

ENERGY SECURITY

ENERGY SUPPLY, DEMAND AND SECURITY

There are many energy sources that can be classified in different ways (flows of renewable sources, stocks of non-renewable and recyclable sources) that have different environmental costs.

Energy classification

Renewable resources which do not need regeneration are often termed flow resources (in constant supply) and include solar, wind and tidal power. Biomass requires regeneration, so does not constitute as a flow resource. They cause little or no pollution. However, they have only been utilised to a limited extent due to problems regarding technology and cost.

Non-renewable resources currently dominate global energy mixes. The challenge is to transform the global energy mix to achieve a better balance between renewable and non-renewable sources of energy.

Recyclable energy resources are those where the fuel that has been used once can be used again to generate power. At present, only nuclear power is classed as reusable. Here, nuclear reprocessing can make uranium waste reusable.

The environmental impacts of energy sources

Energy source	Environmental impact: production and use
Coal	Opencast mining scars large areas of land and requires costly remedial work Although environmental legislation in numerous countries requires nitrogen oxides and sulphur dioxide to be removed, all the CO ₂ produced is released 2 billion tonnes of CO ₂ are released by US coal power plants each year
Oil	Infrastructure required to extract from large oil fields covers very large areas Oil spills at production sites and along pipeline/tanker routes are hazardous Oil-fired power stations create greenhouse gases (much less than coal-fired)
Natural gas	Creates major environmental problems when flared off as a waste product at oilfields, which occurs when there is no infrastructure to pipe the gas away
Nuclear	Power plant accidents can release radiation into the air, land and sea Difficult to store or dispose of radioactive nuclear waste Rogue state or terrorist use of nuclear fuel for weapons There is a possible increase in certain types of cancer near nuclear plants
Hydro- electricity	Large dams and power plants can have huge negative environmental impacts Obstruct the river for aquatic life Deterioration in water quality for consumption Large areas of land are flooded to make the reservoir Submerging large forests without prior clearance releases lots of methane
Wind	There can be a significant visual impact of wind farms on landscapes The hum of wind turbines can disturb wildlife and people
Solar	Both central receivers and photovoltaic cells require large amounts of land to produce a significant amount of power People object to the visual impact of such installations
Geothermal	Geothermal steam causes pollution as it contains e.g. hydrogen sulphide Geothermal hot water has a high brine content, which often corrodes piping The hot water needs to be disposed of once brought to the surface

Biomass	Clearing vegetation for firewood can lead to desertification The use of biomass for cooking and heating in developing countries causes indoor pollution which is a major health hazard
Tidal	Tidal barrages may have a significant impact on the regional environment, as they are often in estuaries of high ecological value
Waves	The main concerns are noise pollution and visual impact

Ecuador is facing severe environmental costs due to sloppy extraction of resources.

- Dependence on oil revenue has hindered environmental law enforcement.
- Indigenous people (Huaorani tribe) have died due to water contamination leading to cancer, miscarriages, dermatitis and infections.
- Thousands of acres of forest have been felled, forcing tribes to move into the forest to hunt.
- Oil placed on roads to reduce dust has drained into rivers.
- Oil spills from ruptured pipelines account for 16 million gallons of oil that have entered the Amazon's ecosystem over the past 18 years.

The Ogoni tribe in Nigeria's river delta suffer from environmental damages caused by oil extraction.

- Ogonis protest Shell's oil production in Nigeria as it has devastated the local environment and destroyed the economic viability of the land for farmers.
- They are vulnerable to food shortages, health hazards, pollution and forced migration.
- Shell dumps by-products directly into water without treatment to reduce costs, and flares gas which causes air and water pollution.

Keywords

Energy mix: the relative contribution of different energy sources to a country's energy production or consumption.

Environmental impact assessment: a document required by law detailing all the impacts on the environment of an energy type or another project above a certain size.

Access to and consumption of energy resources, both renewable and non-renewable, is not evenly distributed, and depends on physical factors, cost, technology and public perception. Some areas suffer from energy poverty, while others have a surplus.

The distribution of energy resources

North America's energy needs come mostly from oil (40%) as there are vast reserves in the Gulf of Mexico, Alaska and Canada. 25% of energy consumption came from gas which is found close to oil deposits, with another 25% from coal, of which it has large reserves of. Its economic growth is due to these fossil fuels, which are consumed by industries e.g. pharmaceutical and chemical, domestic use and the transport sector. North America has more nuclear reactors than any other country (103) as it has huge reserves of uranium, and although it is a controversial form of energy, a small amount of uranium produces a lot of energy and it does not give off greenhouse gases. Less than 10% of North America's energy comes from HEP. Most stations are located on the East and West coasts

where there is plenty of rainfall and fast-flowing rivers. The region can also afford the high capital costs needed to build HEP stations.

65% of South and Central America's energy comes from oil and natural gas. There are vast reserves of both fuels in Venezuela and pipelines and oil tankers connect these supplies and those from the Middle East to the rest of the region. Standards of living have increased in many of the countries in this region, and Brazil, an NIC, is increasing its demand due to rapid economic growth. Of all the regions, South and Central America was the greatest consumer of HEP due to heavy rainfall, fast-flowing rivers and large dams e.g. in Brazil, Paraguay and Argentina. The consumption of coal and nuclear power is minimal. Southern continents are relatively deficient in coal and there are no reserves of uranium. In addition, it is very costly to build nuclear reactors.

