Fossil Fuels

[*by Hannah Ritchie and Max Roser*](https://ourworldindata.org/about/#team)*[cite]*

Fossil fuels (coal, oil, gas) have, and continue to, play a dominant role in global energy systems. Fossil energy was a fundamental driver of the Industrial Revolution, and the technological, social, economic and development progress which has followed. Energy has played a strongly positive role in global change.

However, fossil fuels also have negative impacts, being the dominant source of local [air pollution](https://ourworldindata.org/air-pollution/) and emitter of [carbon dioxide (CO2) and other greenhouse gases](https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions/). The world must therefore balance the role of energy in social and economic development with the need to decarbonise, reduce our reliance on fossil fuels, and [transition towards](https://ourworldindata.org/energy-production-and-changing-energy-sources/) lower-carbon energy sources.

This entry presents the long-run and recent perspectives on coal, oil and gas - global and national production, consumption, reserves, prices and their consequences.

I. Empirical View

I.1 Fossil fuel production & consumption

**Global fossil fuel consumption over the long-term**

Fossil fuel production and consumption began with coal - its first reported uses date as far back as 4000BC in China where carving took place out of black lignite (one of the several forms of coal).[1](https://ourworldindata.org/fossil-fuels#note-1). However, large-scale combustion of coal is typically correlated with the period around the beginning of the Industrial Revolution.

The visualisation shows the global consumption of fossil fuels - coal, oil and gas - from 1800 onwards. Overall, we see that global consumption of fossil energy has increased more than 1300-fold. As shown, coal was the first and only fossil source until the 1860s when crude oil consumption began. Natural gas production began a couple of decades later, in the 1880-90s.

The 20th century saw a large diversification of fossil energy consumption, with coal declining from 96 percent of total production in 1900 to less than 30 percent in 2000. Today, crude oil is the largest energy source, accounting for around 39 percent of fossil energy, followed by coal and natural gas at 33 and 28 percent, respectively.

[Global fossil fuel consumption](https://ourworldindata.org/grapher/global-fossil-fuel-consumption)Global primary energy consumption by fossil fuel source, measured in terawatt-hours (TWh).1800185019001950200020160 TWh20,000 TWh40,000 TWh60,000 TWh80,000 TWh100,000 TWh120,000 TWhNatural gasCrude oilCoalSource: Vaclav Smil (2017). Energy Transitions: Global and National Perspective & BP Statistical Review of World Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Relative

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**Fossil fuel production by country or region**

[Fossil fuel production over the long-term, United Kingdom](https://ourworldindata.org/grapher/fossil-fuel-production-over-the-long-term)Total fossil fuel production - differentiated by coal, oil and natural gas - by country over the long-run, measured interawatt-hour (TWh) equivalents per year.19501960197019801990200020140 TWh500 TWh1,000 TWh1,500 TWh2,000 TWh2,500 TWh3,000 TWhNatural gasCrude oilCoalSource: Coal production - The SHIFT Project, Oil production - Etemad & Luciana, Gas production - Etemad & Luciana[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Per capita fossil fuel production by country or region**

[Fossil fuel production per capita, United Kingdom](https://ourworldindata.org/grapher/fossil-fuel-production-per-capita)Average fossil fuel production per capita across countries and regions, measured in megawatt-hours (MWh) per personper year. Fossil fuel consumption has been categorised by coal, oil and natural gas sources.195019601970198019902000201020160 MWh10 MWh20 MWh30 MWh40 MWhNatural gasCrude oilCoalSource: Long-term per capita fossil fuels - OWID based on UN, Gapminder, BP, Etemad & Luciana[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Fossil fuel consumption by country or region**

The visualisation below presents the fossil fuel consumption mix across individual countries and regions over the last 50 years. Data for different countries and regions can be viewed using the "change country" function of the chart.

Overall, we see large differences across the world, both in terms of the magnitude of fossil energy consumption and their relative mix. Total consumption levels of fossil fuels in higher-income countries have typically peaked, and are now declining as they transition towards lower-carbon energy sources. For example, the United Kingdom's total fossil fuel consumption is at its lowest level in the last 50 years. In many lower-income countries, total consumption of fossil fuels continues to increase as a result of both [population growth](https://ourworldindata.org/world-population-growth/) and rising incomes (resulting in higher [per capita energy](https://ourworldindata.org/grapher/energy-use-per-capita-vs-gdp-per-capita) demands).

The relative mix of coal, oil and gas in total consumption also varies by country. China, for example, sources more than 70 percent of fossil fuel consumption from coal. In contrast, Argentina sources less than two percent from coal, with gas accounting for nearly 60 percent.

[Fossil fuel consumption by fuel type, China](https://ourworldindata.org/grapher/fossil-fuel-consumption-by-fuel-type)Fossil fuel consumption from coal, oil and gas sources by country or region, measured in terawatt-hour (TWh)equivalents per year.19651970198019902000201020160 TWh5,000 TWh10,000 TWh15,000 TWh20,000 TWh25,000 TWh30,000 TWhGasOilCoalSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Change country Relative

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**Fossil fuel consumption per capita**

[Fossil fuel consumption per capita, China](https://ourworldindata.org/grapher/fossil-fuel-consumption-per-capita)Average fossil fuel consumption per capita across countries and regions, measured in megawatt-hours (MWh) perperson per year. Fossil fuel consumption has been categorised by coal, oil and natural gas sources.19651970198019902000201020150 MWh5 MWh10 MWh15 MWh20 MWhNatural gasOilCoalSource: Fossil fuel consumption per capita - BP & UN (2017 revision)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US" \t "_blank)

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I.2 Coal

The series of charts below present levels of coal production and consumption (which do not necessarily correlate) across the world, by region and country.

**Coal production by region**

The visualisation below shows recent trends in coal production by region, since 1981. Overall, we see that global coal production more than doubled over this period. Although too early to confirm, global coal production appears to have peaked over the years 2013-14, with several years of declining production since. This would represent a significant peak in global energy, with coal being the first fossil fuel energy source.

