МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ
«ДНІПРОВСЬКА ПОЛІТЕХНІКА»

М.В. Орел

ПЕРЕКЛАД У ГАЛУЗІ ЕЛЕКТРОЕНЕРГЕТИКИ
МЕТОДИЧНІ РЕКОМЕНДАЦІЇ ДО ПРАКТИЧНИХ ЗАНЯТЬ З ДИСЦИПЛІНИ

для студентів спеціальності 7.030507 «Переклад»
напряму підготовки 035 «Філологія»

Дніпро
2019

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ЕЛЕКТРОТЕХНІЧНИЙ ФАКУЛЬТЕТ

Кафедра перекладу

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Орел М.В.

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UNIT 1 ENERGY EFFICIENCY

Text: THE ELUSIVE NEGAWATT

If energy conservation both saves money and is good for the planet, why don't people do more of it?

IN WONKISH circles, energy efficiency used to be known as "the fifth fuel": it can help to satisfy growing demand for energy just as surely as coal, gas, oil or uranium can. But in these environmentally conscious times it has been climbing the rankings. Whereas the burning of fossil fuels releases greenhouse gases, which contribute to global warming, and nuclear plants generate life-threatening waste, the only by-product of energy efficiency is wealth, in the form of lower fuel bills and less spending on power stations, pipelines and so forth. No wonder that wonks now tend to prefer "negawatts" to megawatts as the best method of slaking the world's growing thirst for energy.

Almost all blueprints for tackling global warming assume that energy efficiency will have a huge role to play. In the greenest of futures mapped out by the International Energy Agency, a think-tank financed by rich countries, greater efficiency accounts for two-thirds of emissions averted. The McKinsey Global Institute (MGI), the research arm of the consultancy, thinks that energy efficiency could get the world halfway towards the goal, espoused by many scientists, of keeping the concentration of greenhouse gases in the atmosphere below 550 parts per million.

MGI believes that unlike most other schemes to reduce emissions, a global energy-efficiency drive would be profitable. The measures it has in mind, all of which rely on existing technology, would earn an average return of 17% and a minimum of 10%. The Intergovernmental Panel on Climate Change makes a similar point. It believes that profitable energy-efficiency investments would allow Pakistan to cut its emissions by almost a third, Greece by a quarter and Britain by more than a fifth.

In other words, big investments in energy efficiency would more than pay for themselves, and fairly fast. Although a lot of money would have to be spent—$170 billion a year until 2020—by MGI's reckoning that is only 1.6% of today's global annual investment in fixed capital. Moreover, with ample profits to be made, financing should be easy to attract.

Yet if there are so many lucrative opportunities to improve efficiency, why are investors not already taking advantage of them? To a degree, they are: in America, for example, "energy intensity"—the amount of energy required to generate each dollar of output—is falling by about 2% a year. This is only partly because America's factories, houses, cars and appliances are becoming more efficient: it is also because energy-guzzling factories have moved to cheaper spots such as China. But globally, too, energy intensity is falling by around 1.5 % a year.

But as McKinsey points out, there are still hundreds of billions of

dollars' worth of unfulfilled but potentially profitable opportunities in energy efficiency available to households and companies. What is holding investors back? One answer is price. In the eyes of many consumers, electricity and fuel are often too cheap to be worth saving, especially in countries where their prices are subsidised.

By and large, energy intensity is, not surprisingly, lower in countries where electricity prices are higher. It is no coincidence that Denmark has both high power prices and an energy-efficient economy. Among American states, for every cent per kilowatt-hour by which prices exceed the national average, energy consumption drops by about 7% of the average. George David, the boss of United Technologies, a conglomerate that makes air-conditioners, lifts and aircraft engines, among other items, argues that higher fuel and power prices are the only motor needed to drive energy efficiency.

But there are still plenty of profitable investment opportunities in energy efficiency, even in the places with the most expensive power. David Goldstein, author of a recent book on energy efficiency, points out that until recently businesses in New York lit their premises more brightly than did those in Seattle, despite New York's much higher power prices. And Hawaii, the American state with the dearest power, is not the most efficient.

The problem, analysts explain, is a series of distortions and market failures that discourage investment in efficiency. Often, consumers are poorly informed about the savings on offer. Even when they can do the sums, the transaction costs are high. Despite recent price increases, spending on energy still accounts for a smaller share of the global economy than it did a few decades ago.

For all these reasons, homeowners, as Lord Stern pointed out, tend to demand exorbitant rates of return on investments in energy efficiency—of around 30%. They generally want new boilers or extra insulation to pay for themselves within two or three years. Businesses are not quite so demanding, he says, but they still tend to put greater emphasis on increasing revenues than on cutting costs.

Similar stories crop up in the markets for new homes and offices, appliances and vehicles. Builders are not the ones who end up paying the utility bills, so have little reason to add to the construction costs— and hence the price of a home or office—by incorporating energy-saving features. The makers of appliances and cars also know that not all consumers and drivers will think as carefully about running costs as about the purchase price. By the same token, landlords have scant incentive to invest in energy efficiency on their tenants' behalf. And power companies are usually keen to encourage their customers to consume as much power as possible.

Financing energy-efficiency investments can also be difficult. In the developing world, capital can be scarce. In rich countries, the savings from making individual homes more efficient are too small and the overheads involved too high to be of much interest to most banks.

READING

A Understanding main points

Read the text and answer these questions.

1 What do you understand by the term 'energy effcency?'
2 What important advantage has energy efficiency over fossil fuels?
3 In what way can energy efficiency help the environment?
4 What does the term 'energy intensity' mean?
5 What are the reasons of insufficient investment in energy efficiency?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Globally, energy intensity is falling.
2 Investments in energy efficiency would pay for themselves.
3 Power companies encourage their customers to consume less power.
4 The makers of appliances and cars know that not all consumers and drivers will think as carefully about the purchase price as about running costs.
5 Denmark has both high power prices and an energy-efficient economy.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The sum of money to be invested in energy efficiency annually. ……
2 The percentage of an average return a global energy-efficiency drive would earn. ……
3 The percentage of rates of return on investments in energy efficiency homeowners demand. ……
4 The supposed number of parts of greenhouse gases in the atmosphere per million. ……
5 The minimum percentage of a return a global energy-efficiency campaign would earn. ……

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1	power (line 120)	**a)**	a company's profit for a year expressed as a percentage of the capital employed during the year;
2	fossil (line 9)	**b)**	a photographic copy of a plan for making a machine or building a house or other structure;
3	rate of return (line 135)	**c)**	buildings or machines which a business owns and which can be used for a long period of time in the production of other goods;
4	think-tank (line 26)	**d)**	something transacted; a piece of business;

5	running costs (line 155)	**e)**	made of substances that were living things many millions of years ago;
6	overheads (line 169)	**f)**	difficult to catch, find or remember;
7	fixed capital (line 59)	**g)**	force that can be used for doing work, driving a machine, or producing electricity (= electricity);
8	transaction (line 128)	**h)**	(especially of a business, trade, or job) bringing in plenty of money; profitable;
9	blueprint (line 21)	**i)**	(of costs, amounts, demands etc) much greater than is reasonable, usual, or expected;
10	lucrative (line 63)	**j)**	the amount of money needed for operating a business or other activity;
11	elusive (title)	**k)**	money spent regularly (e.g. on insurance or heating) to keep a business running;
12	exorbitant (line 135)	**l)**	a committee of people experienced in a particular subject, established by an organization, government etc to develop ideas and advise on matters related to that subject.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Fuel (line 3):
- **a)** a solid substance that is burnt to produce heat or power;
- **b)** a material used mainly for producing power in the engines of cars, aircraft etc;
- **c)** a material that is used for producing heat or power by burning or by atomic means.

