Using Curated Datasets

International Energy Agency

Royal Geographical Society with IBG

Advancing geography and geographical learning

https://www.iea.org

International Energy Agency (IEA)

Established in 1974 as a reaction to the preceding oil crisis, the International Energy Agency is a global intergovernmental organisation that advises countries and transnational corporations on maintaining sustainable levels of energy security. It carries out research into different energy sectors and has become a strong source of information on energy efficiency as well as production and consumption rates.

How do I access the data?

The above link is for the home page of the International Energy Agency. From here there are links to a **Data** subsite which houses numerous routes through to energy data. The **Data Browser** tab gives three further data options. Firstly, the **Energy Topic** menu provides a selection of indicators that can be viewed (see below). Depending on which topic is chosen, further, highly comprehensive **Indicators** are provided in the next menu. The number of these is staggering: an example of the kind of indicators available is also given below. Finally, the researcher has a choice of the **Country or Region** which will be viewed. Data will automatically be viewed from 1990 to the present day.

Categories of data sets available

- Energy supply
- Energy consumption
- Imports and Exports
- Coal
- Natural gas
- Oil
- Renewables and Waste
- Electricity and Heat
- Nuclear
- CO_2 Emissions
- Sustainable Development Goals
- Energy Transition Indicators

The data is automatically presented in its raw form as a **line graph** or **area chart**, and the researcher can toggle between these options through a selection button. There is also the option, if the data allows it, to view the data as **percentages**. Hovering the cursor over the graph shows the actual values on different years.

In order to download data, one must use the **Data Tables** tab. This provides three further menus: **Energy Category**, **Country or Region** and **Year**. This gives production and supply data, covering a range of different variables from 1990 to the present day. Though there is no specific download facility to this part of the site, the table of data which is produced can be copied and pasted into an Excel spreadsheet if necessary.

Examples of some of the indicators available within the 'Energy Supply' data set

- Coal Production by type (lignite; sub-bituminous coal; coking coal; anthracite)
- Electricity production by source
- Total primary energy supply by GDP
- Total primary energy supply per capita

Select the **Get the full dataset** button and one is taken to a part of the site that hosts the full statistical reports, often in PDF format, that are the sources of the data.

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How can I use this in my teaching?

Energy is integral to the teaching of a wide range of geographical topics, as well as being a discrete topic in its own right. It forms a key part of our understanding of development issues and energy resources can be seen as currency in defining where a country appears on the development spectrum. With this understanding comes issues of access to resources, security and inequality - things which are all bound to change as we move closer to a post-carbon world economy. Students wishing to study global governance will therefore find the uneven nature of energy supply and consumption an important factor to be considered in large political and economic systems. How these energy sources flow through different countries links well to any study of globalisation as energy is one factor we might consider a driver of increased interconnectivity between different nations and states.

The study of climate change, its causes and its management also makes wholesale references to energy resource use in the past, present and future. Analysing how different countries have approached reducing their carbon emissions means analysing where they get their energy from and the potential there is for further changes as well as the relationship they have with countries that supply different energy sources.

Curriculum Links

This curated dataset links to a number of parts of the National Curriculum and is relevant to GCSE and A Level Specifications.

Key Stage Three: An understanding, through the use of detailed place-based exemplars, the key processes in the use of natural resources.

An understanding of how processes interact to influence and change climate.

GCSE: A knowledge and understanding of the UK's geography, including environmental challenges and its changing economy and society.

An overview of how humans use, modify and change ecosystems and environments in order to obtain energy resources.

A detailed study of one energy resource, recognising the changing characteristics and distribution of demand and supply.

A Level: An understanding of the pathways and processes which control the cycling of carbon, including fossil fuel combustion.

An understanding of the way in which global systems and global governance underlie our own and other people's lives across the globe.

An understanding of how the characteristics of places are shaped by shifting flows of resources.

The following specifications make particular reference to the study of energy as a discrete topic:

GCSE:		**A Level:**	
AQA	Cambridge iGCSE	AQA	CIE
Edexcel A	Edexcel B	Edexcel	OCR
OCR A			

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An example data walk-through

A student wishes to study whether four countries which hosted various climate change summits have seen any reduction in their dependency on fossil fuels. The student believes that hosting a hugely important and historic summit may kick-start behaviour change in a country's citizens and its industry, as well as potentially ignite policy change which would make such energy resource changes possible.

First the student selected the **Data Tables** tab and selected **Electricity** from the **Energy Category** menu. This allowed the student to see how different countries' domestic production of electricity from renewable energy sources had changed in GWh (gigawatt hours) between 1990 and 2018. From this the student would be able to calculate the percentage share of the country's electricity production that had come from renewable sources - a more accurate figure given that the total amount of energy a country would use over a three year period would most likely increase regardless of the source of its energy.

The student then had to decide on which countries to view data for. They chose three of the more significant climate change summits: **Kyoto, Japan (1997)**; **Copenhagen, Denmark (2009)** and **Paris, France (2015)**. For each of these they wanted to compare data from the year of the summit to three years later to see which had made the biggest move away from fossil fuels and towards renewable energy sources to provide their respective countries with energy.

The student selected **Japan** from the **Country or Region** menu and **1997** from the **Year** menu. The site produced a table from which the data could be read. This was copied into an Excel spreadsheet to allow for ease of manipulation. The student then repeated the procedure for **Denmark** and **France** and their respective years. They then calculated the percentage change in the three year period for each country to allow for greater ease of comparison.