The majority of growth in global coal production has been sourced from the Asia Pacific region, with 5 to 6-fold growth over the last 30 years. Total output from Europe, Eurasia and North America has declined during this period. Asia Pacific now produces more than 70 percent of coal, up from around one-quarter in 1981.

[Coal production by region, terawatt-hours (TWh)](https://ourworldindata.org/grapher/coal-production-by-region)Annual coal production, measured in terawatt-hour (TWh) equivalents.198119851990199520002005201020160 TWh10,000 TWh20,000 TWh30,000 TWh40,000 TWhMiddle EastSouth & CentralAmericaAfricaEurope & EurasiaNorth AmericaAsia PacificSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Coal production by country**

The chart and map [which can viewed by switching between tabs below] shows the change in coal production at the country level over the longer-term. Most countries have series data back to the year 1900, with some such as the United Kingdom dating back to 1700.

The United Kingdom was the first large-scale coal producer - we see its long-run trend growing, peaking just prior to the First World War, and its gradual decline throughout the 20th century. Its production levels are now comparable to those at the beginning of the 1700s.

Today, China dominates global coal production, accounting for nearly half of total output. This growth has been rapid since the 1960-70s. However, Chinese coal production appears to have peaked, with continued decline in the years since. This decline is likely to have been a key contributor to the apparent global peak in 2013.

[Coal production by country, terawatt-hours (TWh)](https://ourworldindata.org/grapher/coal-production-by-country)Annual coal production by country or region, measured in terawatt-hour (TWh) equivalents.17001750180018501900195020160 TWh5,000 TWh10,000 TWh15,000 TWh20,000 TWhChina -India -Australia -United Kingdom -Source: Coal production - The SHIFT Project, Coal output and employment in UK - DECC (2016)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Per capita coal production**

[Coal production per capita over the long-term](https://ourworldindata.org/grapher/coal-production-per-capita-over-the-long-term)Average coal production per capita over the long-term, measured in megawatt-hour (MWh) equivalents per person peryear.17001750180018501900195020160 MWh10 MWh20 MWh30 MWh40 MWh50 MWhChinaUnited StatesWorldIndiaUnited KingdomSource: Long-term per capita fossil fuels - OWID based on UN, Gapminder, BP, Etemad & Luciana[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Coal consumption by region**

The chart below shows the regional trends in coal *consumption* over the last fifty years. The relative regional distribution follows a very similar pattern to that of coal production. Asia Pacific is the dominant coal consumer, accounting for nearly three-quarters of global consumption. This share is slightly larger than its share of coal production, suggesting it is a net importer. In contrast, Africa accounts for only 2.5 percent of consumption; less than its 4 percent of production, suggesting it is a net exporter. Collectively, Europe, Eurasia & North America account for less than one-quarter of coal consumption.

[Coal consumption by region, terawatt-hours (TWh)](https://ourworldindata.org/grapher/coal-consumption-by-region)Annual coal consumption, measured in equivalents of terawatt-hours (TWh) per year.19651970198019902000201020160 TWh10,000 TWh20,000 TWh30,000 TWh40,000 TWhMiddle EastSouth & CentralAmericaAfricaNorth AmericaEurope & EurasiaAsia PacificSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Coal consumption by country**

Below we see these trends in coal consumption at the national level over the last 50 years. Again, China is the world's dominant coal consumer, accounting for nearly half of global consumption. Like its production trends, China's coal consumption appears to have peaked in 2013 with several years of sustained decline.

Other industrialising nations shown strong growth in coal consumption. Driven by continued [population growth](https://ourworldindata.org/grapher/population-by-country?country=IND)and [economic development](https://ourworldindata.org/grapher/maddison-data-gdp-per-capita-in-2011us?tab=chart&country=IND), India's coal consumption grew more than four-fold from 1960 to 1990, and has more than doubled from 1990 to today. Similar trends are seen across various countries, including Brazil, South Africa, Thailand, and Pakistan to name a few.

**Coal consumption per capita**

[Coal consumption per capita, megawatt-hours per year](https://ourworldindata.org/grapher/coal-consumption-per-capita)Average coal consumption per capita, measured in megawatt-hours (MWh) per person per year.19651970198019902000201020150 MWh5 MWh10 MWh15 MWh20 MWh25 MWhChinaUnited StatesGermanyJapanWorldUnited KingdomIndiaSource: Fossil fuel consumption per capita - BP & UN (2017 revision)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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I.3 Oil

The series of charts below present levels of oil production and consumption (which do not necessarily correlate) across the world, by region and country.

**Oil production by region**

As the visualisation below shows - global oil production is much more equally distributed across the world's regions. Unlike coal production (for which it produces a negligible amount), the Middle East is the world's largest oil producer, accounting for nearly 35 percent. The relative contribution of region's to the global total has remained generally consistent over the last 50 years, with Europe & Eurasia and North America both accounting for around 20 percent of total production, and Asia Pacific, Africa and Latin America & the Caribbean all producing between 8-9 percent.

Global oil production has increased more than 2.5-fold over the last 50 years, despite more volatile growth relative to coal. The 1970s 'oil crisis' resulted in a sudden drop in consumption between 1973-74 following an [oil embargo](https://history.state.gov/milestones/1969-1976/oil-embargo) of the Organization of Petroleum Exporting Countries (OPEC) in 1973. This was followed by another oil shock in 1979 (following the Iranian Revolution) and an 'oil glut' in the early 1980s where there was a surplus of crude oil (as a result of reduced consumer demand following the energy crisis of the 1970s).[2](https://ourworldindata.org/fossil-fuels#note-2)

[Oil production by region, terawatt-hours (TWh)](https://ourworldindata.org/grapher/oil-production-by-region)Annual oil production, measured in terawatt-hour (TWh) equivalents.19651970198019902000201020160 TWh10,000 TWh20,000 TWh30,000 TWh40,000 TWh50,000 TWhAfricaSouth & CentralAmericaAsia PacificNorth AmericaEurope & EurasiaMiddle EastSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Oil production by country**

The visualisation below shows the change in oil production at the country-level from 1900 onwards, where data is available. This can be explored as a time-series or in map form. In 2014, the United States is the world's largest country producer of oil, accounting for just under one-fifth of global production. Saudi Arabia is the world's second largest producer, followed by Russia.