Of Europe and Eurasia's consumption, 65% was shared equally by oil and natural gas. There are reserves of natural gas in Russia, UK and Norway and many gas pipelines in Europe move gas from areas of supply to areas of demand. There are gas pipelines in the North Sea and within mainland Europe. 20% of the region's energy needs were met by coal, which is mainly found in the Northern Hemisphere, in countries such as Poland, the UK, Kazakhstan (Eastern Europe). Coal is a cheap and traditionally used form of energy, so there is much infrastructure available for the production of power from coal. 10% of the energy used came from nuclear power as Western Europe can afford to import uranium. France, Kazakhstan and Uzbekistan have reserves of uranium. The UK has reprocessing plants such as Sellafield. The least energy came from HEP, as existing fossil fuel power plants meet the current needs.

The Middle East consumed mainly fossil fuels – oil provided 50% of energy needs and gas 45% - due to the huge reserves in the region e.g. in Saudi Arabia, Iran, Iraq and Kuwait. A small amount of coal is used as coal-fired power stations from many years ago are still running off imported supplies.

Africa mainly used fossil fuels. There are coal reserves (30% of energy consumption) across much of Africa, especially South Africa, and oil reserves (40% of energy use) in Nigeria, Libya and Algeria. This makes fossil fuels cheap and accessible as forms of energy in the region. HEP is not viable in the region due to low rainfall, and nuclear energy is costly and unnecessary in a region which has access to other sources.

Asia Pacific also consumed mainly fossil fuels. 50% of its energy needs were met by using coal, 30% by oil and 15% by gas. China and India have vast coal deposits and it is cheap for them to generate electricity using coal. There are gas pipelines throughout the region and oil is taken by tanker to areas of demand. Like most other regions, it consumed little HEP and nuclear energy. Most of the nuclear energy use is found in South Korea and Japan, which are deficient in fossil fuels and can afford the cost of nuclear power stations.

Renewable energy production

Hydro-electricity dominates renewable energy production. The 'big four' HEP nations of Canada, China, Brazil and the USA account for over 52% of the global total energy production using hydro-electric power. The capacity of the top ten producers of HEP is nearly 600,000MW.

Wind energy's global capacity is 320,000MW, with the USA the world leader with 26.4% of production. Germany, Spain and China account for 40% of world total.

Biofuels are the most technologically advanced form of biomass. They are fossil fuel substitutes that can be made from a range of agri-crop materials, including oilseeds, wheat, corn and sugar. They can be blended with petrol and diesel. In recent years, increasing amounts of cropland have been used to produce biofuels. Ethanol is the most common biofuel globally, particularly in Brazil and the USA. It accounts for over 90% of total biofuel production. Many developing countries rely on traditional biomass for their energy needs through the collection of firewood for burning. 75% of biomass output is generated by OECD countries, with a 76,000MW worldwide capacity in 2012.

Geothermal energy has a global capacity of 18,500MW, with the USA generating 29% of this with plants in Alaska, California, Hawaii, Nevada and Utah. The Philippines and Indonesia together generate the same as the USA.

Installed capacity of solar power (photovoltaic) at the end of 2013 was 137,000MW. China, Japan and the USA produce 17% of the world's solar power.

Demand for energy is growing globally, and at regional and local scales, especially in developed or emergent economies such as China and India.

Why is supply uneven?

Physical factors: fossil fuels are unevenly spread, dependent on where fossilisation occurred in the past. HEP requires rain, so is not a possibility in the Sahel region of Africa unless on a very small scale. Solar power requires sunshine, so would not be of much use in Northern Europe. Wind power requires high and constant wind speeds, so is best on the coast and on mountains. Land space is needed for power stations.

Economic factors: extraction of raw materials is costly due to capital and labour needed. Markets can be volatile, meaning that higher extraction costs e.g. in pristine areas are only worthwhile when the price of the resource is high. Greater demand fuels exploration so TNCs only prospect in areas near high demand.

Political factors: voters worrying about greenhouse gas emissions force governments to change energy mix to favour greener fuels, changing the proportional supply of the different resources. The costs of research and development may be partially funded by governments if it is beneficial to political agendas. International agreement is required before hydro-electric power can be harnessed on transboundary rivers, influencing the supply of this resource.

Marxist guerrillas in Colombia challenge the government's policies.

- They interrupt oil production and often commit terrorist attacks, bombings and kidnappings.
- US\$ 1 billion worth of oil was lost in pipeline attacks.
- The guerrillas want rural development and nationalisation of the oil industry, and challenge Colombian laws regarding environmental degradation due to methods of oil exploration and extraction used by foreign companies such as BP.

Energy poverty in LEDCs is caused by a lack of access to resources, which is common in the developing world. There is a high reliance on fuel wood and fossil fuel consumption is low. Farm

waste levels are high. Up to 40% of the world's population rely on fuelwood for cooking and heating. Nearly 2 billion people have no access to electricity. Access to cheap, reliable energy is related to development.

