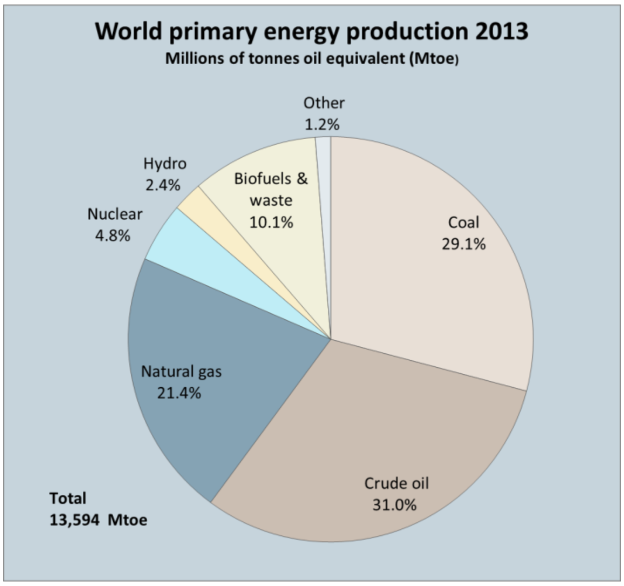
Energy

Availability of clean renewable energy is a critical issue affecting the future of humanity. It is one of the most significant constraints both on the lifestyles and on the number of people that will be sustainable in generations to come.

Energy consumption in perspective

Energy is an essential resource for all life forms, almost all of which are sustained by a food chain which begins originally with energy from sunlight. Most human communities, especially those in industrially developed economies, also depend on huge amounts of energy for many other activities and services.



World primary energy production[1]

Large-scale agriculture relies not only on the sun but also on energy used to manufacture artificial fertilizers and fuel for agricultural machinery, transport and food processing. In developed countries, almost all economic activity is underpinned by large-scale consumption of cheap energy, for manufacturing goods, for transport, for building houses and other infrastructure, and for heating.

Global primary energy supply rose from 6,100 million tonnes of oil equivalent in 1973 to 13,500 million in 2013.[2] It is important to appreciate the present scale of industrial energy consumption.

An energetic person weighing 75 kg who takes two hours to walk up a 1,000-metre-high mountain has an output of only 0.1 kW (though you need more food input than this, because the human body is not very efficient as a machine). The traditional 'one horsepower' draught horse at work produced the equivalent of about 0.75 kW, and therefore five to ten times what a single person could achieve.

At the beginning of the industrial revolution, water power resulted in a step change in the amount of energy used in industry, but the majority of water wheels still only delivered a few kW. The big increase in power available came with steam and other combustion engines, most of which burned fossil fuels — originally coal, and more recently oil or natural gas. A typical modern family car is capable of approximately 75 kW, and a large industrial power turbine more than 100 MW — equivalent to more than 100,000 horses!

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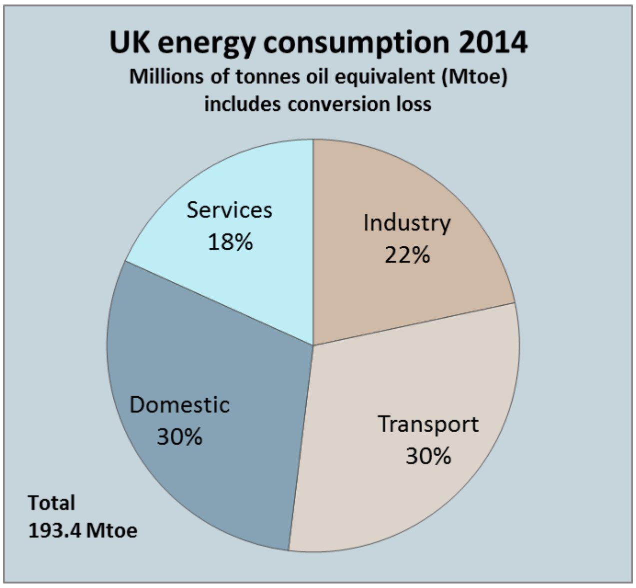
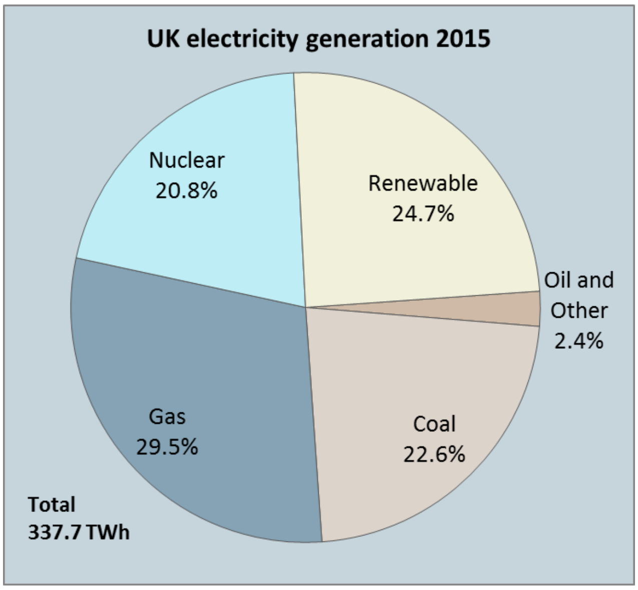