Types of oil production have influenced the shapes of these trends over time. As explored later in this entry, oil production in the United States looked likely to peak and decline in the 1980s before rising again with the extraction of increasing numbers of shale oil resources.

[Oil production by country, terawatt-hours (TWh)](https://ourworldindata.org/grapher/oil-production-by-country)Oil production by country, measured in terawatt-hour (TWh) equivalents per year.19001920194019601980200020140 TWh1,000 TWh2,000 TWh3,000 TWh4,000 TWh5,000 TWh6,000 TWh7,000 TWh8,000 TWhUnited StatesSaudi ArabiaQatarKazakhstanArgentinaSource: The SHIFT Project - Etemad & Luciana; US IEA[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Oil consumption by region**

The chart below shows oil consumption by region over the last 50 years. Over this period, on relative terms we see a decreasing share of global consumption from Europe, Eurasia & North America in contrast to a rising share in all other regions - most notably Asia Pacific (which has more than tripled in its share of global oil consumption, from around 10 percent in 1965 to 32 percent in 2016).

In comparison to oil *production* by region, we see that the Middle East is a much smaller consumer than producer of oil (it produces more than 30 percent, and consumes around 10 percent), meaning it is a large net exporter. In contrast, the Asia Pacific region consumes significantly more oil than it produces (only 8-9 percent production versus 32 percent consumption), meaning it is a net importer.

**Oil consumption by country**

Oil consumption broken down by country is shown in the chart below - in chart, and map form. The single largest oil consumer is the United States, with over 10,000 TWh per year. The USA is followed by China (at 7000-8000 TWh), and India at just under 2500 TWh. Brazil, Canada and Saudi Arabia are also large oil consumers.

Data availability for consumption levels across Sub-Saharan Africa is low. However, given total regional consumption levels are relatively low, we would also expect consumption levels in most countries to be low relative to other regions.

[Oil consumption by country, terawatt-hours (TWh)](https://ourworldindata.org/grapher/oil-consumption-by-country)Oil consumption by country, measured in terawatt-hour (TWh) equivalents per year.19651970198019902000201020160 TWh2,000 TWh4,000 TWh6,000 TWh8,000 TWh10,000 TWhBangladeshSouth AfricaMexicoCanadaBrazilUnited StatesSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Oil consumption per capita**

[Oil consumption per capita, megawatt-hours per year](https://ourworldindata.org/grapher/oil-consumption-per-capita)Average oil consumption per capita, measured in megawatt-hours (MWh) per person per year.19651970198019902000201020150 MWh20 MWh40 MWh60 MWh80 MWh100 MWhUnited Arab EmiratesUnited StatesJapanBrazilChinaSource: Fossil fuel consumption per capita - BP & UN (2017 revision)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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I.4 Natural gas

The series of charts below present levels of natural gas production and consumption (which do not necessarily correlate) across the world, by region and country.

**Gas production by region**

The regional distribution of natural gas production has changed significantly in recent decades. The chart below shows natural gas production by region from 1970 onwards. In 1970, North America, Europe & Eurasia accounted for almost all global gas production (with more than 95 percent combined). Despite both regions growing in absolute terms, their share of global production has declined significantly as regional production has diversified. North America, Europe & Eurasia's share of production has decreased to around 55 percent, with the Middle East, Asia Pacific, Latin America and Africa accounting for 18, 16, 6 and 5, percent respectively.

Overall, natural gas production has nearly quadrupled over the last 40-50 years.

**Gas production by country**

The visualisation below breaks gas production down further to the national level, with some trends extending back to 1900. The United States is the world's largest single producer of natural gas producer, accounting for approximately one-fifth of global production. The USA is followed by Russia, Iran, Canada, China and Saudi Arabia which all produce more than 1000 TWh per year.

[Gas production by country, terawatt-hours (TWh)](https://ourworldindata.org/grapher/gas-production-by-country)Natural gas production, measured in terawatt-hour (TWh) equivalents per year.1922194019601980200020140 TWh2,000 TWh4,000 TWh6,000 TWh8,000 TWhRussiaQatarSaudi ArabiaBrazilSource: The SHIFT Project - Etemad & Luciana; US IEA[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Gas consumption by region**

Regional gas consumption shows a very similar distribution to gas production. In the chart below we see the dominance of North America, Europe & Eurasia in the 1960-70s, and the significant regional diversification as consumption increases across the world. Relative to gas production figures, we see that the Middle East consumes a smaller share of the global total than it produces, whilst the Asia Pacific region consumes slightly more than it produces. The Middle East is therefore a net gas exporter, whilst the Asia Pacific is a net importer.

[Natural gas consumption by region, terawatt-hours (TWh)](https://ourworldindata.org/grapher/natural-gas-consumption-by-region)Annual natural gas consumption, measured in terawatt-hour (TWh) equivalents.19651970198019902000201020160 TWh5,000 TWh10,000 TWh15,000 TWh20,000 TWh25,000 TWh30,000 TWh35,000 TWhAfricaSouth & CentralAmericaMiddle EastAsia PacificNorth AmericaEurope & EurasiaSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Gas consumption by country**

Global distribution of gas consumption at the national level also shows a very similar pattern to that of gas production. Like gas production, the United States is the world's largest consumer, followed by Russia, Iran, Canada, China and Saudi Arabia.

Natural gas consumption has seen significant growth across all regions over the last few decades. This is true of both high and lower-income nations as nations seek to improve domestic energy security, and economies attempt to shift from coal consumption. Natural gas - as we explain later in this entry - produces less carbon dioxide per unit energy than both coal and oil, meaning some countries have adopted natural gas substitution as a pathway to decarbonisation.