2 Conservation (subtitle):
- **a)** the act of keeping something from being wasted or lost;
- **b)** the careful preservation and protection of animals and plants to prevent them being lost for ever;
- **c)** the act of protecting forests and rivers from being wasted.

3 Global warming (line 10):
- **a)** the gradual slight warming of the air surrounding the Earth because of the sun's light and heat;
- **b)** a general increase in world temperatures, caused by carbon dioxide collecting in space immediately around the Earth;
- **c)** the weather conditions under which the temperature of the air is rising.

4 Greenhouse gas (line 9):
- **a)** a gas, especially natural gas which is burnt in the home for heating and cooking;
- **b)** a gas, especially carbon dioxide or methane, which is thought to trap heat above the Earth and cause the greenhouse effect;
- **c)** a gas which is used to poison or cause extreme discomfort.

5 Energy (line 4):
- **a)** the quality of being full of life and action;
- **b)** the power which one can use in working;
- **c)** the power which can do work.

6 Investment (line 110):
- **a)** money claimed for harm done;
- **b)** money given to support unprofitable enterprises;
- **c)** money used for income or profit.

7 Energy intensity (line 67):

a) the amount of energy required to generate each dollar of output;

b) the increase in amount of energy;

c) the amount of energy produced.

8 Incentive (line 157):

a) a situation that is favourable for a particular purpose;

b) something which encourages one to greater activity;

c) the ability to take action without asking for the help or advice of others.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 Their office is in central London, so their …….. are very high.
2 The job makes …….. demands upon my time.
3 The bank charges a fixed rate for each …… transaction.
4 We are trying to reduce our ……. .
5 The engine was specially adapted to increase its …… .
6 Coal is a …….. fossil fuel.
7 The authority of the plant is trying to attract more investment in the ……. .
8 The report is a ……. for the reform of the nation's tax system.
9 Despite all their efforts , success remained …… .
10 She looked for an investment with a better …… .

D Collocations

Match these verbs and nouns as they occur in the text.

1	energy	**a)**	opportunities
2	power	**b)**	efficiency
3	greenhouse	**c)**	increases
4	utility	**d)**	costs
5	aircraft	**e)**	prices
6	climate	**f)**	bills
7	investment	**g)**	gases
8	price	**h)**	engines
9	electricity	**i)**	stations
10	construction	**j)**	change

E Words with similar or related meanings

1 The phrase 'to satisfy growing demand for energy' is used in paragraph 1. What other phrase is used in the same paragraph with a similar meaning?
2 The adjective 'profitable' is used several times in the text. What other word is used in the text with a similar meaning (para 5)?
3 Three words are used in the text with the meaning of 'income' (para 3, para 4, para 10). What are they?
4 The word 'engine' is used in paragraph 7. What other word is used in the same paragraph with a similar but figurative meaning?

5 What word could replace 'reduce' (para 3)?
6 The phrase 'by about 7%' is used in line 101. What other word is used in the text with a similar meaning to 'about' (para 5)?
7 The text uses the noun 'drive' (line 40) to express a planned effort of a group for a particular purpose. Can you think of at least one word to replace it?
8 Does the word 'greenest' (para 2) suggest colour or the environment?

F Words that seem similar

1 The words **1)** 'efficient' (line 121) and **2)** 'effective' are similar, but they have slightly different meanings. Match these definitions to the two words:
a) producing the desired result;
b) working well, quickly, and without waste.

2 The terms **1)** 'power' (line 120) and **2)** 'energy' (line 4) are frequently confused. Which of the following definitions fits the two words?
a) the capacity of a physical system to perform work (is measured in joules);
b) the rate at which work is performed or energy is transmitted (is measured in watts and horsepower).

G Phrasal verbs

Find phrasal verbs in the text that match these definitions.

a) To happen or appear unexpectedly (para 11).	c ……	u……
b) To plan in detail in advance (para 2).	m ……	o……
c) To be in the end (para 11).	e ……	u……
d) To make (something) to stay in place (para 6).	h ……	b……
e) To give or be a satisfactory explanation (para 9).	a ……	f……
f) To trust; to have confidence in (para 3).	r ……	o……
g) To draw attention to the fact (para 6).	p ……	o……
h) To give money in exchange for goods that one has bought (para 10).	P ……	f……

H Opposites

Find a word in the text that has an opposite meaning.

a) encourage (para 9)
b) exorbitant (para 12)
c) cheap (para 8)
d) big (para 9)
e) easy (para 12)
f) less (para 12)
g) lower (para 8)
h) save (money) (para 1)
i) partly (para 5)
j) increase (para 10)

I Measures

Do you know what these measures mean? If not, check the key.

a) watt
b) kilowatt
c) megawatt
d) negawatt
e) gallon
f) litre
g) kilowatt-hour
h) terawatt-hour

UNIT 2 COAL AS AN ENERGY SOURCE

Text A: OLD CLEAN COAL

Using photosynthesis to capture exhaust gases from power plants could reduce the emissions produced by coal-fired stations

FOR its supporters, the idea of growing single-celled algae on exhaust gas piped from power stations is the ultimate in recycling. For its detractors, it is a mere pipe dream. Whoever turns out to be right, though, it is an intriguing idea: instead of releasing the carbon dioxide produced by burning fossil fuels into the atmosphere, why not recapture it by photosynthesis? The result could then be turned into biodiesel (since many species of algae store their food reserves as oil), or even simply dried and fed back into the power station. Of course, if it were really that easy, someone would have done it already. But although no one has yet commercialised the technology, several groups are trying.

One of them is GS CleanTech, which has developed a bioreactor based on a patent held by a group of scientists at the Ohio Coal Research Centre. The GS CleanTech bioreactor uses a parabolic mirror to funnel sunlight into fibre-optic cables that carry the light to acrylic "glow plates" inside the reactor. These diffuse the light over vertical sheets of polyester that form the platform on which the algae grow. Eventually the polyester is unable to support the weight of the algae, and they fall off into a collection duct positioned underneath.

GreenFuel Technologies, based in Cambridge, Massachusetts, has a different approach. Its reactor is composed of a series of clear tubes, each with a second, opaque tube nested inside. This arrangement makes it possible to bubble the exhaust gas down through the outer compartment and then bubble it back up through the opaque middle. The bubbling gas causes turbulence and circulates the algae around the reactor. The constant shift between light and darkness as the algal cells circulate increases the amount of carbon that they fix, probably by promoting chemical reactions that occur naturally only at night.

A preliminary test of GreenFuel's reactor design suggested that it can remove 75% of the carbon dioxide from a power station's exhaust. GreenFuel claims that over the course of a year, a hectare of its reactors should be able to produce 30,000 litres of oil, which could be used as biodiesel, and enough carbohydrates to be fermented into 9,000 litres of ethanol, which can be used as a substitute for petrol.