Which energy sources are used is not a matter of which fossil fuels or renewable forms are available in a country. Cost is critical, as people may not be able to afford to extract readily available fuel sources. Attitudes are sensitive – Germany opposes nuclear power, and is decommissioning all power plants by 2022, and the Fukushima disaster of 2011 has not improved the publicity of nuclear power. The technology required to drill is costly and not available everywhere, especially not in LICs.

Demand for energy

The global demand for energy doubled between 1960 and 1980. Growth in demand has been slower since 1980, however is projected to increase 60% between 2002 and 2030. Demand is increasing due to economic development and population increase, which bring with them higher standards of living and a demand for domestic appliances.

Global demand for oil is set to expand, with the growth in demand expected to come from Asia (China and India), the Middle East and other non-OECD countries (South Africa, Brazil). This is because the greater the development of a country, the greater the demand for oil is. The economies of these countries are based on heavy industry and the processing of raw materials which are very energy intensive. Average incomes in these countries will rise as consumers start buying cars and modern conveniences that tax the power grid, such as refrigerators, dishwashers and dryers. Appliances such as these represent real improvements in quality of life but they are energy drains. Demand for oil will grow in OECD countries too, as oil is needed in transportation in North America and Europe. Demand may fall in Japan due to fuel efficient cars and a switch from oil to gas. Japan also uses nuclear energy however this may decrease following the Fukushima disaster in 2011.

MEDCs

Of the MEDCs, the USA and Japan have increased consumption, but only by a small amount, whereas Germany and the UK have decreased their consumption due to a more efficient use of their energy – factories with cleaner industrial processes, full insulation in houses, green transport and hybrid technology and greener power stations with lower emissions. There has also been an increase in sophisticated technology and a decrease in wastage due to a change in mind set. Deindustrialisation has also reduced demand as factories have relocated to LEDCs for cheaper labour.

Country	1997	2007
USA	2204.8	2361.4
Japan	506.6	517.5
Germany	337.8	311.0
UK	220.4	215.9
South Korea	179.6	234.0
Malaysia	37.8	57.4
China	961.4	1863.4
India	260.6	404.4
Bangladesh	10.6	20.3
Pakistan	41.2	58.3
Peru	10.9	13.8
Algeria	26.5	34.7

Energy consumption 1997-2007
(million tonnes oil equivalent)

NICs

The NICs are increasing demand by the fastest rate. China and India have almost doubled their demand in 10 years due to rapid economic growth and a more affluent population moving into urban areas which have higher standards of living. Greater consumerism in vehicles and domestic appliances such as white goods accounts for the increasing demand. South Korea and Malaysia – the Asian Tigers – were also encouraging foreign direct investment and expanding their industries.

Developing countries

The developing countries have much lower consumption and the countries shown vary in the rates of economic growth and population growth. In general, they have large populations living in rural areas and they have difficulty paying for their energy needs. Algeria has almost doubled its energy consumption due to oil reserves and an increase in economic development, and Pakistan uses a lot of energy for its military transport needs. Bangladesh has many manufacturing industries (TNCs) as labour is cheap and laws are lax, which would account for the rise in energy consumption.

Variable energy patterns over time

Technological development: nuclear electricity has only been available since 1954. Oil and gas can now be extracted from much deeper waters than in the past and renewable energy technology is advancing steadily.

Increasing national wealth: as average incomes increase, living standards improve. This involves the increasing use of energy and the use of a greater variety of energy sources.

Changes in demand: at one time all of Britain's trains and most homes used coal. Before natural gas was discovered in the North Sea, Britain's gas was produced from coal (coal gas).

Changes in price: the relative prices of the different types of energy can influence demand. Electricity production in the UK switched from coal to gas because gas-power stations are cheaper.

Environmental factors/public opinion: public opinion can influence decisions made by governments.

Key words

Geopolitics: political relations among nations, particularly relating to claims and disputes pertaining to borders, territories and resources.

Supply shock: a significant interruption to supply due to an environmental, economic or political event.

Energy security depends on resource availability (domestic and foreign) and security of supply, which can be affected by geopolitics, and is a key issue for many economies.

Energy security

Energy security is the reliable supply of energy at a cost that supports economic growth. It depends on domestic fossil fuel reserves, domestic energy mix, domestic renewable potential and the risks faced by import pathways. Energy crises such as the 1973 Arab-Israeli war and other less serious shortages cause prices to increase. Reliance on long distance international trade in fossil fuels may be risky. The Strategic Petroleum Reserve in the USA has increased their energy security as it provides a 3 month supply in the event of interruptions in supply of imported oil.

Denmark changed its energy mix following the 1973 Arab-Israeli war, when much of Europe found that they were dependent on Arab nations for oil.

- Greenhouse gas emissions have been reduced 14% since 1990.
- Industries are charged energy and green taxes to create incentives for renewable usage.
- Wind energy supplies 30% of Denmark's electricity.
- 39% of waste generates electricity for households.
- Energy technologies comprise 11% of Denmark's exports.