[Gas consumption by country, terawatt-hours (TWh), 2016](https://ourworldindata.org/grapher/gas-consumption-by-country)Natural gas consumption by country, measured in terawatt-hour (TWh) equivalents per year.No data0 TWh2,500 TWh5,000 TWh10,000 TWhSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

1965

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**Gas consumption per capita**

[Natural gas consumption per capita, megawatt-hours per year](https://ourworldindata.org/grapher/gas-consumption-per-capita)Average natural gas consumption per capita, measured in megawatt-hours (MWh) per person per year.19651970198019902000201020150 MWh5 MWh10 MWh15 MWh20 MWh25 MWh30 MWh35 MWhSaudi ArabiaCanadaVenezuelaWorldBrazilSouth AfricaSource: Fossil fuel consumption per capita - BP & UN (2017 revision)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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I.5 Fossil fuels in electricity production

Fossil fuels are consumed for energy supply in a number of ways, including transport, heat and electricity production. In the chart below we see the relative share of coal, natural gas and oil in electricity mixes across the world over the last few decades. At the global level we see that coal is the dominant electricity source accounting for approximately 40 percent of total electricity production. This is followed by natural gas at approximately 22 percent, oil at only 4 percent (and the remainder supplied by other energy sources, including nuclear and renewable technologies).

Overall, we see that the share of fossil fuels in global electricity production has not changed significantly over the decade from 2005-2014. If measured relative to the years pre-2000, the share of fossil fuels in the global electricity mix has in fact increased slightly, despite the need for energy decarbonisation. As we cover in a separate [blog post](https://ourworldindata.org/global-renewables-are-growing-but-are-only-managing-to-offset-a-decline-in-nuclear-production/), some of this stagnation in progress can be explained by the offsetting of an increase in renewable electricity with a decline in nuclear production.

[Share of electricity production from fossil fuels, World](https://ourworldindata.org/grapher/share-of-electricity-production-from-fossil-fuels)The share of total electricity production from coal, oil and natural gas sources.1990199520002005201020140%10%20%30%40%50%60%OilNatural gasCoalSource: International Energy Agency (IEA) via The World Bank[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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I.6 Fossil fuel reserves

Whilst the terms 'reserve' and 'resource' are often used interchangeably, there is an important distinction between them. See [Data Quality & Definitions](https://ourworldindata.org/fossil-fuels/#reserves-vs-resources-when-does-a-resource-become-a-reserve) for a visual explanation of the difference between the two.

**Coal reserves**

How are our fossil fuel reserves distributed across the world? We can see the distribution of coal in the chart below. The largest coal reserves extend across North America, Asia and Oceania. The United States has the largest coal reserves, at nearly 240 billion tonnes. Russia, China, Australia, India and South Africa are also rich in coal reserves.

[Coal Proved Reserves, 2015](https://ourworldindata.org/grapher/coal-proved-reserves)Total proved coal reserves, measured in million tonnes. Proved reserves is generally taken to be those quantities thatgeological and engineering information indicates with reasonable certainty can be recovered in the future from knownreservoirs under existing economic and operating conditions.No data075,000200,000400,000600,000800,000900,000Source: BP Statistical Review[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Coal reserves by type/quality**

Coal sources are not homogeneous - they vary significantly in chemical composition and quality. Coal sources are typically differentiated based on carbon content; coal richer in carbon tends to produce more energy per unit mass (i.e. it has a higher energy yield). The quality of coal also has implications for air pollution. Fuels richer in carbon tend to have lower concentrations of impurities such as sulphur, meaning they produce lower levels of local air pollutants such as [sulphur dioxide](https://ourworldindata.org/air-pollution/#how-have-global-emissions-of-so2-evolved) (SO2). nitrogen oxides (NOx), and ozone (O3).

'Anthracite' coal is typically regarded as the highest quality, followed by bituminous, sub-bituminous and then lignite in decreasing order of quality. In the chart below we see coal reserves categorised based on type and quality. Globally we see that approximately 70 percent of coal reserves are of higher quality (anthracite & bituminous coal), with the remaining 30 percent of sub-bituminous or lignite grade.

The relative share of coal quality grades vary across the world - national and regional ratios can be explored using the "change country" option. For example, almost all coal reserves in the United Kingdom are of high-quality (anthracite & bituminous), whereas Australia has more lower-grade reserves (sub-bituminous and lignite) than high-grade.

[Coal reserves by type, World, 2016](https://ourworldindata.org/grapher/coal-reserves-by-type)Coal reserves broken down by type and quality, measured in million tonnes. Coal types are categorised based on carboncontent, ranking highest to lowest as: anthracite, bituminous, sub-bituminous then lignite. Coal with the highest carboncontent - anthracite and bituminous is typically of higher quality and results in fewer local air pollutants when burned.0 Mt100,000 Mt300,000 Mt500,000 Mt800,000 MtAnthracite and bituminous coal816,214 MtSub-bituminous and lignite323,117 MtSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Oil reserves**

The picture of global oil reserves is typically more well-known than for coal. Unsurprisingly, the Middle East is the richest region in terms of oil reserves, although on a country basis Venezuela has the largest global reserves at more than 300 billion barrels. Russia, Canada, the United States, and China also have relatively high stocks. Relative to its coal reserves (which are very small), Africa has several countries with relatively high oil reserves: these are predominantly concentrated in Libya, Algeria, Nigeria and Angola.

[Oil Proved Reserves, 2015](https://ourworldindata.org/grapher/oil-proved-reserves)Total proved oil reserves, measured in thousand million barrels. Proved reserves is generally taken to be those quantitiesthat geological and engineering information indicates with reasonable certainty can be recovered in the future fromknown reservoirs under existing economic and operating conditions.No data01550100200301Source: BP Statistical Review[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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**Gas reserves**

The Middle East is also rich in natural gas. Iran has the largest gas reserves at 34 trillion cubic metres, followed by Russia and Turkmenistan. with 32 and 17.5 trillion cubic metres, respectively. Again, the United States, Venezuela, and Saudi Arabia also have relatively high reserves. Overall, the maps for oil and natural gas tell a similar story; the distribution of coal, however, is notably different.

[Natural Gas Proved Reserves, 2015](https://ourworldindata.org/grapher/natural-gas-proved-reserves)Total proved gas reserves, measured in trillion cubic metres. Proved reserves is generally taken to be those quantitiesthat geological and engineering information indicates with reasonable certainty can be recovered in the future fromknown reservoirs under existing economic and operating conditions.No data05102030405060Source: BP Statistical Review[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

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I.7 Have we reached peak oil?