There is, of course, no free lunch. As Rob Carlson of the University of Washington points out, if money is to be made selling products made from exhaust gas, then that gas goes from being waste matter to being a valuable resource.

Far from giving it away, power companies might even start charging for it. That would, indeed, be a reversal of fortune.

Text B: DIG DEEP

Carbon storage will be expensive at best. At worst, it may not work

EVEN in the most alternative-friendly future imaginable, coal is unlikely to go away. It is cheap, abundant and often local. So what can be done to make coal's use more acceptable?

One much-discussed possibility is carbon capture and storage, or CCS, which involves burying CO_2 deep underground. The generating companies have high hopes of it. There are just two problems. No one knows if it will work. And everyone knows that, whether it works or not, it will be expensive–so much so that the alternative start to look attractive. The one serious attempt to investigate its use in an actual power station, the FutureGen project, based in Illinois, was cancelled in January because the expected cost had risen from $830m to $1.8 billion.

The "capture" part is not that hard. Carbon dioxide reacts with a group of chemicals called amines. At low temperatures CO_2 and amines combine. At higher temperatures they separate. Power-station exhaust can thus be purged of its CO_2, by running it through an amine bath before it is vented, and the amine can be warmed to release the gas where it will do no harm. Better still, the coal can be reacted with water to produce a mixture of CO_2 and hydrogen in which the carbon dioxide is much more concentrated than in normal flue gas, so it is easier to scrub out. What is then burned is pure hydrogen.

It is what comes next that is the problem. The disposal of carbon dioxide needs to be permanent, so a lot of conditions have to be met. To be a successful burial site, a body of rock needs to be more than 1km underground. That depth provides enough pressure to turn CO_2 into what is known as a supercritical fluid, a form in which the stuff is more likely to stay put. The rock in question also has to have enough pores and cracks in it to accommodate the CO_2. Lastly, it needs to be covered with a layer of non-porous, non-cracked rock to provide a leakproof cap. So far, only three successful CCS projects are under way. None of them is actually linked to generating electricity.

The scale of the problem is awesome. The three showcase projects each dump about a million tonnes of CO_2 a year. But American electricity industry alone produces 1.5m tonnes, which would mean finding 1,500 appropriate sites. Even transporting that amount of gas would be a huge task. As to the cost, a report published by MIT reckons on $25 a tonne to capture CO_2 and pressurise it into a superfluid, and $5 a tonne to transport it to its burial site. It therefore suggests that power stations which dump CO_2 into the atmosphere should be charged $30 a tonne.

Such a charge, whether a tax or a system of tradable permits to pollute, would change energy economics radically but even the most optimistic proponents of carbon capture and storage doubt it will be a serious alternative much before 2020.

READING

A Understanding main points

Read the text and answer these questions.

1 Is coal currently used as a major fuel for electricity generation?
2 What's the connection between coal and electricity?
3 Does the coal industry continue to expand in many parts of the world?
4 Does coal cause enormous damage to human health and local ecosystems?
5 Why do you think countries continue to employ coal-fired power plants even when they pollute the environment?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Coal is classified as a nonrenewable energy source because it takes millions of years to form.
2 Coal contains energy that the plants absorbed from the sun – burning coal releases this energy which can be used to generate electricity.
3 Generating electricity using coal is currently relatively inexpensive, but the cost is affected by world coal prices, which can be volatile.
4 Burning coal doesn't produce greenhouse gas emissions.
5 "Clean coal" usually means capturing carbon emissions from burning coal and storing them under the earth.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The amount of oil which a hectare of reactors can produce per year. ……
2 The supposed amount of ethanol GreenFuel's reactors can obtain. ……
3 The annual amount of CO_2 dumped by each CCS profect. ……
4 The amount of CO_2 American electricity industry produces. ……
5 The number of sites needed for burying 1.5m tonnes of CO_2. ……
6 The amount of money needed for capturing a tonne of CO_2. ……
7 The cost of transpoting a tonne of CO_2 to its burial site. ……

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1	recycling (A, line 4)	**a)**	very simple, usually very small plants that live in or near water;
2	detractor (A, line 5)	**b)**	an area where used, damaged, or unwanted matter is buried;
3	ultimate (A, line 4)	**c)**	a person who supports or argues in favour of smth;
4	algae (A, line 14)	**d)**	the activity of reusing things that have already been used;

5	photosynthesis (A, line 11)	**e)**	a person who says bad things about smb or smth in order to make him/her/it seem less good or valuable;
6	pipe dream (A, line 5)	**f)**	a defeat or piece of bad luck;
7	duct (A, line 36)	**g)**	a thing used in place of another;
8	exhaust gas(A, line 45)	**h)**	unwanted gas;
9	substitute (A, line 67)	**i)**	a pipe or tube for carrying liquids, air etc;
10	reversal of fortune (A, line 78)	**j)**	the production of special sugar-like substances that keep plants alive, caused by the action of sunlight;
11	burial site (B, line 44)	**k)**	irregular and violent movement of the air;
12	turbulence (A, line 48)	**l)**	an impossible hope, plan, idea etc;
13	proponent (B, line 80)	**m)**	the highest point.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Carbon (A, line 52):

a) a poisonous yellowish simple substance (element) that shines faintly in the dark and starts to burn when brought out into the air;

b) a simple substance found in a pure form as diamonds, graphite etc or in impure form as coal, petrol etc;

c) a simple substance (element) that is used especially in the production of atomic power.

2 Carbon dioxide (A, line 8):

a) the gas produced when animals breathe out, when carbon is burned in air, or when animal or vegetable matter decays;

b) a gas that is lighter than air; will not burn and is used in some kinds of lights;

c) a non-metallic substance (element), usually in the form of a greenish-yellow gas.

3 Ethanol (A, line 66):

a) ordinary alcohol found in alcoholic drinks, it is also used for removing fat and oil;

b) a heavy silver-white metal that is a simple substance. Is liquid at ordinary temperatures, and is used in thermometers, barometers etc;

c) poisonous alcohol found in some natural substances, such as wood.

4 Petrol (A, line 67):

a) a thin oil made from the wood or certain trees, used for removing unwanted paint from clothes, brushes etc;

b) a liquid obtained especially from petroleum, used mainly for producing power in the engines of cars, aircraft etc;

c) an oil made from petroleum, coal etc, burnt for heat and in lamps for light.

5 Oil (A, line 63):

a) any of several types of thick fatty liquid used for cooking;

b) petroleum; a mineral oil obtained from below the surface of the earth, and used to produce petrol;

c) a pale greenish-yellow oil obtained

6 Coal (B, line 34):

a) rock, earth etc from which metal can be obtained;

b) a sort of white limestone that is hard, cold to touch, and used for buildings, statues, gravestones etc;

c) a black or brownish-black mineral

from olives, used in cooking and for making salad dressings.

7 Carbohydrate (A, line 65):
- **a)** a common silver-white substance (element), burns with a bright white light, and is used in making fireworks and mixtures of metals;
- **b)** a soft heavy easily melted greyish-blue metal, used for waterpipes, to cover roofs etc;
- **c)** any of several substances, such as sugar, which consist of oxygen, hydrogen, and carbon, and which provide the body with heat and power (energy).

which is dug from the earth, which can be burnt to give heat.