Reasons for energy insecurity

Geopolitical tensions include the Arab-Israeli war, during which the Arab nations reduced the supply of oil to the USA and Western Europe in an effort to reduce their support for Israel. This led to a serious energy shortage which became known as the 'Energy Crisis'. Price disputes can also cause energy insecurity, for example Russia's various disputes with the Ukraine and other European states.

Interruptions to energy pathways can occur due to piracy and terrorism (Somalia) in choke points, as well as those caused by people siphoning off from pipelines e.g. the Ogoni tribe in Nigeria. Natural disasters such as hurricane Katrina can break supply lines. Inhospitable environments such as Alaska, home to the Trans-Alaskan pipeline, can make checking for damage difficult, causing problems if there is a leak – huge damage to a pristine environment would be caused. Human disasters such as Deepwater Horizon 2010 cause large economic losses as valuable resources are lost, which causes interruptions to supply in areas dependent on these oil rigs.

Key words

Energy crisis: a serious shortage of energy which interrupts domestic supplies and impacts all sectors of the economy.

Proved reserves of oil: quantities of oil that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions.

Reserves-to-production ratio: the reserves remaining at the end of any year are divided by the production in that year. The result is the length of time those remaining reserves would last if production were to continue at that level.

Strategic Petroleum Reserve: the USA's supply of oil which should last for about 3 months in the event of severe interruptions to imported oil.

THE IMPACTS OF ENERGY INSECURITY

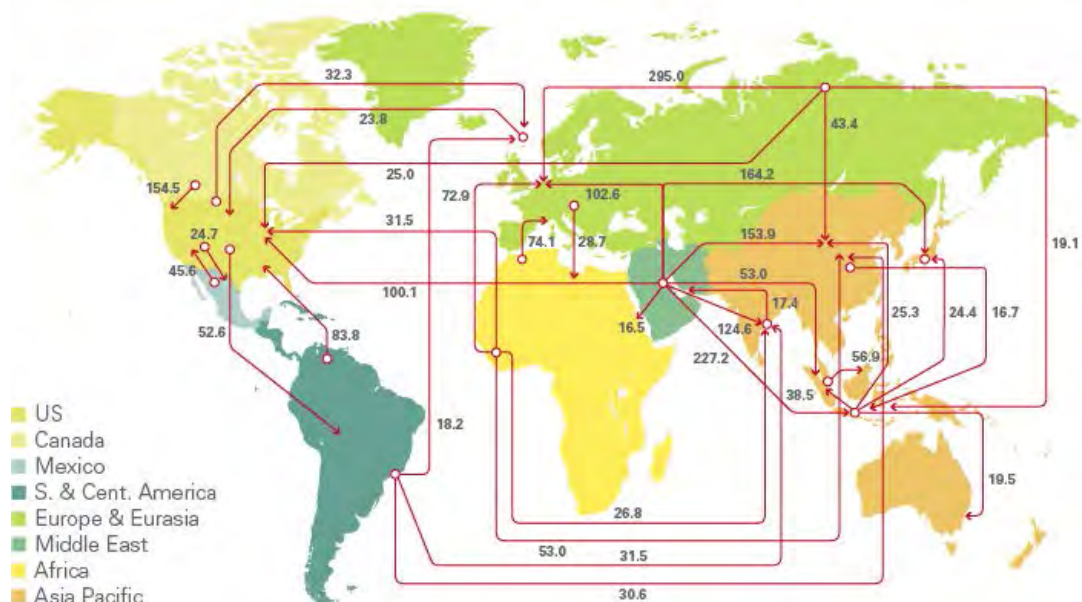
Energy pathways, between producers and consumers, are complex and show increasing levels of risk e.g. the trans-Siberian gas pipeline into Western Europe, or Middle Eastern supplies.

Energy infrastructure and supply pathways

Energy infrastructure refers to the exploitation, development and production of energy, such as oil rigs, pipelines, tankers, power stations, mining operations and electricity grids. Such infrastructure requires considerable initial investment and maintenance. Substantial costs may also be involved when infrastructure reaches the end of its life cycle. The USA's Nuclear Regulatory Commission estimates that it costs \$300 million or more to shut down and decommission a nuclear power plant.

Oil major trade movements 2013

Trade flows worldwide (million tonnes)



Energy pathways are complex, exhibiting considerable levels of risk. They link producers and consumers through pipelines, shipping routes, electricity cables and tankers. As major energy consumers have had to search further and further for reliable sources of power, supply lines have become longer and more vulnerable to economic, environmental, political and terrorist disruption.

There are growing concerns about protecting the world's immense energy infrastructure. There are more than 160,000 miles of oil pipeline on the USA alone. This huge length makes it difficult to check for leaks or sabotage.

The long-running tensions that exist in the Middle East have at times caused serious concerns about the vulnerability of oil fields, pipelines and oil tanker routes. The destruction of oil wells and pipelines during the Iraq war showed all too clearly how supply can be disrupted. Most Middle East oil exports go by tanker through the Straits of Hormuz. Iran has threatened to block the Straits of Hormuz (55km wide) during times of political tension – roughly 30% of the world's oil supply passes through the strait, making it one of the world's strategically important choke points. If blocked, this could cause huge supply problems for many importing countries.