Fossil fuels (coal, oil and gas) are finite-consume them for long enough and global resources will eventually run out. Concerns surrounding this risk have persisted for decades. Arguably the most well-known example of this was Hubbert's Peak Theory-also known as the Hubbert curve (shown in the chart below).[3](https://ourworldindata.org/fossil-fuels#note-3)

Many have attempted to apply Hubbert's theory at not only a regional, but also a global level. Most attempts have, however, been proven wrong. We have provided discussion on predictions of peak oil - and why they are often proven false - in our blog post "[How long before we run out of fossil fuels?](https://ourworldindata.org/how-long-before-we-run-out-of-fossil-fuels/)".

[Hubbert's peak vs. actual oil production in the United States](https://ourworldindata.org/grapher/hubberts-peak-vs-actual-oil-production-in-the-united-states)Hubbert's hypothesis of peak oil production in the United States, alongside actual oil production trends in the UnitedStates, both measured in barrels per year.191019201940196019802000202020300500 million1 billion1.5 billion2 billion2.5 billion3 billion3.5 billionSource: Cavallo (2004) & EIA[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add data

* CHART
* DATA
* SOURCES

I.8 When will we run out of fossil fuels?

The obvious question people ask with regards to fuel reserves is: when are we going to run out? Fossil fuels are, of course, are finite resource and we will eventually run out if consumed indefinitely.

This question is an important and complex one to answer which we have addressed in our blog post "[How long before we run out of fossil fuels?](https://ourworldindata.org/how-long-before-we-run-out-of-fossil-fuels/)".

Best estimates of the number of years of fossil fuels remaining based on current known reserves is shown in the chart below. However, whilst we often worry about having too few global fuel resources (leading to a scarcity crisis), from a climate change perspective we actually have far too much. If we are to have any chance of keeping global average temperature increases below our 2°C target, we have to leave the majority (up to 80 percent) of our fossil fuels in the ground.[4](https://ourworldindata.org/fossil-fuels#note-4)

[Years of fossil fuel reserves left](https://ourworldindata.org/grapher/years-of-fossil-fuel-reserves-left)Years of global coal, oil and natural gas left, reported as the reserves-to-product (R/P) ratio which measures the numberof years of production left based on known reserves and annual production levels in 2015. Note that these values canchange with time based on the discovery of new reserves, and changes in annual production020406080100Coal114Natural Gas52.8Oil50.7Source: BP Statistical Review of World Energy 2016[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

* CHART
* DATA
* SOURCES

I.9 Fossil fuel prices

The chart below shows the index of average fossil fuel prices - for coal, oil and natural gas - over the last 30 years. This index is measured relative to the year 2000, where prices in 2000 are equal to 100. The charts in the sections to follow provide more detail on the absolute price as well as changes in prices of each fossil fuel across regional sources.

Overall, we see that natural gas prices have been the least variable over this period (remaining relatively close to 100 across the last 30 years). Coal has shown the greatest volatility - rising to four times the 2000 price in 2008, and nearly 3.5-times in 2011. Oil has similarly shown volatility - varying by two to three-fold over this period.

[Fossil fuel price index](https://ourworldindata.org/grapher/fossil-fuel-price-index)Average global prices of oil, natural gas and coal, measured as an energy index where prices in 2000=100.1987199019952000200520102015050100150200250300350400CoalOilNatural GasSource: BP Statistical Review 2016[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add data

* CHART
* DATA
* SOURCES

**Crude oil prices**

In the chart below we see the long-term trend in global crude oil prices, measured in 2016 US dollars per barrel.Overall we see strong volatility in oil prices, with significant spikes and shocks. In 2016, crude oil prices were US$43.73 per barrel - this represents a 275 percent drop in prices from 2011 when prices close to an all-time high at US$118.71.

Overall, we see that oil prices were relatively consistent throughout the 19th and first half of the 20th century, until a significant rise in prices in the 1970s. Prices spiked in 1980, reaching a high of US$107.27 before a rapid decline which coincides closely with the OPEC embargo of the early 1980s.

Oil prices later spiked again in 2008 before crashing following the financial crisis, with a later spike in 2011, falling to very low oil prices in 2016.

[Crude oil prices over the long term, US$ per barrel](https://ourworldindata.org/grapher/crude-oil-prices)Global crude oil prices, measured in 2016 US dollars per barrel.186118801900192019401960198020002016$0$20$40$60$80$100$120Source: BP Statistical Review 2016[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add country

* CHART
* DATA
* SOURCES

**Oil spot prices**

The visualisation below shows the crude oil spot prices across various oil blends, as measured in US$ per terawatt-hours (rather than per barrel) for comparison to energy prices of coal and natural gas below. As shown, the key oil blends have a closely matched spot price (despite very small differences).

In 2016, crude oil spot prices averaged around US$25 per terawatt-hour - the most expensive of the fossil fuels (as seen for coal and natural gas in the sections below).

[Crude oil spot prices, US$ per MWh](https://ourworldindata.org/grapher/crude-oil-spot-prices)Crude oil spot price of the most common oil blends, measured in 2016 US dollars per megawatt-hour (MWh) equivalents.197219801990200020102016$0$10$20$30$40$50$60Nigerian ForcadosBrentWest Texas IntermdiateDubaiSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add oil blend

* CHART
* DATA
* SOURCES

**Consumer pump prices for gasoline**

[Pump price for gasoline (US$ per liter), 2014](https://ourworldindata.org/grapher/pump-price-for-gasoline-us-per-liter)Fuel prices refer to the pump prices of the most widely sold grade of gasoline. Prices have been converted from the localcurrency to U.S. dollars.No data$0$0.4$0.8$1.2$1.6>$2Source: World Bank – WDI[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

1991

2014

* CHART
* MAP
* DATA
* SOURCES

**Consumer pump prices for diesel fuel**

[Pump price for diesel fuel (US$ per liter), 2014](https://ourworldindata.org/grapher/pump-price-for-diesel-fuel-us-per-liter)Fuel prices refer to the pump prices of the most widely sold grade of diesel fuel. Prices have been converted from thelocal currency to U.S. dollars.No data$0$0.3$0.6$0.9$1.2>$1.5Source: World Bank – WDI[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

1991

2014

* CHART
* MAP
* DATA
* SOURCES

**Coal prices**

The chart below shows coal prices over the last 30 years across different regional sources, measured in US dollars per terawatt-hour. Unlike oil, where blends tend to converge on a very similar spot price, coal types can vary quite significantly. The quality of coal deposits - in terms of their carbon content - can have a notable impact on their energy density, which will determine the tonnage of coal required for a give energy output.

