Technology & Society now!

Englisch für das Berufliche & Technische Gymnasium
Band 3

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Vorwort

Mit dem vorliegenden Band findet die Lehrwerkreihe „Technology & Society now!“ ihren Abschluss. Inhaltlich und methodisch werden die Ansätze der Bände 1 und 2 zur Fortbildung der berufsrelevanten Kommunikationskompetenz für mündliche und schriftliche Äußerungen in der englischen Sprache fortgeführt.

Aufbau des Lehrwerks

Band 3 der Reihe „Technology & Society now!“ enthält ebenfalls sechs themenspezifische Module und einen Skills-Teil. Wichtige Aspekte in der Entwicklung unserer technikorientierten Gesellschaft werden angesprochen. Dazu gehören Formen und Probleme der Nutzung von Energie (Modul 13 - From traditional to renewable energies), eine exemplarisch angelegte Sicht auf die Zukunft in Wissenschaft und Technik (Modul 14 – Engineering the future), ein Einblick in die Geschichte, Produktion und Trends in der Textil- und Modebranche (Modul 15 – Clothing the world of today), die Betrachtung verschiedener Facetten der Globalisierung (Modul 16 – Aspects of globalisation), der Blick auf unterschiedliche Formen und Zwecke internationaler Zusammenarbeit (Modul 17 – International cooperation) und schließlich der Fokus auf die Entwicklung und die Folgen zunehmender Verstädterung (Modul 18 – Urbanisation).

Die Module folgen unterschiedlichen Konzepten. Sie bilden das jeweilige Thema aus verschiedenen Blickwinkeln mit einer großen Vielfalt von Textsorten ab. Dabei besteht Gelegenheit zur Vorbereitung auf das jeweilige Thema (Einstieg), zur Kontextualisierung und Analyse unter Nutzung eigener Erfahrungen und Recherche sowie zur gelenkten Meinungsäußerung und kritischen Auseinandersetzung (Präsentationen und Diskussionen) sowie der sprachmittelnden Kompetenz (Mediation). Alle Module geben Gelegenheit zur Beschreibung und Auswertung von Grafiken und Schaubildern. In den Wortlisten zu den Modulen werden außer den themenspezifischen Lexemen auch Phrasen aufgeführt, die sich der unmittelbaren Erschließung entziehen oder wegen ihrer Ausbildung und Struktur aneignenswert erscheinen.

Die Texte im Skills-Teil können zur Vorbereitung auf die Abschlussprüfung im Fach Englisch genutzt werden. Sie greifen die Modulthemen auf, fügen ihnen jedoch neue inhaltliche Facetten hinzu. Die Aufgabentypologie und insbesondere auch die Textvolumina richten sich hier an den Vorgaben der länderspezifischen Prüfungsordnungen aus.

In diesem Buch wird grundsätzlich die englische Standardorthografie verwendet. Bei allen Fremdtexten wird die jeweilige Orthografie beibehalten.

Mit dem vorliegenden 3. Band der Reihe „Technology & Society now!“ und insbesondere mit dem Fokus auf Sachtexte wollen wir, die Autorinnen und Autoren, einen Beitrag zur Fortentwicklung der (fach)sprachlichen, fachlichen und auch analytischen Kompetenzen der Lernenden leisten. Wir hoffen, dass uns dies gelungen ist. Helfen Sie uns, das Lehrwerk zu optimieren, und lassen Sie uns wissen, was es in der nächsten Auflage, im nächsten Druck zu verbessern gibt. Schreiben Sie uns unter lektorat@europa-lehrmittel.de. Über ein Echo, gleichgültig, wie es ausfallen mag, freuen wir uns.

Im Herbst 2019 Autoren und Verlag

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13 From traditional to renewable energies

Getting started

TASK 1

In groups discuss and write a report on where the energy comes from that you, your family and friends use and what you use it for.

13.1 What is energy?

The word "energy" is derived from the Greek word "energeia" [ενεργεία], which is made up of "en" meaning "in" and "ergon" meaning "work". "Energy" was first used in the English language in the 1660s and referred to "power". In the 19th century scientists started to use the word as we use it today to mean "the ability to do work". This energy or power we get from resources can be categorised as **primary** and **secondary** energy.