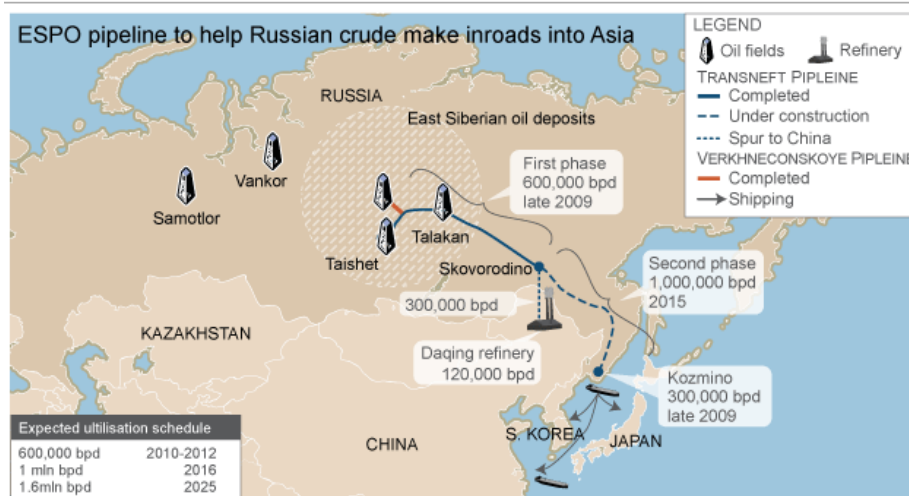
The Trans-Alaskan pipeline is an energy pathway that has several risks.

- It crosses an earthquake belt which could damage the pipe, and spills could go unnoticed.
- Valdez port has strong weather conditions, and the Beaufort sea is frozen most of the year.
- High snowfall endangers buildings causing possible collapse or limiting access to pumping stations, and the extreme cold makes pumping very difficult.

Eastern Siberia-Pacific Ocean oil pipeline from Taishet to Daqing

- Expected to have 1.6 million barrels per day maximum discharge.
- Transneft claimed that the China National Petroleum Corporation violated their supply contract, which stipulated the monthly volumes of oil according to the agreed price formula.

East Siberian - Pacific Ocean (ESPO) Pipeline



Key terms

Energy infrastructure: the built environment constructed for the exploration, development and production of energy, and all the networks that transport energy from points of production to consumers.

Energy pathways: supply routes between energy producers and consumers which may be pipelines, shipping routes or electricity cables.

There are real risks, in economic and political terms, if energy supplies are disrupted.

Tensions between producers and consumers

Tensions can exist between energy producers and consumers. This can cause economic problems in terms of supply disruptions and rising costs. It can also result in political problems if sellers and buyers of energy seriously disagree. This has happened between Russia and some of its customer countries.

Russia is the world's largest producer of oil, and has plentiful gas reserves. It supplies gas to the EU through Gazprom, a state-owned company. The World Bank reports that oil and gas accounts for

over 20% of Russia's GDP, and the production of these fossil fuels is vital to the country's economic success. The high energy prices of recent years have been of massive benefit to the Russian economy. There is no shortage of demand for Russian oil and gas. To the west lies energy-hungry Europe. To the south and East are the rapidly expanding economies of India and China, along with the developed economies of South Korea and Japan. European countries in particular have become increasingly reliant on energy supplies from their giant neighbour.

Russian oil production has increased considerably over the last decade to put it along Saudi Arabia in percentage of world total produced (both are at 12.6%). Russia vies with the USA as the world's number one gas producer, with Russia producing 20.6% of the world total compared to 18.8% by the USA.

Russia has had many disputes with the Ukraine over supply of gas.

- Winter 2006: 7.8 billion m³ of gas Gazprom stored in Ukrainian reservoirs had gone missing. Russia stopped gas supply to the Ukraine until a price with reduced subsidy was agreed on.
- 2007-08: supply cut due to US\$1.3 billion in unpaid debt.
- 2008-09: supply cut due to US\$2.4 billion in unpaid debt.
- Summer 2014: supply cut due to US\$ 1.7 billion debt in April, price jumped to \$485 per 1,000m³ and debt rises to US\$4.5 billion in June. Gazprom decides Ukraine must pay for natural gas upfront.

Russia also has had disputes with other countries.

- Azerbaijan, winter 2007: Gazprom increased the price of natural gas to US\$235 per 1000m³. Azerbaijan refused to pay so Russia stopped gas export. In return, Azerbaijan stopped exporting oil to Russia.
- Belarus, winter 2007: Transneft stopped pumping oil through the Druzhba pipeline after accusing Belarus of stealing oil, but resumed pumping after tariffs were lifted by Belarus.

Disputes have increased fears of energy insecurity

Such disputes have again raised EU fears about its increasing reliance on energy supplies from Russia. Critics argue that Russia has a habit of manipulating gas and oil supplies for political purposes. Chancellor Merkel said the dispute illustrated that Europe's energy sources needed to be more diverse. Thus the EU is looking to build interconnecting pipelines and power lines, such as electricity hook-ups, between Germany, Poland and Lithuania and between France and Spain. It also aims to diversify supply however the failure of the Nabucco pipeline is a major setback for Europe, as it was supposed to connect Europe with gas fields in the Middle East, Caucasus and central Asia via the Balkans and Turkey. The EU is also looking to build more terminals for the import of LNG in order to diversify supply more.