[Coal prices, US$ per MWh](https://ourworldindata.org/grapher/coal-prices)Coal prices of various production locations, measured in 2016 US dollars per megawatt-hour (MWh).1987199019952000200520102016$0$5$10$15$20$25Japan coking coal import cif priceJapan steam coal import cif priceJapan steam spot cif priceChina Qinhuangdao spot priceAsian marker priceNorthwest Europe marker priceUS Central Appalachian coal spot priceindexSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add production zone

* CHART
* DATA
* SOURCES

**Natural gas prices**

The chart below shows natural gas prices over the last 30 years across different regional sources, measured in US dollars per terawatt-hour. Like coal, natural gas prices can [vary significantly](https://www.eia.gov/energyexplained/index.cfm?page=natural_gas_factors_affecting_prices) by source - this difference has been more marked over the last decade where gas from the United States can be up to five times cheaper than that in the Japanese markets.

This difference in price is partly explained by the differences in natural gas source. Accessible and economic shale gas supplies in the United States have grown dramatically over the last decade; this large supply security has leading to a significant fall in US gas prices. In contrast, much of natural gas in Asian markets is sourced as liquefied natural gas (LNG). LNG - which is compressed to form a liquid - is easier to to transport and store in a non-pressurized environment. However, this liquefaction process tends to incur a 'sunk cost', leading to relatively higher prices.

[Natural gas prices, US$ per MWh](https://ourworldindata.org/grapher/natural-gas-prices)Natural gas prices, measured in US dollars per megawatt-hour (MWh) by country or regional source.1984199019952000200520102016$0$10$20$30$40$50$60OECDJapanAverage German importUnited KingdomUnited StatesCanadaSource: BP Statistical Review of Global Energy[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add country

* CHART
* DATA
* SOURCES

I.10 Employment in fossil fuels

The energy industry has historically - and continues to be, in many countries - a large source of employment. In the charts below we see the long-term trends of employment in the coal industry in the United Kingdom (where large-scale coal production began) from 1873 to 2016.

**Absolute numbers employed in the coal industry**

The chart below shows UK coal employment in absolute numbers - this includes the number of workers contracted by the coal industry for work. In absolute numbers, employment in UK coal peaked in 1920, with nearly 1.2 million working in the industry. Since then, employment has continued to decline, reaching a low of less than one thousand workers in 2016.

[Employment in the coal industry in the United Kingdom, 1873-2016](https://ourworldindata.org/grapher/employment-in-the-coal-industry-in-the-united-kingdom-1873-2016)Total number of individuals employed in the coal industry in the United Kingdom from 1873-2016. Figures include thoseemployed as contractors by the coal industry.187319001920194019601980200020160200,000400,000600,000800,0001 millionUnited KingdomSource: UK Department for Energy and Climate Change (DECC)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

* CHART
* DATA
* SOURCES

**Share of the workforce employed in the coal indusry**

We can also visualise changes in coal employment by plotting the numbers in UK coal as a share of the total UK workforce. This change in share over time is shown in the chart below. Due to changes in the total workforce numbers, UK employment peaked slightly later in percentage terms, peaking at nearly six percent in 1924. This has declined to a low of less than 0.01 percent in 2016.

In the 1920s, 1 in every 20 workers in the UK were employed in the coal industry. In 2016, this has reached a low of only 1 in every 40,000 workers.

[Share of the workforce employed in the coal industry, United Kingdom](https://ourworldindata.org/grapher/share-of-the-workforce-employed-in-the-coal-industry-united-kingdom)The share of workers employed in coal production, measured as the percentage of the total workforce directly employedor contracted by the coal industry.187319001920194019601980200020160%1%2%3%4%5%United KingdomSource: UK Department for Energy and Climate Change (DECC); Bank of England Statistics[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

* CHART
* DATA
* SOURCES

II. Correlates, Determinants & Consequences

II.1 Greenhouse gas emissions from fossil fuels

**Emission factors of fossil fuels**

Fossil fuels can have short-term (in the form of local air pollution) and long-term (in the form of climatic change) environmental impacts. Fossil fuels - being the [dominant source](https://ourworldindata.org/grapher/global-primary-energy-consumption) of global energy production - are a key source of [carbon dioxide](https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions/) (CO2).

However, fossil fuels can vary significantly in their relative emissions of CO2 per unit energy. To compare these differences, we use a metric called a 'carbon dioxide emissions factor' - which is shown for various fossil fuel sources in the chart below. This is measured as the quantity of CO2 emitted (in kilograms) per unit of energy produced (in megawatt-hours). These factors are defined by the Intergovernmental Panel on Climate Change (IPCC), and are applied across global and national accounts of greenhouse gas emissions.[5](https://ourworldindata.org/fossil-fuels#note-5)

Although there can be notable differences in emissions factors between different types of a given fuel (for example, differences in coal types), there are some more general trends in the relative emissions between coal, oil and gas. Typically coal produces the most CO2 per unit energy, followed by oil (which is about one-third lower than coal), and natural gas (which can produce around half the emissions of coal).

As a result, coal is often termed the most polluting of the fossil fuels. Several countries - the largest example being the United States - have therefore achieved [carbon dioxide reductions](https://ourworldindata.org/grapher/annual-co-emissions-per-country?country=USA) in recent years by substituting coal production in its energy supply with natural gas.