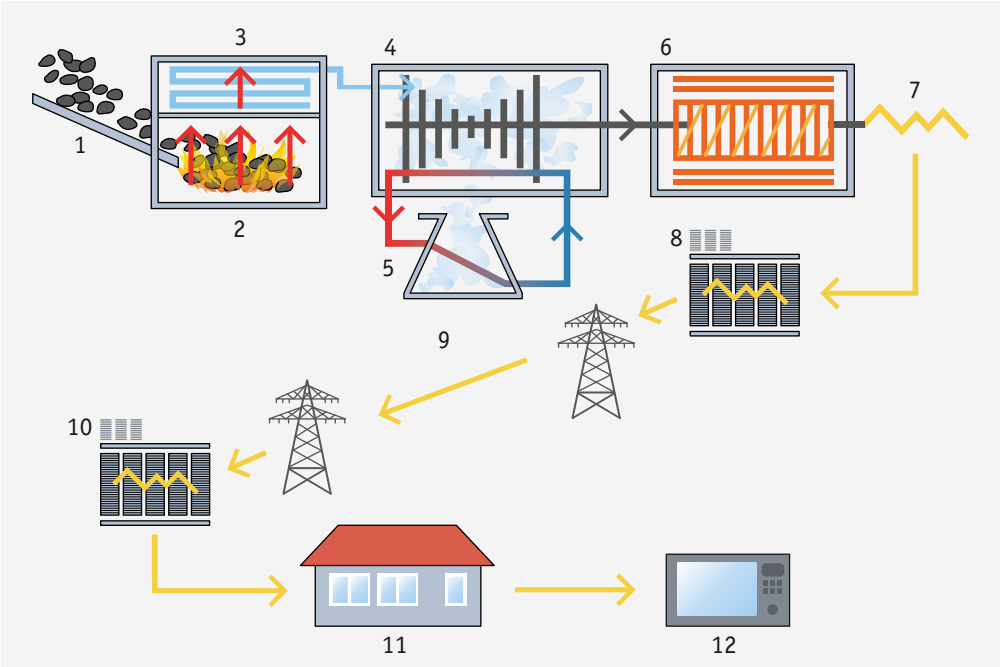
Primary energy is the energy that is found in the natural environment and that has not been subjected to any human processing. It is energy contained in raw fuels such as oil, coal, natural gas, peat, shale, biofuels such as wood and sugar cane and geothermal energy.

Secondary energy sources derive from the transformation of primary sources. Petrol is extracted from crude oil and electricity is generated from power stations using processed coal, oil, nuclear fuels, natural gas, biofuels, biomass, and from sources such as hydroelectric plants and solar installations. (166 words)

Ratcliffe-on-Soar power station in Nottinghamshire, England

In groups work out and write down how you think a power station works. Then compare your description with the diagram on the next page and the results of Task 3.

TASK 2



TASKS **3**

Work with the diagram

1. Match the following descriptions of what happens in a power station with the numbers on the diagram:

   Pylons: High metal towers carry electricity along overhead cables to wherever it is needed.

   Generator: The turbine is linked by an axle to a generator, so the generator spins around with the turbine blades. As it spins, the generator uses the kinetic energy from the turbine to make electricity.

   Step-down transformer: Once the electricity reaches its destination, another transformer converts the electricity back to a lower voltage safe for homes to use.

   Furnace: The fuel is burned in a giant furnace to release heat energy.

   Appliances: Electricity flows all around your home to outlets (sockets) on the wall. They make a very indirect connection to a piece of coal hundreds of miles away.

   Boiler: In the boiler heat from the furnace flows around pipes full of cold water. The heat boils the water and turns it into steam.

   Turbine: The steam flows at high pressure around a wheel that is a bit like a windmill made of tightly packed metal blades (see picture on p. 9). The blades start turning as the steam flows past. This turbine converts the steam's energy into kinetic energy.

   Homes: Electricity flows into homes through underground and overhead cables.

   Fuel: Some power plants run on coal, while others use oil, nuclear power, natural gas, or methane gas from decomposing rubbish.

   Electric cables: The electricity travels out of the generator to a transformer nearby.

Turbine blades on a steam turbine rotor used in a power station

Step-up transformer: Electricity loses some of its energy as it travels down wire cables, but high-voltage electricity loses less energy than low-voltage electricity. So the electricity generated in the plant is increased to a very high voltage as it leaves the power plant.

Cooling tower: The giant cooling towers make the turbines more efficient. Boiling hot water from the steam turbine is cooled in a heat exchanger, called a condensor. Then it is sprayed into the giant cooling towers and pumped back for reuse. Only a small amount of the water used escapes as steam from the towers themselves, but huge amounts of heat and energy are lost.