Serious doubts have been expressed about the management and efficiency of the energy industry in Russia. In May 2006, the head of the IEA voiced concerns that Gazprom may not have enough gas to supply Europe over the next decade. An IEA study concluded that Gazprom was not reinvesting enough to ensure continued adequate supplies in the future. Gazprom relies on a very limited number of large gas fields and has so far failed to invest in developing new resources in the Arctic. Already Gazprom makes up the difference between its exports to Europe and its falling output from Western Siberia by increasing imports from central Asia.

Increasing energy insecurity has stimulated exploration of technically difficult and environmentally sensitive areas, such as the Arctic Circle, the West Shetland field and Canadian oil shales, which may incur environmental costs.

The costs and benefits of exploiting new areas

Energy insecurity means exploiting new areas is cost-effective. Exploitation is feasible when prices are high, but when they fall it is not as economically beneficial as production costs remain high. New areas tend to be isolated, environmentally sensitive and pristine, so there is resistance from environmentalist groups.

Oil sands in Alberta, Canada and in Venezuela increase domestic oil production from unconventional sources.

- Tar sand production reached 1 million b/d in 2005 and is projected to increase to 5 million b/d by 2030, less than 5% of estimated world production in 2030.
- The synthetic oil produced can be refined into gasoline and other products.

The Arctic Circle is a pristine environment thought to be home to huge oil-rich sea beds.

- Some estimates say up to 25% of the world's undiscovered oil and gas may be located here.
- The USGS estimate that a 1 billion barrel field would cost US\$40 per barrel to extract, in comparison to US\$2 per barrel in Saudi Arabia.
- The Arctic National Wildlife Reserve is under threat from energy development, but so far the environmental lobby has managed to hold the line against intense lobbying from oil companies.
- As the USA becomes more concerned about its energy situation the ANWR will come under threat of development once again.

The West Shetland Field, aka the UK's Atlantic Frontier, is the most isolated development of oil fields in the world.

- The wave and current conditions are stronger than in the North Sea and the water is also considerably deeper.
- The oil is extracted using floating production vessels which are connected to sub-sea wells via flexible risers and sub-sea flow lines.
- Two oil fields have been brought into production: Foinaven in 1997 and Schiehallion in 1998.

Key terms

Oil sands: also known as tar sands or extra heavy oil. Naturally occurring mixtures of sand or clay, water and an extremely dense and viscous form of petroleum called bitumen that can be cracked to form shorter chained and more useful hydrocarbons.

Energy TNCs, OPEC countries and other large producers are increasingly powerful players in the global supply of energy.

Energy TNCs

Energy TNCs hold much control over the global supply of energy. This is because they are the main extractors and producers of fuel, and can therefore control the price of fuel globally. There is huge competition between the energy TNCs and OPEC. Both vie for rights to explore areas in order to exploit the natural resources there.

BP is an energy TNC that works globally.

- BP has come to an agreement with Gazprom to extend the North Stream pipeline which will be responsible for 20% of Britain's gas by 2016, reducing dependence on the Middle East.
- Diversified into exploring biofuels and wind energy.
- 300 wind turbines provide zero-carbon electricity for 120,000 households annually.
- Uses sustainable feedstock to minimize the pressure on food supplies when making biofuels.

Shell aims to become sustainable, however exploits some resources unsustainably.

- In 2014, planned new exploration into the Alaskan Chukchi Sea, but this has not been approved yet.
- Shell extracts natural gas, the cleanest of the fossil fuels, in Malaysia at the Majoram-1 well.
- They try to avoid tax to reduce costs by moving one of their drill ships into Arctic waters.
- Shell is responsible for the damage to the environment in the Niger delta following an oil spill of 14,000 tonnes, threatening 150 species of fish.

Organisation of the Petroleum Exporting Countries

OPEC is an intergovernmental organisation formed between Algeria, Angola, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela. The stated objective is 'to coordinate and unify the petroleum policies of Member Countries and ensure the stabilisation of oil markets in order to secure an efficient, economic and regular supply of petroleum to customers, a steady income to producers and a fair return on capital to those investing in the petroleum industry'. OPEC's decisions have had a substantial influence on oil prices over the years.

OPEC first discovered that oil could be used as a geopolitical weapon in 1973 during the Yom Kippur War.

- OPEC declared an oil embargo in response to the US's and Western Europe's support of Israel in the war.
- Oil prices rose from US\$3 per barrel to US\$12 per barrel however this was also due to a market and consumer panic reaction and the devaluation of the US dollar.
- Gas rationing started in the affected countries and prices continued to rise even after the embargo was lifted.
- Inflation spiked and unemployment rose.
- Sales of large, fuel-intensive vehicles dropped as customers favoured smaller cars.
- In response to high prices, industrial nations moved to reduce their dependence on oil, favouring coal, natural gas and nuclear power.