8 Hydrogen (B, line 36):
- **a)** a gas that is a simple substance (element), without colour or smell, that forms most of the Earth's air;
- **b)** a gas, without colour or smell, that is lighter than air, and burns very easily;
- **c)** a greenish-yellow strong-smelling gas that is a simple substance (element) and is found in many chemical compounds. It is usually added to the water in public swimming pools to help to keep it clean.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 We experienced a …….. in the second half of the game.
2 She is one of the strongest …….. of the tax reform.
3 Grasses, trees and …….. are raw materials for biofuels.
4 The children are very enthusiastic about …….. .
5 The recipe calls for butter, but you can use margarin as a …….. .
6 The concentration of the …….. in the atmosphere is very high.
7 Her …….. say she does not really understand ordinary people.
8 The flight was very uncomfortable because of …….. .
9 His scheme for building a perpetual-motion machine is just a …….. .
10 To look for the gas leak with a lighted match really was the …….. in stupidity.
11 The Weyburn-Midale CO2 project transports carbon dioxide from a coal gasification plant to its ……. in a depleted oil field in Saskatchewan.

D Collocations

Match these verbs and nouns as they occur in the text.

1	capture	**a)**	oil
2	reduce	**b)**	products
3	grow	**c)**	hydrogen
4	diffuse	**d)**	algae
5	produce	**e)**	exhaust gases
6	bury	**f)**	chemical reactions
7	burn	**g)**	light
8	warm	**h)**	emissions
9	make	**i)**	carbon dioxide

E Words with similar or related meanings

1 The phrase 'power station' (A, para 1) is used to describe a building in which electricity is made. What other phrase is used in the same text with a similar meaning?

2 What other word is used in the text (B, para 6) with the same meaning as 'supporter'?

3 The word 'constant' is used in the text with the meaning of 'continually happening or repeated'. What other word is used in the text (B, para 4) with a similar meaning to 'constant'?

4 The phrase 'carbon dioxide' is used several times in the texts. Find the chemical formula for 'carbon dioxide' (B, para 3).

5 Two words are used in the texts (A, para 4; B, para 3) with the meaning of 'to get rid of'. What are they?

6 The word 'to dump' is used in paragraph 5 (B). What similar word is used earlier (para 3) in the text?

7 The writer uses two different words (A, para 5; B, para 4) in the meaning of 'material'. What are they?

F Opposites

Find a word in the text that has an opposite meaning.

a) supporter (A, para 1)
b) increase (A, subtitle)
c) light (A, para 3)
d) waste matter (A, para 5)
e) at best (A, subtitle)
f) combine (B, para 3)
g) low (B, para 3)
h) likely (B, para 1)

G Phrasal verbs

Find phrasal verbs in the text that match these definitions.

a)	His statement ……..… to be false.	t …. o….
b)	An acid can …….. a base to form a salt.	r …. w….
c)	Water is ……. hydrogen and oxygen.	c …. o….
d)	The information is …….. to the appropriate government department.	f …. b….
e)	The film is …… a novel by D.H. Lawrence.	b …. o….
f)	The noise was so loud that she …… her ears ..…… her hands.	c …. w….
g)	I'd like to …… that if don't leave now we shall miss the bus.	p …. o….
h)	She …… all her money to the poor.	g …. a….

H Questions

Below you will find answers to four different questions. Read the Text B and try to supply the missing questions.

1 But although no one has yet commercialised the technology, several groups are trying.

2 GreenFuel Technologies, based in Massachusetts, has a different approach.

3 The bubbling gas causes turbulence and circulates the algae around the reactor.

4 Carbon dioxide reacts with a group of chemicals called amines.

5 They doubt it will be a serious alternative much before 2020.

UNIT 3 NUCLEAR POWER

Text: THE SHAPE OF THINGS TO COME

How tomorrow's nuclear power stations will differ from today's

THE agency in charge of promoting nuclear power in America describes a new generation of reactors that will be "highly economical" with "enhanced safety", that "minimise wastes" and will prove "proliferation resistant". No doubt they will bake a mean apple pie, too.

Unfortunately, in the world of nuclear energy, fine words are not enough. America got away lightly with its nuclear accident. When the Three Mile Island plant in Pennsylvania overheated in 1979 very little radiation leaked, and there were no injuries. Europe was not so lucky. The accident at Chernobyl in Ukraine in 1986 killed dozens immediately and has affected (sometimes fatally) the health of tens of thousands at the least. Even discounting the association of nuclear power with nuclear weaponry, people have good reason to be suspicious of claims that reactors are safe.

Yet political interest in nuclear power is reviving across the world, thanks in part to concerns about global warming and energy security. Already, some 441 commercial reactors operate in 31 countries and provide 17% of the planet's electricity, according to America's Department of Energy. Until recently, the talk was of how to retire these reactors gracefully. Now it is of how to extend their lives. In addition, another 32 reactors are being built, mostly in India, China and their neighbours. These new power stations belong to what has been called the third generation of reactors, designs that have been informed by experience and that are considered by their creators to be advanced. But will these new stations really be safer than their predecessors?

Clearly, modern designs need to be less accident prone. The most important feature of a safe design is that it "fails safe". For a reactor, this means that if its control systems stop working it shuts down automatically, safely dissipates the heat produced by the reactions in its core, and stops both the fuel and the radioactive waste produced by nuclear reactions from escaping by keeping them within some sort of containment vessel. Reactors that follow such rules are called "passive". Most modern designs are passive to some extent and some newer ones are truly so. However, some of the genuinely passive reactors are also likely to be more expensive to run.

Safety chain?

Nuclear energy is produced by atomic fission. A large atom (usually uranium or platonium) breaks into two smaller ones, releasing energy and neutrons. The neutrons then trigger further break-ups. If this “chain reaction” can be controlled, the energy released can be used to boil water, produce steam and drive a turbine that generates

electricity. If it runs away, the result is a meltdown and an accident (or in extreme circumstances, a nuclear explosion—though circumstances are never that extreme in a reactor because the fuel is less fissile than the material in a bomb).

In many new designs the neutrons, and thus the chain reaction, are kept under control by passing them through water to slow them down. (Slow neutrons trigger more break ups than fast ones.) This water is exposed to a pressure of about 150 atmospheres—a pressure that means it remains liquid even at high temperatures. When nuclear reactions warm the water, its density drops, and the neutrons passing through it are no longer slowed enough to trigger further reactions. That negative feedback stabilises the reaction rate.

Most American nuclear reactors are pressurised-water reactors of this type. So is the reactor being built in Olkiluoto in Finland—the largest planned to date. This reactor will produce 1,600 megawatts when it starts generating electricity, enough by itself to supply the needs of 1.8m households. The Olkiluoto reactor has several protective measures against accidents in addition to its innate design. These include four independent emergency-cooling systems, each capable of taking heat out of the reactor after a shutdown, and a concrete wall designed to withstand the impact, accidental or otherwise, of an aeroplane.

Canada, a country that has spent its entire history trying to distinguish itself from its southern neighbour, has its own nuclear design, too. Its pressurised heavy-water reactors, known as CANDU, are similar to ordinary pressurised-water reactors (or light-water reactors, as they are sometimes known) but they contain water in which the hydrogen atoms have been replaced by deuterium. Heavy water is expensive. However, the fuel used by CANDU is cheap.