2. At the heart of every power station is the turbine. There are three main types of turbine: a) steam turbine, b) gas turbine and c) combined designs. Using the internet find out and describe how these three types of power station turbines function.

Work with language

Find definitions in English for the following words and phrases:
voltage • generator • kinetic energy • transformer • furnace • condensor.

Mediate. In German write a description of how a power station functions for a magazine aimed at readers aged between 12 and 16 years.

Going beyond the text

Power stations vary in their efficiency, i.e. in the amount of energy locked inside the fuel which they convert to electricity. Do research on the internet and write a report on which are the most efficient power station designs and fuels.

13.2 Is there an alternative to oil?

TASK 4 **Getting started**

In groups think of and list ways in which oil "runs the world".

Two Reasons Oil Will Continue to Run the World

By Jude Clemente

Anacortes Oil Refinery, Washington State, USA

Supplying 33 % of all energy, oil is the world's primary fuel. Oil is so important that global demand is ever-growing: 67 million barrels per day in 1990, 77 million barrels per day in 2000, and 91 million barrels per day in 2014. I'll never understand the animosity of some Westerners toward critical fuels that they depend on every day, making their lives easier in ways their great grandparents only dreamed of. Oil, after all, is the reason the world is truly globalized.

1. More Cars, Trucks, Gasoline, and Diesel Fuel

Thanks to derivatives gasoline and diesel fuel, the ongoing dominance of oil in the rapidly expanding vehicle market just now reaching into developing Asia is about as sure a thing as we have in our energy/environment discussion today. If there's ever going to be common ground between fossil fuel companies, liberals, conservatives, environmental groups, the anti-oil crowd HAS to get over that fact. The power of oil is simply overwhelming. There are now about 1.2 billion passenger cars alone, over 98 % of them rely on oil. The fleet is expected to reach 2 billion by 2035 and over 3 billion by 2050, with developing Asia leading the way thanks to rising personal incomes. [...] The world consumes about 24 million barrels per day of gasoline and 27 million b/d of diesel fuel every day, a staggering 1.5 million gallons every minute. Like it or not, more oil is a numbers game. The U.S., for instance, has 82 cars per every 100 people; China has just 7. And India has just 4 cars per every 100 people – and 385 million kids under the age of 15. Focused in heavy-duty vehicles, diesel could eventually surpass gasoline to become the number one transportation fuel worldwide, as commercial activity can only grow. When nations become more developed, their heavy-duty truck sales are tracked closely with changes in GDP. Despite noise and emission concerns since it's less refined, diesel engines are also making

headway in the passenger car market, offering up to 40 % more efficiency.

And contrary to what we keep hearing, not even the rich U.S., easily the largest consumer in the world, is a saturated oil market. Some 16.5 million cars were sold in the U.S. last year; about 120,000 of them were plug-ins, easily the largest electric vehicle market in the world. Truck and SUV sales, meanwhile, were over 8 million. In the U.S., vehicle stock can stay on the road for over 20 years. There are legal obstacles: but that gas guzzler you thought disappeared but really just got scrapped to Mexico has broader potential. Used vehicles make up less than 20 % of total car sales volume in China, compared to over 70 % in the U.S. China is selling nearly 25 million new vehicles a year, and only 75,000 of them run on electricity. It's certainly not for a lack of trying: each plug-in hybrid Chevy Volt sold in the U.S. has been supported by over $250,000 in government subsidies. Over a 10-fold advantage in energy density and highly established global infrastructure give gasoline especially the cost advantage over electric vehicles, a crucial consideration for the poorer nations now crashing the global vehicle market.

2. 83 % of the World Has Just Started to Consume Oil

The idea that the world has really just started to consume oil is one that is very difficult for some Westerners to accept. It's easy to see why: we have all the oil that we need and want. Americans consume over 2.6 gallons of oil products every day, and there are 255 million oil-based cars in the country. But, most of the world doesn't have it as easy as we do. A rising 83 % of the world is undeveloped, and the transport demands for the poor are just now coming to light. The developed OECD nations use 50 % of the world's oil but are just 17 % of the population. The rich consume 1.6 gallons of oil products a day, while the poor consume just 0.32 gallons. Given the importance of oil, this five-fold disadvantage for the poor is indeed a moral issue: oil-dependent Westerners are the ones leading the anti-oil charge. Our hypocrisy just isn't selling in the developing world. Why would it? Poor people wanna be rich too. From 2010–2030, the poor nations are projected to add 800 million new registered vehicles.