[Carbon Dioxide Emissions Factor, kg CO₂ per MWh](https://ourworldindata.org/grapher/carbon-dioxide-emissions-factor)Carbon dioxide (CO₂) emissions factor, measured in kilograms of CO₂ produced per megawatt-hour (MWh) of energyproduced from a given fossil fuel source.0 kgCO₂50 kgCO₂150 kgCO₂250 kgCO₂400 kgCO₂Charcoal403.2 kgCO₂Coke385.2 kgCO₂Oil Shale & Tar Sands385.2 kgCO₂Peat381.6 kgCO₂Lignite363.6 kgCO₂Anthracite353.88 kgCO₂Sub-Bituminous Coal345.96 kgCO₂Bitumen290.52 kgCO₂Diesel Oil266.76 kgCO₂Crude Oil263.88 kgCO₂Shale Oil263.88 kgCO₂Jet Gasoline252 kgCO₂Aviation Gasoline252 kgCO₂Motor Gasoline249.48 kgCO₂Natural Gas201.96 kgCO₂Source: Intergovernmental Panel on Climate Change (IPCC)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US)

 Add country

* CHART
* DATA
* SOURCES

II.2 Unburnable carbon

In order to meet our international climate change target of limiting global warming to 2 degrees celcius (2°C) above pre-industrial temperatures, we can emit only a limited amount of greenhouse gases. This limit on emissions is often termed our 'carbon budget' - a budget of much carbon we can emit if we want to achieve a given probability of limiting warming to 2°C.

This budget - to achieve a 50 percent probability of meeting our target is shown in the chart below. This is measured relative to the total carbon which would be released if we were to burn all of our current known fossil fuel reserves (without the use of carbon capture and storage technology). As we explain in more detail in our [blog post](https://ourworldindata.org/how-long-before-we-run-out-of-fossil-fuels/), we see that if we are to have any chance of keeping global average temperature increases below our 2°C target, we have to leave the majority (up to 80 percent) of our fossil fuels in the ground.[6](https://ourworldindata.org/fossil-fuels#note-6)

The reserves of fossil fuels which we must leave untouched to stay within our carbon budget are often referred to as 'unburnable carbon'. These reserves are important, not only from an environmental perspective, but also an economic one. According to a widely-quoted study by Carbon Tracker, there is significant potential for this unburnable carbon to result in major economic losses.[7](https://ourworldindata.org/fossil-fuels#note-7) If capital investment in carbon-emitting infrastructure continues at recent rates, it estimates that up to 6.74 trillion US$ (nearly twice the [GDP of Germany](http://data.worldbank.org/indicator) in 2016) would be wasted over the next decade in the development of reserves that will eventually be unburnable.

[Global carbon budget for a two-degree world](https://ourworldindata.org/grapher/global-carbon-budget-for-a-two-degree-world)The carbon budget refers to the maximum quantity of carbon which can be released to maintain a 50 percent probabilityof global average temperature rise remaining below two-degrees celcius (the target set within the UN Paris climateagreement). This has been measured relative to the quantity of carbon which would be released if all fossil fuel reserveswere burned without the use of carbon capture and storage (CCS) technology. The difference between the two is definedas 'unburnable carbon'.0100200300400500600700Global Fossil Fuel Reserves746Unburnable Reserves471Carbon Budget for 2C275Source: Intergovernmental Panel on Climate Change (IPCC, 2013)[CC BY-SA](http://creativecommons.org/licenses/by-sa/4.0/deed.en_US" \t "_blank)

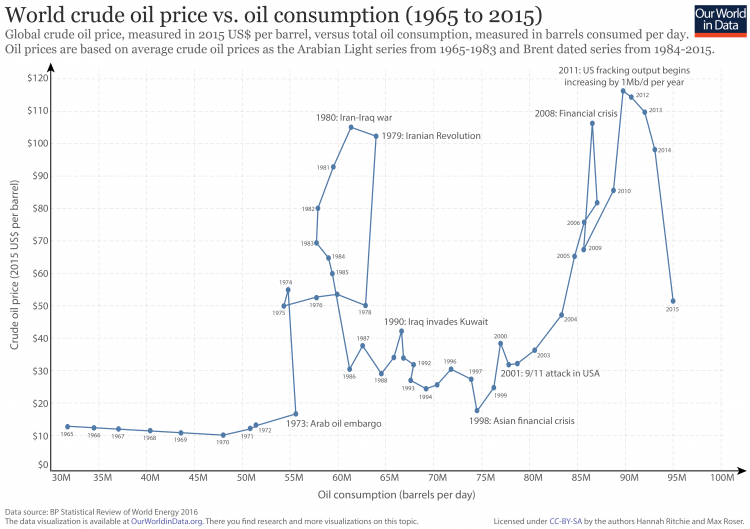
* CHART
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II.3 Oil prices vs. consumption

Oil demand - or alternatively, consumption - is one of the key determinants of oil prices. However, as shown in the chart below, and as widely discussed in the literature, oil shocks and declines are also tightly linked to distinct political and socioeconomic events.[8](https://ourworldindata.org/fossil-fuels#note-8)

The chart below shows the crude oil price (measured in 2015 US$ per barrel) versus global oil consumption, measured in barrels per day. Each marker represents the price-consumption values for a given year from 1965 to 2015. Key political, economic and social events have also been detailed below. This chart is also available to view in interactive form, [here](https://ourworldindata.org/grapher/world-crude-oil-price-vs-oil-consumption).

Overall, we see that the sharp changes in oil price coincide with large sociopolitical events - for example, the OPEC oil embargo of 1973 led to a sharp rise in prices; the Iranian Revolution of 1979 and the 2008 financial crisis to a sharp decline; and a continued fall in prices since 2011, when US output of shale oil has been consistently growing.