A South African design, called the "pebble-bed", is, however, truly passive. Instead of water, it uses graphite to regulate the flow of neutrons, and instead of making steam, the reactor's output heats an inert or semi-inert gas such as helium, nitrogen or carbon dioxide, which is then used to drive the turbines. The name of the design comes from the fact that the graphite is used to coat pebblelike spheres of nuclear fuel. Like the CANDU design, pebble-bed reactors can be refuelled while running.

Further into the future, engineers are developing designs for so-called fourth-generation plants that could be built between 2030 and 2040. Work on these designs is the job of a ten-nation research programme whose members include America, Britain, China, France, Japan, South Africa and South Korea.

Three of these designs are for fast reactors (which work without any need for the neutrons to be slowed down). But fast reactors have complicated designs that could prove expensive to build.

Whether such reactors would be apple-pie safe is a different question. But 2030 is still a long way away. Plenty of time for the sloganeers to sharpen their pencils.

READING

A Understanding main points

Read the text and answer these questions.

1 How is nuclear energy created? How does it work?
2 What are the advantages of nuclear energy?
3 How is the safety of nuclear power stations ensured?
4 How dangerous is nuclear power compared with other forms of energy?
5 What kind of resources does nuclear energy require?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Uranium is the fuel most widely used by nuclear plants for nuclear fission.
2 Nuclear energy is cleaner and more environmentally friendly than coal-, oil- or gas-fired power stations.
3 Nuclear power is a source of energy that emits greenhouse gases.
4 Nuclear power plants provide an energy source that is not sustainable.
5 Fourth-generation nuclear plants are offering significant advances in safety.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The number of commercial reactors operating in the world. ……
2 The percentage of electricity generated by commercial reactors. ……
3 The number of reactors being built in India, China and their neighbours. ……
4 A figure showing the pressure of water in new nuclear designs. ……
5 The amount of electrical power to be produced by the reactor in Olkiluoto in Finland. ……

LANGUAGE FOCUS

A Definitions

Match these terms with their definitions:

1	nuclear energy (line 10)	**a)**	a process in which the parts of the nucleus (=centre) of an atom are rearranged to form new substances;
2	nuclear power (line 23)	**b)**	an accident in a nuclear reactor;
3	nuclear reactor (line 104)	**c)**	a number of related chemical changes, each of which causes the next;
4	nuclear weaponry (line 23)	**d)**	the splitting of the nucleus (=centre) of an atom, which results in much power being released;
5	radioactive waste (line 59)	**e)**	a bomb which explodes because of the atomic reactions inside it and which causes terrible destruction;

6	atomic fission (line 72)	**f)**	very powerful weapon which uses atomic power to cause mass destruction and death;
7	nuclear reaction (line 60)	**g)**	the powerful force that is produced when the nucleus (=central part) of an atom is either splittor joined to another atom;
8	nuclear explosion (line 83)	**h)**	(a) material (usually uranium or platonium) that is used for producing heat or power in a nuclear reactor;
9	nuclear accident (line 12)	**i)**	power, usually electricity, from nuclear energy;
10	chain reaction (line 77)	**j)**	a large machine that produces nuclear energy, especially as a means of producing electricity;
11	(nuclear) bomb (line 87)	**k)**	the radioactive by-products from a nuclear reactor, which are difficult to get rid of safely and are usually buried;
12	nuclear fuel (line 148)	**l)**	the extremely fast release of a large quantity of energy as a result of a nuclear chain reaction.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Radiation (line 11):
- **a)** something which is radiated;
- **b)** the radiating of heat, light etc;
- **c)** radioactivity.

2 Atmosphere (line 95):
- **a)** the mixture of gases that surrounds the Earth;
- **b)** the standard unit of pressure;
- **c)** the air, especially in a room.

3 Neutron (line 75):
- **a)** a very small piece of matter that moves round the nucleus of an atom and that by its movement causes an electric current in metal;
- **b)** a very small piece of matter that carries no electricity and that together with the proton forms the neucleus of an atom;
- **c)** a very small piece of matter that carries positive electricity and that together with the neutron forrms the neucleus of an atom.

4 Rate (line 103):
- **a)** a quantity such as value, cost, or speed, measured by its relation to some other amount;
- **b)** a figure showing the number of times one quantity contains another used to show the relationship between two amounts;
- **c)** a charge or payment fixed according to a standard scale.

5 Protective measure (line 113):
- **a)** an action taken to bring about a certain result;
- **b)** an instrument used for calculating the stated amount, length, weight etc;
- **c)** an action taken to prevent

6 Density (line 98):
- **a)** the amount of information that can be stored per unit of space on a magnetic tape or disk;
- **b)** the relation of the amount of matter (the mass) to the space in which the matter is packed (its volume);
- **c)** the quality of being dense.

something dangerous from happening.

7 Generation (line 3):
- **a)** all people of about the same age;
- **b)** the act or process of generating;
- **c)** the members of a developing class of things at certain stage.

8 Pressure (line 94):
- **a)** force or weight onto something;
- **b)** forceful influence; strong persuation;
- **c)** conditions in one's work , one's style of living etc that cause anxiety and difficulty.

C Word search

Complete the text with the words given below.

A 1_____ was designed by George Westinghouse and adapted from the reactors used in 2_____ . Inside a 3_____, water which is kept under high 4_____ to prevent it from boiling has a double function. In a closed 5_____, it serves as a coolant for the 6_____ and as a 7_____ to slow down the fast 8_____ created during 9_____. As the water in the primary loop circulates, it becomes very hot. This 10_____ is then transferred to a 11_____ of water. The resulting 12_____ is used to 13_____ that 14_____.

a) pressure
b) moderator
c) drive turbines
d) primary loop
e) heat energy
f) pressurised water reactor
g) secondary loop
h) generate electricity
i) reactor core
j) steam
k) neutrons
l) nuclear submarines
m) fission
n) pressurised water reactor

D Words with similar or related meanings

1 The adjective 'nuclear' is combined with a number of nouns, such as 'energy', 'accident', 'weapon' etc. What other word from the text can substitute 'nuclear'?

2 The word-combination 'nuclear power' is used several times. What other word is used in paragraph 2 with a similar meaning to 'power'?

3 The article deals with the question about how tomorrow's nuclear power stations will differ from today's. One more word is used in the text (para 2) with the same meaning as 'station'. What is it?

4 What word is used in the text (para 5) with the same meaning as the phrase 'keep under control' (line 89)?

5 The verb 'contain' is used in line 136. What other word is used (para 7) that has a similar meaning?

6 Two words are used in line 155 that are synonymous. What are they?

7 What word from the text could replace the word 'security' (subtitle)?

8 "Commercial reactors operate in 31 countries" (para 3). What other word is used in the text (para 4) with a similar meaning to 'operate'?

E Words that seem similar

1 The verbs **1)** 'stabilise'(line 102) and **2)** 'regulate' (line 144) have different meanings. Which of the following definitions fits the word 'stabilise' and which fits the word 'regulate'?

a) to make work at a certain speed;
b) to become firm, stable or unchanging.