Oil pump in West Texas

After vehicles, the second emerging oil market to watch could be jet fuel. Boeing affirms that commercial aircraft in the world will double to over 40,000 by 2032, with Asia-Pacific becoming the focal point of aviation. Jet fuel demand in the region has more than doubled to over 2 million b/d since 2000. Indeed, twinned with electricity, oil is the cornerstone of modernity where more demand indicates higher standards of living. (791 words)

13

Work with the text TASKS 5

1. Present in chart form the growth of the following as described in the text:
   a) oil production,
   b) car production,
   c) cars per one hundred people.

2. Explain what the author means when he writes that
   a) oil is making our lives easier.
   b) "the power of oil is simply overwhelming".
   c) the United States is not a "saturated oil market".
   d) electric vehicles cannot compete with petrol and diesel driven vehicles.
3. Comment on the author's view that anti-oil westerners are hypocritical.
4. Examine the author's statement that diesel engines offer up to 40 % more efficiency (than petrol engines).
5. Analyse and comment on the author's optimistic view of the world's consumption of oil.

Mediate. Translate the paragraph beginning "Thanks to derivatives ..." into German.

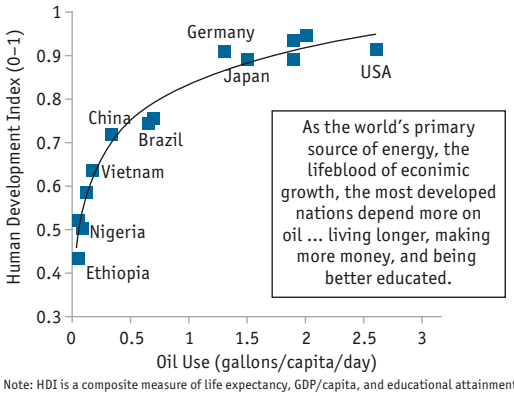
Research work. Examine the author's statement that "we have all the oil that we need and want". Find out what oil reserves we have and how long they will last if the number of new vehicles in poor countries increases at the rate the author suggests.

Discussion. In groups discuss how realistic the author's thesis is that higher standards of living in poor countries will inevitably mean more vehicles and a higher consumption of oil in those countries.

Work with the diagram

The graph used by the author implies that there is not just a correlation (a connection between two or more features, events, ideas, facts but with no causal effect) between oil use and human development but that oil use actually causes and promotes human development. For example, there is a correlation between the consumption of ice cream and deaths in swimming pools, but there is no evidence that the one causes the other.

1. Consult the Human Development Index in Wikipedia on the internet (en.wikipedia.org/wiki/Human_Development_Index) and compare the figures given there with the figures given in the diagram. Point out the information that the author has left out of the chart.
2. Examine the figures for countries with lower oil use than the United States and compare their Human Development Index with that of the United States.



Note: HDI is a composite measure of life expectancy, GDP/capita, and educational attainment

More oil use signifies more human development

13.3 Global warming and climate change – fact or fiction?

TASKS
6

Getting started

1. **"Global warming" and "climate change" both refer to the same phenomenon but emphasise different aspects of it. Define the words (global + warming and climate + change) used in both expressions and outline the way the two terms differ in meaning and emphasis. Include in your report a definition of the difference in meaning between "climate" and "weather".**
2. **Define the term "greenhouse gases" and their role in climate change. Explain how far they derive from human beings and how far from natural events.**

Climate change: what's so alarming?

By Bjorn Lomborg

Carbon emissions are rising – and faster than most scientists predicted.

But many climate-change alarmists seem to claim that all climate change is worse than expected. This ignores that much of the data is actually more encouraging than expected.

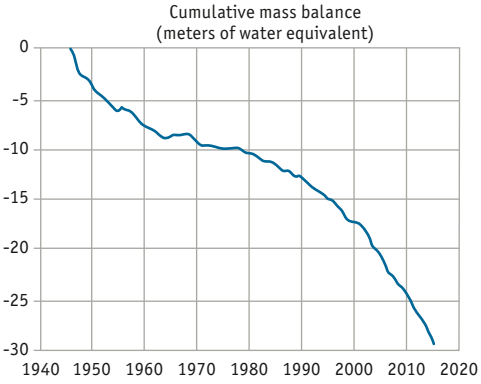
Yes, Arctic sea ice is melting faster than the models expected. But models also predicted that Antarctic sea ice would decrease, yet Antarctic Sea ice is increasing.