UK energy 2014 energy consumption by sector of use[3]

In 2014 the UK economy used a total of 193.4 million tonnes of oil equivalent (see pie diagram). For the then population of 64.6 million, this is equivalent to a continuous non-stop energy consumption of approximately 4 kW by every UK citizen.[4,5]



UK sources of energy for electricity generation[6]

Reliance on so much energy, nationally and globally, is a high-risk strategy, especially when the vast majority of energy used in most developed countries is so heavily dependent on fossil fuels.

There is only a finite amount of fossil fuels on the planet, representing energy resources built up by prehistoric animals and plants over millions of years. At our current rates of consumption, we will have exhausted these irreplaceable energy stores in just a few centuries.

As the more readily-attainable fossil fuels are used up, it is becoming increasingly expensive to extract what remains. Petroleum geologists believe we are close to the time of Peak Oil, when the global rate of oil extraction will inevitably decline.

A rapid decline in the availability of fuels and the consequent increase in the price of energy are likely to cause major economic dislocation.

Energy and climate change

A major and immediate problem with fossil fuels is that their combustion releases large quantities of greenhouse gases (GHGs) into the atmosphere, notably carbon dioxide (CO_2), which is the principal anthropogenic contributor to the overall greenhouse effect. Continued large-scale emissions greatly increase the probability that the increase in global temperatures will lead to catastrophic climate change.

The December 2015 UN Climate Change Conference in Paris (COP21) resulted in an international agreement to reduce atmospheric GHG levels sufficiently to avoid dangerous climate change. The aim is to keep the global temperature rise this century well below 2 degrees Celsius above pre-industrial levels, with further efforts to limit the increase to 1.5 degrees. The extent to which this objective will be achieved in practice remains to be seen.

Achieving a sufficient reduction in GHG levels will require a combination of reduced energy demand, replacement of fossil fuels by energy sources with lower GHG emissions, and active removal of GHGs from the atmosphere.

Because atmospheric CO_2 breaks down very slowly, once emissions have occurred they will continue to affect global temperature for many years. Therefore, a substantial reduction in emissions needs to be undertaken without further delay.

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Energy for the future

Low-carbon energy sources include such renewables as hydro-electricity, biomass, wind, wave, tidal, solar thermal, solar photovoltaic power, geothermal, etc. These are all likely to play a part in providing sustainable and environmentally-friendly power, but they should not be seen as a panacea for the energy problems facing human societies in the foreseeable future.

Exploiting renewable energy requires substantial investment to develop the technology and build the necessary equipment and infrastructure. Though the cost per kWh of some forms of renewable electricity generation has been dropping, it has to compete with fossil-fuel power generation, which is still often supported by subsidies.[7, 8] Intermittent availability also adds to the real cost of many renewables — wind, for example, is both variable and unpredictable — making it difficult and expensive to integrate a high percentage of renewable-based energy into the general energy supply.

Energy storage is a developing field which should contribute increasingly to the uptake of renewables and help to facilitate local decentralised energy schemes to rely less on large-scale investment and long distance transmission. Nevertheless, the need to store energy from renewable sources will always be an additional cost, and every time energy is transformed some of it is lost into the environment, thereby increasing the amount that must be generated to meet any given demand.

