products, such as newspapers, books, periodicals, business forms, greeting cards, and other materials, and associated support activities, such as bookbinding, plate-making services, and data imaging. It also includes the reproduction of recorded media, such as compact discs, video recordings, software on discs or a tape, records etc, but excludes publishing activities. The unit consumption of paper is calculated as the ratio between the final energy consumption of the paper industry and paper output measured in tons.

$$\text{uctotpaper} = \frac{\text{totfcpaper}}{\text{prdsteel}} \quad (\text{toe} / \text{t})$$

with:
totfcpaper: energy consumption of paper(Mtoe)
prdpaper: production of paper (Mt)

Specific electricity consumption for primary aluminum

It corresponds to electricity consumption per tonne of primary aluminum produced. The bulk of aluminum production is made up of primary aluminum production while recycling represents a limited part. The specific electricity consumption is calculated as the ratio between power consumption and primary aluminum production in metric tons. The indicator is provided by the International Aluminium Institute.

Machinery and equipment

The branch corresponds to the manufacture of machinery and equipment that act independently on materials either mechanically or thermally or perform operations on materials (eg, handling, spraying, weighing or packing). This includes the manufacture of fixed and mobile or hand-held devices, regardless of whether they are designed for industrial, building and civil engineering, agricultural or home use. The manufacture of special equipment for passenger or freight transport within demarcated premises also belongs within this division.

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Share of industrial cogeneration
Represents the share of industrial electricity consumption, which comes from cogeneration (CHP).

Industrial CHP capacity per capita
The industrial cogeneration (CHP) capacity per capita is calculated by dividing installed power capacity from CHP by the population.

$$chppop = \frac{chpmw}{pop} \times 100 \quad (\%)$$

with:
chppop: Installed power capacity from CHP (MW)
pop: number of inhabitants (millions)

CO_2 intensity of industry
The CO_2 intensity of industry is calculated by dividing the CO_2 emissions from industry through fuel combustion by value added of industry measured at constant purchasing power parity (ppp).

$$co2ind\$xxp = \frac{}{} \quad (kCO_2 / \$2005ppp)$$

with:
CO_2ind: CO_2 emissions of industry ($MtCO_2$)
vadind$xxppp: value added of industry at constant exchange rate and purchasing power parity of the year 2005 in dollar (US$2005bn ppp)

Economy
Constant 2005 dollars ($2005)
Monetary values are measured at constant price of a given reference year (2005) to remove the impact of inflation in comparison. Constant prices are obtained by dividing current (or normal) prices by a deflator (price index).

Purchasing power parities (ppp)
The purchasing power parity eliminates the differences in price levels between different countries: a money unit, at ppp, can buy the same basket of goods and services in all world regions. It reflects differences in general price levels and relates the energy consumption to the real level of economic activity. For instance, in regions with a low cost of living, the energy intensity will be lowered when measured at ppp (instead of exchange rates) since this will increase the value of the country's GDP. In addition ppp do not fluctuate as much as exchange rates, and provide a more stable comparison of energy intensities.

GDP
GDP measures the economic activity of a country; it is usually measured at market prices. The GDP at market price is the sum of value added at factor cost, plus indirect taxes less subsidies.

Value added
Value added is the usual mode of measurement of the net output of a branch or sector in monetary units; it equals the difference between the gross output and the value of inputs; the value added can be measured at factor cost or at market prices.

Definition of world regions:
North America corresponds to Canada, United States.

Latin America groups together Central America, Mexico, South America and the Caribbean. Central America corresponds to Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama; while South America includes Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela. Caribbean countries are Bahamas, Barbados, Bermuda, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Netherlands Antilles & Aruba, St Lucia, St Vincent and the Grenadines and Trinidad & Tobago.

Europe includes the European Union (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic, Slovenia, Bulgaria and Romania) and Albania, Bosnia-Herzegovina, Croatia, Iceland, Macedonia, Norway, Serbia & Montenegro, Switzerland and Turkey.

CIS countries are Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

OECD Asia includes Australia, Japan, New Zealand and South Korea.

Other Asia corresponds to the Asia and Pacific regions, excluding OECD Asia, China and India. It includes Afghanistan, Bangladesh, Bhutan, Brunei, Cambodia, Hong Kong, Indonesia, Nepal, Pakistan, Sri-Lanka, Lao, Macao, Malaysia, Maldives, Mongolia, Myanmar, North Korea, Philippines, Singapore, Taiwan, Thailand, Vietnam and the Pacific Islands.

Middle East includes Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen.

Africa is made up of North Africa countries, ie, Algeria, Egypt, Libya, Morocco and Tunisia, and Sub-Saharan countries: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoro Islands, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, RD Congo, Rwanda, São Tomé and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.