Yes, sea levels are rising, but the rise is not accelerating – if anything, two recent papers, one by Chinese scientists published in January 2014, and the other by U.S. scientists published in May 2013, have shown a small decline in the rate of sea-level increase. We are often being told that we're seeing more and more droughts, but a study published in March 2014 in the journal Nature actually shows a decrease in the world's surface that has been afflicted by droughts since 1982.

Facts like these are important because a one-sided focus on worst-case stories is a poor foundation for sound policies.

Hurricanes are likewise used as an example of things getting worse. But look at the U.S., where we have the best statistics: if we adjust for population and wealth, hurricane damage during the period of 1900-2013 actually decreased slightly.

At the UN climate conference in Lima, Peru in December 2014 attendees were told that their



Loss of ice and snow in glaciers 1945–2015

countries should cut carbon emissions to avoid future storms like Typhoon Hagupit, which hit the Philippines during the conference, killing at least 21 people and forcing more than a million into shelters. Yet the trend for strong typhoons around the Philippines has actually declined since 1950, according to a study published in 2012 by the Journal of Climate.

Again, we're told that all things are getting worse, but the facts don't support this. This does not mean that global warming is not real, or a problem, but the one-sided story of alarmism makes us lose focus. If we want to help the world's poor, who are the most threatened by natural disasters, it's less about cutting carbon emissions than it is about pulling them out of poverty.

The best way to see this is to look at the world's deaths from natural disasters over time. In the Oxford University database for death rates from floods, extreme temperatures, droughts, and

storms, the average in the first half of the last century, was more than 130 dead every year per million people. Since then, the death rates have dropped 90 % to a new low in the 2010s of less than 4 per million.

The dramatic decline is mostly due to economic developments that help nations withstand catastrophes. If you're rich like Florida, a major hurricane might cause plenty of damage to expensive buildings, but it kills few people and causes only a temporary dent in economic output.

If a similar hurricane hits a poorer country like the Philippines or Guatemala, it kills many more people and can devastate the economy.

So let's be clear. Climate change is not "worse than we thought". That doesn't mean it's not a reality or not a problem. It is.

But the narrative that the world's climate is changing from bad to worse is unhelpful alarmism that prevents us from focusing on smart solutions.

A well-meaning environmentalist might argue that, because climate change is a reality, why not ramp up the rhetoric and focus on the bad news to make sure the public understands its importance? But that's exactly what we've done for the past 20 years.

Yet despite dramatic headlines, apocalyptic documentaries and annual climate summits, carbon emissions continue to rise, especially in developing countries like India, China and many African nations.

Alarmism has encouraged the pursuit of a one-sided climate policy of trying to cut carbon emissions by subsidizing wind farms and solar panels. Yet today, according to the International Energy Agency, only about 0.4 % of global energy consumption comes from solar photovoltaics and windmills. And even with exceptionally optimistic assumptions about the future deployment of wind and solar, the International Energy Agency expects that these energy forms will provide a minuscule 2.2 % of the world's energy by 2040.

We urgently need a more balanced climate conversation if we are to make sensible choices and pick the right climate policy that can actually help fix climate change. (716 words)

TASKS 7

Work with the text

1. **In groups use the internet to examine the evidence that supports the thesis that climate change is not as alarming as some people say. In particular examine and comment on the evidence supporting or denying the statements below. Use the chart on p. 13. Give a presentation on the results you find.**

a	Increase in Antarctic ice	f	Decline in deaths from natural disasters since 1900–1950
b	Rise in sea levels not accelerating	g	Cutting carbon emissions is a one-sided policy for dealing with climate change.
c	Decrease in droughts since 1982	h	Solar and wind energy will have a minimal impact on climate change.
d	Decrease in hurricane damage in the period 1900-2012	i	Solar voltaics and wind turbines (2014) provide 0.4 % of the world's energy consumption.
e	Decline in trend for strong typhoons around the Philippines since 1950	j	Solar and wind energy too expensive

2. **Explain what "carbon emissions" are and what effect they have on our climate and what the connection is with fossil fuels.**
3. **Use the internet and reference books and explain the significance of the dates in this paper. Examine how far the choice of dates changes the evidence.**
4. **Analyse the text and point out which words and phrases make advocates of climate change seem less credible.**