Environmentalists

Environmentalists have a smaller role in energy supply. They look to reduce carbon emissions, stop exploitation and further exploration for fossil fuels and develop renewable resources as a 'greener' energy supply. Although there would be many challenges, the WWF claims that by 2050 we could get all the energy we need from renewable resources. There have been many campaigns from environmentalists to raise awareness for control of energy supply from different sources. Once they have enough supporters and have raised enough awareness, they are powerful enough to impact energy supply decisions for different companies or countries.

Over the years, environmental groups have been involved in energy supply.

- 1974: the EPA was accused of being responsible for the USA's energy crisis by holding the USA back from making hasty decisions that might damage the environment.
- 2012-13: Bill McKibbin campaigned against the fossil fuel industry with the 'Do The Math' tour to raise awareness in the USA and Australia.
- 2014: Russia has been working with and funding environmentalists that oppose fracking. Russia is sensitive to new gas supply competition as they are the main supplier of gas to most of Europe.

Governments

Governments have a large amount of control over the energy mix of a nation, as well as the renewable energy policy.

Different governments have different approaches to these policies.

- The UK: the national energy mix is dominated by coal and gas, however renewables are increasing. 15% of the UK's energy demand must be produced by renewables by 2020, and new nuclear power stations are going to be built for 2019.
- Germany: nuclear energy production has decreased due to a change in policy in 1990. Renewables have increased to compensate with this reduction. 40-45% of electricity will be produced by renewables by 2025, and all nuclear power stations will be closed by 2022. A 20% reduction in CO₂ is aimed for 2020.
- China: energy mix dominated by coal. In 2006, 16 new HEP dams were approved (the Gansu Dang River Hydropower Project and the Three Gorges Dam are the largest dams in China). Plans to produce 11.4% of primary energy requirements from non-fossil sources by 2015.

State-owned companies

A number of state-owned companies have been formed by resource nationalisation, which eliminates private business operations and confiscates smaller scale oil production operations and private property, generally for the purpose of obtaining more revenue from oil for a government.

Gazprom is a Russian state-owned company.

- Owns the largest gas transmission network, the Unified Gas Supply System of Russia (168,000 km).
- Exploits gas reserves at the Yamal Peninsula, Arctic Shelf, Eastern Siberia and the Far East.
- Gazprom exports gas to over 30 countries.

Saudi Aramco is a company wholly owned by Saudi Arabia.

- Operations include exploration, production, refining, chemicals, distribution and marketing.
- Has created a subsidiary company, Vela International Marine Limited, to handle shipping to North America, Europe and Asia.
- The largest storage installation of the company is the frontier region and the Red Sea.

Petronas is a Malaysian state-owned company.

- LNG complex in Bintulu, Sarawak is one of the world's largest – 23mill tonnes/year capacity.
- Petronas has expanded to the Atlantic Basin, and has interests in the Egyptian LNG project and the LNG regasification terminal in the UK.
- Owns more than 10,000km of natural gas pipelines worldwide.

The China National Offshore Oil Cooperation is a Chinese state-owned company.

- Owns oil and gas assets in Bohai, the South China Sea, the East China Sea, Asia, Africa, North and South America and Oceania.

Key terms

OPEC: the Organisation of Petroleum Exporting Countries.

Resource nationalisation: when a country decides to place part or all of one or a number of natural resourced under state ownership.

ENERGY SECURITY AND THE FUTURE

There is uncertainty over both global energy supply in terms of reserves (e.g. peak oil and gas) and demand (economic growth rates, conservation of resources, a switch to renewable sources).

Economic growth

There is uncertainty over global energy supply in terms of both reserves and energy demand. Demand is strongly affected by economic growth rates, conservation of resources and the pace with which the world can switch to renewable sources of power.

The future demand for energy will depend very much on the rate of global economic growth. The price of oil per barrel was US\$147 in the summer of 2008, but dropped to US\$40 by December. In March 2010 the price was US\$85, and in December 2014, the price was as low as US\$54. The global recession that began in 2008 caused a significant decline in the demand for energy, but as the economy recovers demand will increase again. The significant increase in the number of NICs in recent decades will be a major factor in future energy demand.

According to the IEA in 2005, world oil demand will grow by 32% by 2020 and global gas demand by 48%. This will be due to a combination of population growth and demand increase.

Peak oil

No-one really knows when peak oil will be reached (or if it has been already). This is because there is a constant influx of new data that is changing predictions all the time. The USGS predicts peak oil could be as far as 50 years away, but most observers think it will be between 2005 and 2015. We do not know what will happen after peak oil, or how fast oil production will decrease, and whether or not we will have enough time to develop sustainable policies after peak oil.

Extending the life of fossil fuels

There are three ways we could increase the lifespan of fossil fuel resources: coal gasification, clean coal technology, and the use of more unconventional natural gas resources. Coal gasification converts solid coal into gas, and although it is expensive, the technology already exists. Clean coal technologies are improvements to power plant processes that both increase efficiency and reduce the emissions of greenhouse gases and other pollutants. Unconventional natural gas is costly but would reduce the strain on conventional resources. The main categories of unconventional natural gas are deep gas, tight gas, gas-containing shales, coal-bed methane, geopressurised zones and Arctic and sub-sea hydrates.