Moreover, simply because an energy source is renewable does not mean that it is unlimited. The greater the total energy demand, the more difficult it will be to satisfy it in an entirely sustainable manner.

Some commentators argue that further investment in nuclear power will be essential to meet the COP21 GHG emission targets, advocating nuclear as a low-carbon source of renewable energy. This needs to be seen in perspective. All existing nuclear power plants are based on fission (release of nuclear energy by splitting heavy elements). Extraction and preparation of the fuel, and construction of the power plant, are very energy intensive — much of this embedded energy being fossil-fuel derived. Furthermore, the massive investment required to build a typical nuclear power station results in very high costs per net kWh generated, and there is a very long lead time between construction go-ahead and bringing a plant on line.

Though modern plants are built to very high standards, there is not yet a full consensus regarding either the satisfactory disposal of radioactive waste or operational safety. Many people regard even an extremely low probability of a major loss of containment incident, or of terrorists obtaining plutonium, to be unacceptable.

It is also possible to release energy by nuclear fusion, but no viable method of doing so for peaceful purposes has yet been developed. Fusion may eventually have a part to play, but estimates of its availability have remained at several decades into the future over the last 50 years. It would be highly irresponsible to rely on it being available within the foreseeable future. Some have suggested that process

Use of the terms ***resources*** and ***reserves*** can lead to confusion. **Resources** refer to the total amount of material that exists whereas **reserves** refer to the amount of material known to be economically extractable. Both will be reduced by consumption, but reserves may increase when new discoveries are made or factors alter the economics of exploiting them.

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intensification of nuclear power generation may reduce the scale of investment and risks to more acceptable levels. However, the precautionary principle again argues against assuming that yet another unproven technology will lead to an abundance of clean, safe and economically viable energy.

Constraints and timescales

Minimising the risk of dangerous climate change requires more effort to reduce GHG emissions as soon as possible. Further delay may result in so much greenhouse gas in the atmosphere that it will be too late to avoid a large rise in global temperature, even if net emissions are later reduced to almost zero. Much of the initial reduction will therefore need to be achieved with already-proven technology.

Any morally acceptable path to globally sustainable energy consumption must allow poorer countries to develop their economies so they can enjoy similar living standards to those in countries which are already prosperous. Many environmentalists believe that resource availability and climate change constraints will necessitate a drastic reduction of per capita energy consumption in the more prosperous countries. The principle of "contraction and convergence" proposed by the Global Commons Institute[9] is a potential methodology for equitably reducing global emissions. By convergence of allowed per capita emissions, developing and developed countries would eventually reach equivalent living standards.

It is self-evident that the larger the population, the more difficult it will be for all to enjoy an acceptable standard of living at a sustainable level of energy consumption. The UN publishes a range of future population-size projections. Their 2015-based figures show a high projection for 2100 world population that is more than double that of the low one; even for 2050, the difference is nearly 25 per cent.[10] Clearly, it is no longer acceptable to treat population growth as inevitable; ethically acceptable means of constraining population numbers to the lower end of the projected range become a top priority. Because of the time lag between falling birth rates and a significant difference in population size, it is important that appropriate measures are put in place as soon as possible.

Conclusion

Simply replacing fossil fuels with renewable sources will not be sufficient for an ever-growing world population to enjoy an ever-increasing standard of living.

It is a matter of urgency to reduce per capita energy consumption and to put the brakes on population growth.

References

Internet references accessed 18/04/2016

[1] International Energy Agency, Key World Energy Statistics 2015

[2] https://www.iea.org/publications/freepublications/publication/key-world-energy-statistics-2015.html

[3] https://www.gov.uk/government/statistics/energy-consumption-in-the-uk

[4] ibid

[5] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/timeseries/ukpop

[6] UK Office of National Statistics — UK Energy Statistics, 2015 & Q4 2015

[7] http://www.theguardian.com/environment/2015/nov/12/uk-breaks-pledge-to-become-only-g7-country-increase-fossil-fuel-subsidies

[8] http://www.odi.org/publications/10058-production-subsidies-oil-gas-coal-fossil-fuels-g20-broken-promises

[9] http://www.gci.org.uk/

[10] http://esa.un.org/unpd/wpp/Publications/Files/WPP2015_Volume-I_Comprehensive-Tables.pdf

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