Rance tidal power station (France)

5. **Using the internet and reference books examine the reasons for believing that climate change/global warming is taking place. Gather evidence from, amongst others, the following sources: IPPC (Intergovernmental Panel on Climate Change), NASA (National Aeronautics and Space Administration), Wikipedia, US Energy Information Agency (EIA), EPA (U.S. Environmental Protection Agency), Fraunhofer Institute for Solar Energy. Also take into account the following factors:**

a	Rise in global temperature	e	Declining Arctic sea ice
b	Warming of the oceans	f	Extreme weather events: low and high temperatures, floods, hurricanes
c	Shrinking of ice sheets (Arctic & Antarctic)	g	Ocean acidification
d	Decreased snow cover	h	Effects on plant life, animal habitats, coral reefs, air pollution

Mediate. Write a summary of the text in German for your school magazine.

Discussion. Hold a debate on the motion "Climate change: what's so alarming?"

13.4 Renewable and sustainable energy

Two of the answers to global warming and climate change are renewable and sustainable energy. Often these terms are used interchangeably; however, they have very different meanings. Not everything that is renewable is sustainable, and not everything that is sustainable is necessarily renewable.

TASK 8

Getting started

Working in small groups, use the internet and reference books to define the terms "sustainable energy" and "renewable energy", making sure you emphasise the differences between them. Give some examples of sustainable and renewable energy sources. Explain which renewable energy sources could be unsustainable and which energy sources are considered non-renewable. Compare your results in class and decide on one definition for each of the two terms.

Solar energy

Solar panels on the roof of the Freiherr vom Stein guest house in Speyer

Solar energy is often considered the best form of sustainable energy as it is available in such abundance. Every 43 minutes the amount of sunlight falling on the earth is equivalent to the total amount of energy humankind uses in a whole year. The amount falling on the earth in one week is equivalent to all known coal reserves. But power from the sun is difficult to exploit by human beings: it is intermittent and it is diffuse so that to trap it properly would require huge areas of land. Nevertheless, there are several ways in which energy from the sun is being exploited.

One way is **solar-thermal power**, which is the use of arrays of mirrors to focus the sun's heat onto a central furnace to produce steam which can then drive a turbine. This is, however, a relatively expensive way of producing electricity.

Solar power can also be converted directly into electricity using what are called **photovoltaic** (PV) cells. Sunlight, or more precisely photons, falling onto a piece of semi-conducting crystalline silicon within the PV cell, knocks electrons loose and these flow to produce an electric current. A solar cell which uses a lens to concentrate sunlight onto a chip of single crystal silicon can convert about 29 per cent of the sunlight falling on it into electricity. Many individual solar cells attached to each other make up a solar panel.

Wind power

Compared with fossil fuels and nuclear energy, wind power is, like solar power, relatively cheap, simple and clean. Wind turbines do not produce carbon dioxide (CO_2), nitrous oxide (N_2O) or radioactive waste. They can be adapted in size to suit their purpose. A large wind turbine can produce megawatts of electricity; a small one can provide enough electricity for a single household. There are two basic types of wind turbine: those that rotate around a **horizontal axis** and those that rotate around a **vertical axis**. Horizontal-axis wind turbines (HAWT) have the main rotor shaft and electrical generator at the top of a tower and must be pointed into the wind. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electric generator. Vertical-axis wind turbines (VAWT) have the main rotor shaft arranged vertically. One advantage of this arrangement is that the turbine does not need to be pointed into the wind to be effective. Also, the generator and gearbox can be placed near the ground, using a direct drive from the rotor assembly to the ground-based gearbox. This makes these components more accessible for repairs and maintenance.

The electricity generated by wind power is relatively cheap, and in Europe it is now the cheapest form of renewable energy; the energy source is clean; and wind turbines are fairly efficient. However, horizontal-axis wind turbines are very large, up to 130 metres tall, with turbine blades 50 metres long. The visual impact of a wind farm with up to 150 turbines can be disturbing and ruin the beauty of rural areas. Wind turbines can also harm wildlife and thousands of birds, including rare species, have been killed by their blades. Their effect on birds, though, is relatively insignificant if we consider that for every bird killed by a wind turbine in the USA, nearly 500,000 were killed by feral cats. Like solar energy, the energy harnessed by wind turbines is intermittent and therefore not very reliable. The energy obtained from wind is weak

Nesjavillir geothermal plant in Thingvellir, Iceland

Glen Canyon Dam hydroelectric plant in Arizona, USA

compared to the energy packed into fossil fuels. To generate large quantities of electricity you need large areas of land or sea covered with wind turbines.