[](https://ourworldindata.org/wp-content/uploads/2017/10/Oil-prices-vs.-consumption.png)

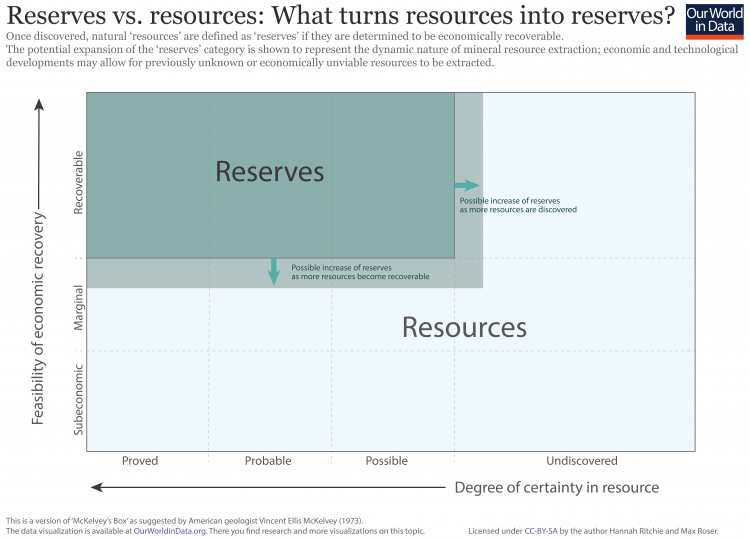
III. Data Definitions & Quality

III.1 Reserves vs. Resources: When does a resource become a reserve?

The terms 'reserves' and 'reserves' are often used interchangeably. However, there is an important distinction between the two. The chart below explains this distinction visually.

It is true that every reserve is a resource, but not every resource is a reserve. There are two requirements which determine whether a mineral resource becomes a reserve. The first is the degree of certainty that it exists: the planet likely has many mineral resources which we have not yet discovered. So to be defined as a reserve, we must have either a proved, probably or possible understanding of its existence. The second criteria relates to the economic feasibility of being able to access and extract the mineral resource. To be defined as a reserve, it must be economically and technologically viable to recover. If the economics are subeconomic (i.e. would result in a net loss) or marginal, a mineral resource is not defined as a reserve.

Whilst the original source of this concept - the American geologist Vincent McKelvey - visualised it as a static box, this transition between resources and reserve classifications is dynamic. As we discover previously unknown resources, and develop improved extraction technologies for economic recovery, this reserves box can grow with time (or shrink as we consume them).

[](https://ourworldindata.org/wp-content/uploads/2017/11/Reserves-vs.-Resources-01.png)

III.2 Units of energy

To maintain consistency between metrics and sources, we have attempted to normalise all energy data to units of watt-hours (Wh), or one of its SI prefixes. The table below shows the conversion of watt-hours to the range of SI prefixes used.

|  |  |
| --- | --- |
| **SI Unit** | **Watt-hour (Wh) equivalent** |
| Watt-hour (Wh) | - |
| Kilowatt-hour (kWh) | One thousand watt-hours (103 Wh) |
| Megawatt-hour (MWh) | One million watt-hours (106 Wh) |
| Gigawatt-hour (GWh) | One billion watt-hours (109 Wh) |
| Terawatt-hour (TWh) | One trillion watt-hours (1012 Wh) |

IV. Data Sources

BP Statistical Review of World Energy

* **Data:** BP publishes data on Oil, Gas Coal, Nuclear Energy, Hydroelectricity, Renewables, Primary Energy Consumption, Electricity Generation, Carbon Doixide Emissions
* **Geographical coverage:** Global - by country and region
* **Time span:** Annual data since 1951
* **Available at:** Online at [www.BP.com](http://web.archive.org/web/20140605044810/http:/www.bp.com:80/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy-2013.html)

The Shift Project (TSP)

* **Data:** Historical Energy Consumption Statistics and Historical Energy Production Statistics
* **Geographical coverage:** Global - by country and world region
* **Time span:** Since 1900
* **Available at:** Both datasets are online at [www.tsp-data-portal.org](http://www.tsp-data-portal.org/all-datasets).

IEA - International Energy Agency

* **Data:** Data on electricity, oil, gas, coal and renewables. Data on CO2 emissions (also projections)
* **Geographical coverage:** Global - by country
* **Time span:** Last decades
* **Available at:**Online at [www.iea.org](http://data.iea.org/)
* *The IEA is publishing the*[*World Energy Outlook*](http://www.worldenergyoutlook.org/)*.*
* *You have to pay to access the IEA databases. But some data is available through Gapminder, for example*[*Residential Energy Use (%)*](http://www.gapminder.org/world/#$majorMode=chart$is;shi=t;ly=2003;lb=f;il=t;fs=11;al=30;stl=t;st=t;nsl=t;se=t$wst;tts=C$ts;sp=8.91419354838709;ti=2010$zpv;v=0$inc_x;mmid=XCOORDS;iid=phAwcNAVuyj1jiMAkmq1iMg;by=ind$inc_y;mmid=YCOORDS;iid=0ArfEDsV3bBwCdEV1RkJqTEItQnJYVXJlZzVuc3Y3Mmc;by=ind$inc_s;uniValue=8.21;iid=phAwcNAVuyj0XOoBL_n5tAQ;by=ind$inc_c;uniValue=255;gid=CATID0;by=grp$map_x;scale=log;dataMin=282;dataMax=119849$map_y;scale=lin;dataMin=0;dataMax=98$map_s;sma=49;smi=2.65$cd;bd=0$inds=)*. (for few countries since 1960, for more countries since 1971 or 1981)*

Energy Information Administration

* **Data:** Total and crude oil production, oil consumption, natural gas production and consumption, coal production and consumption, electricity generation and consumption, primary energy, energy intensity, CO2 emissions and imports and exports for all fuels
* **Geographical coverage:** Global - by country
* **Time span:** Annual data since 1980
* **Available at:** Online at [ww.eia.gov](http://www.eia.gov/)
* *EIA is a US government agency.*

World Development Indicators - World Bank

* **Geographical coverage:**Global - by country and world region
* **Time span:** Last decades
* **Data:**[Energy use (kt of oil equivalent)](http://data.worldbank.org/indicator/EG.USE.COMM.KT.OE) - [Energy use (kg of oil equivalent *per capita*)](http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE) - [Energy production (kt of oil equivalent)](http://data.worldbank.org/indicator/EG.EGY.PROD.KT.OE)
* *Many more related indicators.*

Eurostat

* **Data:** Production & consumption of energy.
* **Geographical coverage:** Europe
* **Time span:**
* **Data on:**[Energy production and imports](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Energy_production_and_imports) - [Consumption of energy](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Consumption_of_energy) - [Electricity production, consumption and markets](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Electricity_production,_consumption_and_market_overview).