2 The verbs **1)** 'leak' which is met in the text with the noun 'radiation' (line 15) and the verb **2)** 'escape' which is used in the text with the noun 'waste' (line 60) have slightly different meanings. Match these definitions to the two words:

a) to get away from an enclosed space;
b) to let (a liquid, gas etc) in or out of a hole or crack.

3 The phrase **1)** 'nuclear fission' (line 72) shouldn't be confused with the phrase **2)** 'nuclear fusion'. Match these definitions to the two phrases:

a) a nuclear reaction in which a heavy nucleus splits spontaneously or on impact with another particle, with the release of energy;
b) a nuclear reaction in which atomic nuclei of low atomic number fuse to form a heavier nucleus with the release of energy.

F Opposites

Find a word or phrase in the text that has an opposite meaning.

a) cheap (para 4)
b) slow (para 6)
c) retire a reactor (para 3)
d) accident prone (para 4)
e) similar (para 12)
f) stop (para 7)
g) more (para 5)
h) light (para 8)

G Phrasal verbs

Find phrasal verbs in the text that match these definitions:

a) to escape punishment for something wrong that you have done (para 2); g ….. a ….. w …..
b) to (cause to) stop operating (para 4); s …… d ……
c) to split into smaller units (para 5); b …… i ……
d) to escape (para 5); r …… a ……
e) to make or become slower (para 6); s …… d ……
f) to behave or perform noticeably well (para 8); d …… o ….. f ….
g) to go through (para 6); p …… t ……
h) to have as a place or point of origin (para 9). c …… f ……

H References

What do these words refer to in the text?

a) these (line 31)
b) these (line 4)
c) ones (line 74)
d) ones (line 66)
e) it (line 81)
f) its (line 130)
g) its (line 9)
h) its (line 98)
i) their (line 41)
j) them (line 90)

UNIT 4 ALTERNATIVE ENERGY

Text: THE POWER AND THE GLORY

The next technology boom may well be based on alternative energy. But which sort to back

EVERYONE loves a booming market, and most booms happen on the back of technological change. The world's venture capitalists, having fed on the computing boom of the 1980s, the internet boom of the 1990s and the biotech and nanotech boomlets of the early 2000s, are now looking around for the next one. They think they have found it: energy.

Many past booms have been energy-fed: coal-fired steam power, oil-fired internal-combustion engines, the rise of electricity, even the mass tourism of the jet era. But the past few decades have been quiet on that front. Coal has been cheap. Natural gas has been cheap. The 1970s aside, oil has been cheap. The one real novelty, nuclear power, went spectacularly off the rails. The pressure to innovate has been minimal.

In the space of a couple of years, all that has changed. Oil is no longer cheap; indeed, it has never been more expensive. Moreover, there is growing concern that the supply of oil may soon peak as consumption continues to grow, known supplies run out and new reserves become harder to find.

The price of natural gas, too, has risen in sympathy with oil. That is putting up the cost of electricity. Wind- and solar-powered alternatives no longer look so costly by comparison. It is true that coal remains cheap, and is the favoured fuel for power stations in industrialising Asia. But the rich world sees things differently.

In theory, there is a long queue of coal-fired power stations waiting to be built in America. But few have been completed in the past 15 years and many in that queue have been put on hold or withdrawn, for two reasons. First, Americans have become intolerant of large, polluting industrial plants on their doorsteps. Second, American power companies are fearful that they will soon have to pay for one particular pollutant, carbon dioxide, as is starting to happen in other parts of the rich world. Having invested heavily in gas-fired stations, only to find themselves locked into an increasingly expensive fuel, they do not want to make another mistake.

That has opened up a capacity gap and an opportunity for wind and sunlight. The future price of these resources–zero–is known. That certainty has economic value as a hedge, even if the capital cost of wind and solar power stations is, at the moment, higher than that of coal-fired ones.

A prize beyond the dreams of avarice

The market for energy is huge. At present, the world's population consumes about 15 terawatts of power. And by 2050, power consumption is likely to have risen to 30 terawatts.

Scale is one of the important

differences between the coming energy boom, if it materialises, and its recent predecessors–particularly those that relied on information technology, a market measured in mere hundreds of billions. Another difference is that new information technologies tend to be disruptive, forcing the replacement of existing equipment, whereas, say, building wind farms does not force the closure of coal-fired power stations.

For both of these reasons, any transition from an economy based on fossil fuels to one based on renewable, alternative, green energy–call it like you will–is likely to be slow, as similar changes have been in the past. On the other hand, the scale of the market provides opportunities for alternatives to prove themselves as the margin and then move into the mainstream, as is happening with wind power at the moment. And some energy technologies do have the potential to be disruptive. Plug-in cars, for example, could be fuelled with electricity at a price equivalent to 25 cents a litre of petrol. That could shake up the oil, carmaking and electricity industries all in one go.

This renewed interest in energy is bringing forth a raft of ideas, some bright, some batty, that is indeed reminiscent of the dotcom boom. As happened in that boom, most of these ideas will come to naught. But there could just be PayPal or a Google or a Sun among them.

More traditional companies are also taking an interest. General Electric (GE), a large American engineering firm, already has a thriving wind-turbine business and is gearing up its solar-energy business. Meanwhile, BR and Shell, two of the world's biggest oil companies, are sponsoring both academic researchers and new, small firms with bright ideas, as is Du-Pont, one of the biggest chemical companies.

The poor world turns greener too

That, at least, is the view from the rich world. But poorer, rapidly developing countries are also taking more of an interest in renewable energy sources, despite assertions to the contrary by some Western businessmen. It is true that China is building coal-fired power stations at a blazing rate. But it also has a large wind-generation capacity, which is expected to grow by two-thirds this year, and is the world's second-largest manufacturer of solar panels–not to mention having the largest number of solar-heated rooftop hot-water systems in its buildings.

Brazil, meanwhile, has the world's second-largest and most economically honest biofuel industry, which already provides 40% of the fuel consumed by its cars and should soon supply 15% of its electricity, too. South Africa is leading the effort to develop a new class of safe and simple nuclear reactor–not renewable energy in the strict sense, but carbon-free and thus increasingly welcome. These countries, and others like them, are prepared to look beyond fossil fuels. They will get their energy where they can. So if renewables and other alternatives can compete on cost, the poor and the rich world alike will adopt them.

READING

A Understanding main points

Read the text and answer these questions.

1 What are the alternative energy sources?
2 Why is solar sometimes termed the primary renewable energy?
3 What are the disadvantages of geothermal energy?
4 Why is renewable energy preferable?
5 What are the benefits of using renewable energy?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Wood still remains the most common source to produce biomass energy.
2 Solar energy is one the alternative energy source that is used most widely across the globe.
3 Hydrogen energy is completely renewable and can be produced over and over again on demand.
4 Many of the wind turbines can capture much power all at once before feeding it to the power grid.
5 Alternative sources of energy produce significant amounts of pollution.

C Information search

Scan the text quickly and find the figures, percentage or sums of money that correspond to the following pieces of information.