To overcome the problems of the unsightliness of wind turbines on land, many wind parks are now being built offshore. But this creates a new problem. The wind turbines are even further away from the urban and industrial areas where the electricity is needed. This means that the electricity has to be transmitted via unsightly overhead high-voltage power lines to the end users, and in doing so up to 10 % of the power produced is lost. (681 words)

Work with the text. Explain the advantages and disadvantages of wind and solar power.

TASKS 9

Mediate. Translate the section of the text on solar energy into German.

Research work

1. Nuclear energy is often proposed as an energy resource which emits a minimal amount of greenhouse gas, concentrates sufficient power in one place to produce huge quantities of energy where it is needed, and is not intermittent. Examine and write a report on the advantages and disadvantages of nuclear power, including the costs involved in dealing with nuclear waste and decommissioning obsolete nuclear power stations.
2. Solar and wind power are only two of the many forms of sustainable energy that exist. In pairs carry out research on the internet and in reference books on other forms of sustainable energy: wave power, tidal power, geothermal energy, biomass, biofuels, hydroelectric power, hydrogen, and pumped storage. Examine how sustainable each of these ways of generating energy are and their advantages and disadvantages.
3. The other resource we have that is sustainable is energy efficiency. This is a resource that every country possesses in abundance and is the quickest and least costly way of dealing with energy security, and environmental and economic problems. Using the internet and reference books examine and write a report on how energy efficiency can be applied to the following areas of energy consumption: transport, industry, non-residential buildings (schools, universities, offices, factories), residential buildings (houses, blocks of flats), and household and industrial appliances.

The Koepchenwerk on the River Ruhr

Discussion. In groups compare which forms of sustainable energy are most suitable for use in Germany.

13.5 Pros and cons of renewable energy

Just as not everyone is convinced by the evidence for climate change and global warming (see 13.2 above), not everyone believes that renewable energy is the answer to reducing greenhouse gases or for producing electricity with lower pollution.

Wind turbines are neither clean nor green

By Matt Ridley

The Green Mountain wind farm, Fluvanna, Australia

We urgently need to stop the ecological posturing and invest in gas and nuclear.

The Global Wind Energy Council recently released its latest report, excitedly boasting that 'the proliferation of wind energy into the global power market continues at a furious pace, after it was revealed that more than 54 gigawatts of clean renewable wind power was installed across the global market last year'.

You may have got the impression from the obligatory pictures of wind turbines in any BBC story or airport advert about energy, that wind power is making a big contribution to world energy today. You would be wrong. Its contribution is still, after decades – nay centuries – of development, trivial to the point of irrelevance.

Here's a quiz: to the nearest whole number, what percentage of the world's energy consumption was supplied by wind power in 2014, the last year for which there are reliable figures? Was it it 20 per cent, 10 per cent or 5 per cent? None of the above: it was 0 per cent. That is to say, to the nearest whole number, there is still no wind power on Earth.

Even put together, wind and photovoltaic solar are supplying less than 1 per cent of global energy demand. From the International Energy Agency's 2016 Key Renewables Trends, we can see that wind provided 0.46 per cent of global energy consumption in 2014, and solar and tide combined provided 0.35 per cent. Remember this is total energy, not just electricity, which is less than a fifth of all final energy, the rest being the solid, gaseous, and liquid fuels that do the heavy lifting for heat, transport and industry. [...]

If wind turbines were to supply all of that growth but no more, how many would need to be built each year? The answer is nearly 350,000, since a two-megawatt turbine can produce about 0.005 terawatt-hours per annum. That's one-and-a-half times as many as have been built in the world since governments started pouring consumer funds into this so-called industry in the early 2000s.

At a density of, very roughly, 50 acres per megawatt, typical for wind farms, that many turbines would require a land area greater than the British Isles, including Ireland. Every year. if we kept this up for 50 years, we would have covered every square mile of a land area the size of Russia with wind farms. Remember, this would be just to fulfil the new demand for energy, not to displace the vast existing supply of energy from fossil fuels, which currently supply 80 per cent of global energy needs.