	Year	% share of electricity production from renewables	Year	% share of electricity production from renewables	Change in % over 3 year period
Japan	1997	11.3%	2000	10.6%	-0.8%
Denmark	2009	29.8%	2012	50.7%	20.9%
France	2015	17.1%	2018	20.8%	3.7%

From this the student saw that Denmark had by far had the best reaction to their summit and had moved away from non-renewable sources of electricity production at a far greater rate than the other two countries. However, the student realised that in order to really get an understanding of how the use of renewables had changed in that time, they needed to compare these results with the renewable share percentage at a global level for the time periods in question. This would tell the student how these countries performed at increasing their renewable energy use compared to the world average.

The same process was used to download data, though this time **World** was chosen from the **Country or Region** menu. This showed that both Denmark and France had moved from non-renewable to renewable sources of energy for electricity production at a far greater rate than the rest of the world during those time periods.

Years		Change in % over 3 year period	**World** Change in % over 3 year period
1997 - 2000	**Japan**	-0.8%	1.8%
2009 - 2012	**Denmark**	20.9%	1.6%
2015 - 2018	**France**	3.7%	1.8%

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Suggested delivery activities

Mapping Renewables

Data could be extracted and downloaded to show renewable energy production by sector in use by different countries. This could be manipulated to show which renewable energy source (if any) makes up the largest percentage of the domestic production of electricity within the country. These 'dominant' renewable energy sources could be mapped on a world map, either by hand using colour coding or through a simple GIS package that can allocate a different symbol to each country. Students can then look for patterns in the map and see if spatially there is pattern to the kind of renewable energy source most likely to be adopted by a country. Students could also create a GIS layer showing GDP per capita and see if there is any relationship between a country's wealth and which renewable energy source it favours.

Living graph

Students can use the data from the site to create a simple line graph of world energy consumption. They can then be given cards that each have a different global event on them and a short descriptor, with the descriptor omitting the date the event took place. Examples could include events such as the 1973 oil crisis, the 2008 economic crash or the 2003 US invasion of Iraq. Students then have to look at their line graph and think about where to best place each of the cards on the line so they tell the story of why the line rises and falls at different points in history. The exercise can be made more challenging for older students by including more complex events or by using an area graph of energy source rather than a line graph - this would give the students the scope to think about how different energy sources may have been affected.

Who's who?

Teachers can use the data from the site to draw pie charts of different countries according to the different sources of energy they use. Countries that have a particular affiliation with a certain energy type such as China (coal) Brazil (hydroelectric) and France (nuclear) should be used, as well as countries from all parts of the development spectrum. Students can then try to guess from a pre-populated list which country is which pie chart, based on what they already know of different countries, or by having been given time to research different countries. If the pie charts are printed onto separate cards, students could also do card sorts with them - for example by placing them in a line from most to least sustainable future or most or least developed economically.

Chi Squared

Chi Squared calculations show the strength of association between two sets of categorical data. It works by comparing the observed frequency of something occurring (i.e. the actual data) with the expected frequency (the data that one would expect if no external variables were acting on it). It is possible to use the Chi Squared test if the data is discrete so that it can easily be placed into categories.

In this case, different regions' energy mix data can be downloaded and a student can test whether there is an association between the region and the type of energy sources utilised there to produce electricity domestically. A guide to the Chi Squared test appears on the next page.

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A Guide to Calculating Chi Squared using International Energy Data

The Chi Squared (χ^2) test is a statistical method used to find the strength of association between two sets of categorical data. It works by comparing the 'observed data' (that which is true) with 'expected data' (that which would theoretically be true if no factors were acting upon it).

Using 2017 data from the IEA site, a student might want to see how close an association there is between a continent and the use of different energy sources to produce electricity.

Worked example:

OBSERVED	Africa	Europe	Asia Pacific	TOTAL
Biofuels	1797	166409	171968	340174
Fossil Fuels	654281	1859602	8579347	11093230
Nuclear	14193	935670	500081	1449944
Other renewables	150267	1145138	2374226	3669631
TOTAL	820538	4106819	11625622	16552979

The relevant data was extracted from the IEA site (electricity production by source in GWh) and placed into a data table. The totals for each continent and for each energy type were calculated and added to the table.

The expected data was then calculated. The expected data assumes that all continents use different energy sources as much as each other. To calculate the expected data the student used the following equation:

$$\text{Expected} = \frac{\text{column total x row total}}{\text{overall total}}$$

So to calculate the expected use of biofuels in Africa, the students multiplied 820538 by 340174 and divided this by 16552979. When completed for each of the twelve values an 'expected data' table was drawn up.

EXPECTED	Africa	Europe	Asia Pacific	TOTAL
Biofuels	16863	84398	238914	340174
Fossil Fuels	549896	2752247	7791087	11093230
Nuclear	71874	359733	1018336	1449944
Other renewables	181905	910441	2577285	3669631
TOTAL	820538	4106819	11625622	16552979

A new value for each entry in the table is then calculated using the equation below where O is the observed value and E is the expected value.

$$\chi^2 = \frac{\Sigma (O - E)^2}{E}$$

Putting this in a table helped the student to calculate the chi squared (χ^2) value which was the sum of all those in the table. In this case the chi squared value was 1,815,119. The larger the chi squared value, the more likely there is an association between continent and energy source. The student used a significance table to see if the amount of data made the result significant. In this case the chi squared value was greater than the critical value in the significance table so one can conclude that there is a significant association between a continent and the source of energy used for electricity production there.

χ^2	Africa	Europe	Asia Pacific	TOTAL
Biofuels	13460	79692	18759	111911
Fossil Fuels	19815	289514	79752	389081
Nuclear	46291	922081	263752	1232124
Other renewables	5503	60501	15999	82002
TOTAL	85069	1351789	378262	1815119

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