1 The amount of power which is presently consumed by the world's population. .....
2 The amount of power which the world's population is likely to have consumed by 2050. .....
3 The cost in cents of a litre of petrol at which plug-in cars could be fuelled with electricity. .....
4 The number of the world's biggest oil companies. .....
5 The percentage of total fuel consumed by Brazil's cars which is provided by its biofuel industry. .....
6 The percentage of total electricity Brazil's biofuel industry supplies. .....
7 The percentage of total China's wind-generation capacity by which it is expected to grow. .....

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1 glory (title)
2 hedge (line 68)

a) a (period of) rapid growth or increase;
b) the capacity of the largest sort of coal-fired power station;

3	renewable (line 139)	**c)**	a matter made of substances that were living things many millions of years ago;
4	nanotech boomlet (line 8)	**d)**	the use in science and industry of living things such as cells and bacteria to make drugs and chemicals, destroy waste matter etc;
5	boom (line 2)	**e)**	great fame and admiration;
6	biotech boomlet (line 5)	**f)**	machinery methods etc which can perform processes extremely quickly or make or measure objects which are extremely small;
7	internal-combustion engine (line 14)	**g)**	energy from nonconventional [alternative] sources of energy;
8	capacity (line 63)	**h)**	1,000 gigawatts;
9	fossil fuel (line 165)	**i)**	that can be renewed, especially by natural processes or good management;
10	terawatt (line 76)	**j)**	the amount that something can produce;
11	gigawatt (line 76)	**k)**	something that gives protection, especially against possible loss;
12	alternative energy (subtitle)	**l)**	an engine which produces power by the burning of a substance, such as petrol, inside itself.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Green energy (line 96):
- **a)** energy which is produced by a generator;
- **b)** energy which does not cause harm to the environment;
- **c)** energy which is produced by a wind turbine.

2 Novelty (line 21):
- **a)** a writer of novels;
- **b)** a short, not very serious novel, usually about love;
- **c)** the quality of being novel; interesting newness.

3 Information technology (line 84):
- **a)** the mathematical principles that deal with information and the sending of information between humans and machines;
- **b)** the science of collecting, arranging, storing, retrieving, and sending out information;
- **c)** the science or practice of collecting, storing, using, and sending out information by means of computer systems and telecommunications.

4 Nuclear reactor (line 160):
- **a)** a process in which the parts of the nucleus (=centre) of an atom are rearranged to form new substances;
- **b)** a large machine that produces nuclear energy, especially as a means of producing electricity;
- **c)** a factory or other place where nuclear weapons might be made.

5 Margin (line 102):
- **a)** a process in which the parts of the nucleus (=centre) of an atom are rearranged to form new substances;

6 Academic researcher (line 130):
- **a)** a person with great knowledge of the subjects that are taught to develop the mind rather than to provide practical skills;

b) a large machine that produces nuclear energy, especially as a means of producing electricity;
c) a factory or other place where nuclear weapons might be made.

7 Scale (line 80):
a) size or level in relation to other things or to what is usual;
b) a rule or set of numbers comparing measurements on a map or model with actual measurements;
c) a set of musical notes in order, upward or downward, and at fixed separations.

b) a person who works in a science, especially physics, chemistry, or biology;
c) a person who thinks only about the real world and real problems.

8 Avarice (line 73):
a) extreme eagerness and desire to get or keep wealth;
b) the quality of always thinking about oneself and about what will be best for oneself;
c) one's opinion of oneself; selfesteem.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 Computer circuitry now includes advanced processes made possible by …….. .
2 The big tax cuts fuelled a consumer …….. .
3 BMW engineers are examining how to make a saloon car that can run with a hydrogen …….. .
4 New Zealand and Sweden import a lot of …….. .
5 Those who died bravely in battle earned everlasting …….. .
6 Buing a house will be a …….. against inflation.
7 This factory has a productive …….. of 200 cars a week.
8 …….. refers to energy sources that have no undesired consequences such as, for example, fossil fuels or nuclear energy.
9 By buying more efficient bridges, over the years, Americans save more than 200 ……..-hours annually.
10 Sun, wind, and waves are …….. sources of energy.

D Collocations

Match these verbs and nouns as they occur in the text.

1 venture	**a)** company
2 mass	**b)** boom
3 industrial	**c)** researcher
4 economic	**d)** business
5 energy	**e)** power
6 dotcom	**f)** tourism
7 solar-energy	**g)** value
8 academic	**h)** plant
9 chemical	**i)** capitalist
10 nuclear	**j)** technology

E Words with similar or related meanings

1 What word is used in the text with the same meaning as 'boom' (para 1)?
2 What other adjective is used in the text (para 11) with the same meaning as 'booming' (para 1)?
3 The leading energy sources are coal, oil and natural gas (para 2). What is a general term for all of them (para 13)?
4 What word from the text could replace the verb 'grow' (para 4)?
5 The word 'price' is used in paragraph 4. What word with a similar meaning is used in the same paragraph?
6 The adjective 'renewable' is combined with the noun 'energy' (para 9). What other adjectives from the text (subtitle, para 9) can substitute 'renewable'?
7 In paragraph 12 there is a phrase 'renewable energy source'. Find two words in the text (para 13) that has a similar meaning.

F Words that seem similar

1 The verbs **1)** 'invest'(line 58) and **2)** 'sponsor' (line 129) have different meanings. Match these definitions to the two words:
a) to support and pay for (part of) an activity;
b) to put (money) to a particular use, in order to have a profit.
2 The adjective **1)** 'favoured' (line 40) and the adjective **2)** 'welcome' (line 163) have slightly different meanings. Match these definitions to the two words:
a) gladly accepted; received with pleasure;
b) having special advantages or desirable qualities.

G Phrasal verbs

Find phrasal verbs in the text that match these definitions:

a)	to search (para 1);	l ……	a …….
b)	to start to behave in a strange, confused way (para 2);	g ……	o …….
c)	to come to an end, so that there is no more (para 3);	r ……	o …….
d)	to increase in amount (para 4);	p ……	u …….
e)	delay (para 5);	p ……	o ……. h ….
f)	to make possible the development of (para 6);	o ……	u ……..
g)	to look for outside the range or limits of (para 13);	l ……	b ……..
h)	to set free (from control, prison, duty etc) (para 9);	s ……	u ……..
i)	to form or make (something) (para 9);	b ……	o ……..
j)	to produce, especially give birth to (para 10).	b ……	f ……..

H Prepositions

Complete these sentences with a suitable preposition.

1 "The television doesn't work." "Have you plugged it …… ?"
2 They opened the country to trade …… to trade.
3 Don't rely …… the bank lending you the money.
4 The new chairman will shake …… the company.
5 We were looking …… for a nice place for a new job.
6 They've put the price …… .

UNIT 5 SOLAR ENERGY

Text: BRIGHT PROSPECTS

Energy: Solar power is in the ascendant. But despite its rapid growth it will not provide a significant share of the world's electricity for decades

LAST year Microsoft outfitted its campus in Silicon Valley with a solar system from Sun-Power, a local company that makes high-efficiency (and, some say, the world's best-looking) solar panels. A few months later Microsoft's arch-rival, Google, began building something on an even grander scale-one of the largest corporate solar installations to date. But all of this may yet be topped by Wal-Mart. In December the retail giant solicited bids for placing solar systems on the roofs of many of its supermarkets. Besides producing favourable publicity, the appeal of using solar power is obvious. Unlike fossil fuels, which produce significant amounts of pollution and enormous amounts of greenhouse gases, the sun's energy is clean and its supply virtually limitless. In just one hour the Earth receives more energy from the sun than human beings consume during an entire year. According to America's Department of Energy, solar panels could, if placed on about 0.5% of the country's mainland landmass, provide for all of its current electricity needs.