Key terms

Clean coal technology: power plant processes that both increase the efficiency of coal-burning and significantly reduce emissions.

Coal gasification: a process that converts solid coal into a gas that can be used for power generation.

Peak oil production: the year in which the world or a country reaches its highest level of production, with production declining thereafter.

Unconventional natural gas: natural gas that is more difficult to access and therefore more expensive to extract than 'conventional' reserves.

There are different responses to increasing energy demands – such as 'business as usual' reliance on fossil fuels or the adoption of alternative sources such as nuclear, or wind power. Each has costs and benefits, such as future climate change, and local opposition.

Increase nuclear power

Increasing the capacity of nuclear power is beneficial to a country as there are zero carbon emissions and they reduce the reliance on imported fossil fuels. China and India are both investing heavily in nuclear power. Iran has one nuclear reactor, thanks to Russia's funding. 75% of France's energy comes from nuclear reactors, and there are plans to replace older power plants with new ones to increase efficiency. The USA has 103 reactors which supply 20% of the USA's energy however development of the nuclear energy sector is slowing down in the USA. Following the Fukushima disaster in 2011, Japan shut down all of its nuclear power plants, however the new government announced in April of 2014 that it intended to re-open nuclear power plants. In 1990, Germany decided that it would close all of its nuclear power stations by 2022.

Wind power

An increase in research and development has reduced the price of generating electricity from wind to 10% of what it was 20 years ago. More aesthetically pleasing designs are being developed to reduce the impact of NIMBYism on developments. In 2008 a Dutch company installed the world's first floating wind turbine off the southern coast of Italy.

Key terms

Fast-breeder reactor: a nuclear reactor in which the chain reaction is maintained mainly by fast neutrons. It is capable of producing more fissionable material than it consumes.

Energy insecurity may lead to increased geopolitical tension and the potential for conflict, e.g. in the Middle East, or between gas consumers in Europe and producers in Russia, as consumers attempt to secure supplies.

Geopolitical tensions

Energy insecurity may lead to increased energy insecurity, and this will be most likely if a 'business as usual' approach is taken about fossil fuel extraction and use. In order to maximise energy conservation, a top-down approach from governments to train youth and advertise to the general public is needed. In order for countries to reduce their gas and oil imports, they need to have renewable forms of energy.

If progress is slow in investing in radical policies and maximising energy, it is possible that the current areas of tension, where energy supply is an issue, may edge closer to conflict in the future.

Era of energy insecurity

The era of energy insecurity has been brought about by numerous factors.

- Globalisation: increased demand for fossil fuels by NICs as they are needed to fuel economic growth.
- Geology: only the oil fields that are expensive and difficult to extract from remain.
- Geopolitics: political disputes have highlighted the vulnerability of energy insecurity, e.g. the use of oil and gas as a political weapon.
- Terrorists: can force the shutting down of production, such as in Iraq and Nigeria, and creates uncertainty and mistrust in the global oil market.
- Natural hazards: can disrupt pathways, such as New Orleans after hurricane Katrina.
- Complying with environmental rules is costly, for example Deepwater Horizon.
- Oil price volatility: uncertainty of prices can disrupt the economies of countries.

Key terms

Oil price volatility: a measure of how rapidly and strongly traders think prices could move.

Refined oil inventories: stocks of refined oil.

Meeting future energy needs in developing, emergent and developed economies while avoiding serious environmental degradation requires up-scaling of radical new approaches (conservation, recycling, reliance on renewables, carbon credits and 'green' taxation) involving difficult choices.

Measures governments can take

Governments need to improve public transport to encourage higher levels of usage. A higher tax should also be set on petrol and aviation fuel to increase incentives to use public transport and travel less in general. They need to ensure that public utility vehicles are energy-efficient. Minimum fuel consumption requirements for cars and commercial vehicles should be set. Congestion charging needs to be used to deter non-essential car use in city centres. Subsidies should be offered to households to improve energy efficiency. Businesses need to monitor and reduce their energy usage. Recycling should be encouraged. Investment must be promoted for renewable forms of energy. Laws must be passed to produce higher energy-efficiency electrical vehicles.

Measures individuals can take

Transport-wise, individuals should walk, rather than drive for short local journeys. Bicycles should be used for short to moderate distance journeys. Low fuel consumption vehicles should be bought. Car usage should be reduced by planning 'multipurpose' trips. Public transport should be used instead of private transport. Carpooling should be adopted.

In the home, individuals can install low-energy light bulbs, cavity wall insulation and roof insulation. Boiler and radiator settings should be turned down slightly. Clothes should be washed at lower temperatures. Energy-efficient appliances should be purchased. Appliances should not be left on standby.

Key terms

Carbon credit: a permit that allows an organisation to emit a specified amount of greenhouse gases.

Carbon trading: a company that does not use up the level of emissions it is entitled to can sell the remainder to another company that pollutes above its entitlement.

Community energy: energy produced close to the point of consumption.

Green taxation: taxes levied to discourage behaviour that will be harmful to the environment.

Microgeneration: generators producing electricity with an output of less than 50KW.