Do not take refuge in the idea that wind turbines can become more efficient. There is a limit to how much energy you can extract from a moving fluid, the Betz limit, and wind turbines are already close to it. Their effectiveness (the load factor, to use the engineering term) is determined by the wind that is available, and that

Ikataa nuclear power station, Japan

varies at its own sweet will from second to second, day to day, year to year.

As machines, wind turbines are pretty good already; the problem is the wind resource itself, and we cannot change that. It's a fluctuating stream of low-density energy. Mankind stopped using it for mission-critical transport and mechanical power long ago, for sound reasons. It's just not very good.

As for resource consumption and environmental impacts, the direct effects of wind turbines – killing birds and bats, sinking concrete foundations deep into wild lands – are bad enough. But out of sight and out of mind is the dirty pollution generated in Inner Mongolia by the mining of rare-earth metals for the magnets in the turbines. This generates toxic and radioactive waste on an epic scale, which is why the phrase 'clean energy' is such a sick joke and ministers should be ashamed every time it passes their lips.

It gets worse. Wind turbines, apart from the fibreglass blades, are made mostly of steel, with concrete bases. They need about 200 times as much material per unit of capacity as a modern combined cycle gas turbine. Steel is made with coal, not just to provide the heat for smelting ore, but to supply the carbon in the alloy. Cement is also often made using coal. The machinery of 'clean renewables' is the output of the fossil fuel economy, and largely the coal economy.

A two-megawatt wind turbine weighs about 250 tonnes, including the tower, nacelle, rotor and blades. Globally, it takes about half a tonne of coal to make a tonne of steel. Add another 25 tonnes of coal for making the cement and you're talking about 150 tonnes of coal per turbine. Now if we are to build 350,000 wind turbines a year (or a smaller number of bigger ones), just to keep up with increasing energy demand, that will require 50 million tonnes of coal a year. That's about half the EU's hard coal-mining output. [...]

The point of running through these numbers is to demonstrate that it is utterly futile, on *a priori* grounds, even to think that wind power can make any significant contribution to world energy supply, let alone emissions reductions, without ruining the planet. [...]

The truth is, if you want to power civilisation with fewer greenhouse gas emissions, then you should focus on shifting power generation, heat and transport to natural gas, the economically recoverable reserves of which – thanks to horizontal drilling and hydraulic fracturing – are much more abundant than we dreamed they would ever be. It is also the lowest-emitting of the fossil fuels, so the emissions intensity of our wealth creation can actually fall while our wealth increases. Good.

And let's put some of that burgeoning wealth in nuclear, fission and fusion, so that it can take over from gas in the second half of this century. That is an engineerable, clean future. Everything else is a political displacement activity, one that is counterproductive as a climate policy and, worst of all, shamefully robs the poor to make the rich even richer. (1011 words)

TASKS 10

Work with the text

1. Analyse the words and phrases the author uses to make advocates of wind turbines appear less credible.
2. Summarise the arguments that the author puts forward against the use of wind turbines.
3. List the strategies the author proposes for reducing the pollution caused by energy production.
4. Explain the last sentence in the text: "Everything else is a political displacement activity, one that is counterproductive as a climate policy and, worst of all, shamefully robs the poor to make the rich even richer".
5. In groups use the internet to analyse the validity of the following figures and statements in the text:
   a) The world's energy consumption supplied by wind power, tidal power and photovoltaic solar is under 1 % (figure for 2014). What is the figure now?
   b) Three quarters of the world's renewable energy is produced by biomass (mainly wood);
   c) Nearly 350,000 two-megawatt wind turbines would have to be built each year just to cover the two per cent growth in energy demand each year;
   d) Building this number of wind turbines (350,000) each year for 50 years would require the land area the size of Russia. (It is not clear whether the author means Russia or the Russian Federation – make the distinction clear in your answer);
   e) Pollution is caused by the mining of rare-earth minerals for wind turbine magnets;
   f) The manufacturing of wind turbines, including their concrete bases, requires 200 times as much material per unit of capacity as a modern combined cycle gas turbine. Explain the term "unit of capacity";
   g) The reserves of natural gas can replace the energy produced by wind turbines until 2050.

Mediate. Write a summary of the text in German for your school magazine.

Discussion. Hold a debate on the motion "Wind turbines are neither clean nor green".

Research. Use the internet and reference books to find the latest figures for the world's energy consumption provided by wind power, tidal power and photovoltaic solar.