Yet since they were first invented more than five decades ago, photovoltaic solar cells–devices made of semiconductor materials that convert sunlight into electricity–have generated much publicity but little energy. In 2010 photovoltaic systems produced 0.04% of the world's electricity, according to the International Energy Agency. The thing that has held back the widespread deployment of solar panels is their price. Sunshine is free, but converting it into electricity is not. At present, solar power is at least two to three times as expensive as the typical electricity generated in America for retail customers.

Even so, many people believe the prospects for solar energy have never looked brighter. Decades of research have improved the efficiency of silicon-based solar cells from 6% to an average of 15% today, whereas improvements in manufacturing have reduced the price of modules from about $200 per watt in the 1950s to $2.70 in 2010. Within three to eight years, many in the industry expect the price of solar power to be cost-competitive with electricity from the grid.

In the meantime, some European countries and parts of America have instituted subsidies to support the adoption of solar power. California's "Million Solar Roofs" initiative, for example, will hand out about $3 billion in rebates and other incentives over a decade to encourage the installation of solar panels. In Europe Germany offers producers of solar power generous feed-in tariffs. As a result of such incentives, the market for solar power has grown by about 40% a

year for the past five years. In a matter of a few years, solar power has become a big business. This development has not gone unnoticed by America's venture capitalists, who have embarked on a spending spree. Solar power has become one of the fastest-growing areas: investments have risen from $59m in 2008 to $308m in 2010.

The main beneficiaries of this windfall are start-ups, such as Nanosolar and Miasole, which are based in Silicon Valley and focus on new technologies. Both firms are betting on "thin film" solar cells, which can be made with vastly less semiconductor material than traditional silicon-based devices. They also intend to employ new, continuous manufacturing processes that promise to reduce the cost of solar panels very quickly in future.

Dawn of a new technology

Humans have always depended on energy from the sun, though it was exploited mostly indirectly for thousands of years. The photoelectric effect was not discovered until 1839, when Alexandre Becquerel, a French physicist, observed that light could generate an electric current between two metal electrodes immersed in a conductive liquid. About 40 years later Charles Fritts, an American inventor, devised the first solar cell. Made with selenium and a thin layer of gold, the device was less than 1% efficient.

The first terrestrial solar cells were used for off-grid applications in remote locations where placing conventional power lines was not possible or economical. Among the earliest buyers of solar panels were gas and oil companies, which began to use solar power in the mid-1970s to protect wellheads and underground pipelines from corrosion and to power navigational aids on offshore oil rigs. In the 1980s America's Coast Guard began using solar panels to America's Coast Guard to buoys. By the early 1990s solar cells powered hundreds of diverse off-grid applications including telecoms equipment, emergency roadside phone boxes, and consumer devices such as calculators and watches.

Slow sunrise

The solar industry has in the past profited from the manufacturing improvements of chipmakers, and is now finding ways to benefit from innovations in other high-tech fields. "I think of the silicon solar-cell industry as a marriage between the semiconductor industry, where it gets its base technology, and the CD industry, which is very high volume," says Richard Swan-son, SunPower's president.

But despite the growing infusion of capital, innovation and talent, solar power will provide only a tiny fraction of the world's electricity needs for the foreseeable future. Even if the industry continues to grow at the same torrid pace, it will not be able to supply more than 1% or so of the world's electricity needs for at least another decade. That may sound like a gloomy forecast, but some regard it as a huge opportunity. It means there is a lot of room for growth, says Mr Roscheisen, Nanosolar's irreverent boss.

READING

A Understanding main points

Read the text and answer these questions.

1 Three big companies are mentioned in the article. Rank them in terms of their contribution to the success of solar industry, starting with the one most effective.
2 What is the main reason for insufficient deployment of solar panels?
3 What measures are taken by developed countries to encourage the adoption of solar power?
4 What are the pros and cons of solar energy?
5 What is the future of solar energy?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 The company Sun-Power produces highly efficient solar panels.
2 By using new technologies, start-ups plan to increase the cost of solar panels.
3 The first solar cell was made of silicon and a thin layer of gold.
4 Solar power provides only a tiny fraction of the world's electricity needs.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The percentage of the world's electricity produced by photovoltaic systems in 2010. ……
2 The percentage by which the market for solar power has grown for the past five years. ……
3 The sum of money invested into solar power in America in 2010. ……
4 The percentage of the efficiency the first solar cell had. ……
5 The sum of money for which modules were bought in 2010. ……

LANGUAGE FOCUS

A Definitions

Match these terms with their definitions:

1	photoelectric effect (line 107)	**a)**	a very small piece of silicon containing a set of electronic parts and their connections, which is used in computers and other machines;
2	solar cell (line 34)	**b)**	a substance, such as silicon, which allows the passing of an electric current more easily than an insulator, but not as well as a conductor;
3	solar panel (line 6)	**c)**	an offer to do some work at a certain price;
4	semiconductor (line 35)	**d)**	an apparatus for producing electric power from sunlight;
5	chip *also* silicon chip (line 143)	**e)**	the receiver of a benefit or advantage, especially of money or property;

6	power line (line 122)	**f)**	the process connected with the generation of electricity between two metal electrodes immersed in a conductive liquid under the influence of light;
7	grid (line 64)	**g)**	an unexpected lucky gift or gain, especially money;
8	module (line 58)	**h)**	a very great rival;
9	windfall (line 90)	**i)**	a network of electricity supply wires connecting power stations;
10	bid (line 14)	**j)**	a number of solar cells working together;
11	arch-rival (line 8)	**k)**	an independent part or unit which can be combined with others to form a structure or arrangement;
12	beneficiary (line 89)	**l)**	a large wire carrying electricity over land or underground from where the electricity is produced to where it is used.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Electricity (line 36):
- **a)** the power which is carried usually by wires;
- **b)** the powerful force that is produced when the nucleus of an atom is either split or joined to another atom;
- **c)** the power which is produced or caused by heat.

2 Technology (line 93):
- **a)** a method of doing something that need skill;
- **b)** knowledge dealing with scientific and industrial methods and their practical use in industry;
- **c)** a planned way of doing something.

3 Installation (line 11):
- **a)** a piece of equipment intended for particular purpose;
- **b)** an apparatus in a fixed state ready for use;
- **c)** something necessary or useful for doing one's job.

4 Conductive liquid (line 113):
- **a)** (a) liquid containing a solid or gas mixed into it, usually without chemical change;
- **b)** (a) liquid able to conduct electricity;
- **c)** a substance which flows, is wet, and has no fixed shape.

5 Solar system (line 3):
- **a)** the sun together with the planets going round;
- **b)** such a system round another star;
- **c)** the system which uses the power of the sun's light.

6 Prospect (line 51):
- **a)** the expectation that something will happen as one wishes;
- **b)** (a) possibility;
- **c)** something which is productive soon.

7 Innovation (line 145):
- **a)** a suggested (business) offer, arrangement, or settlement;
- **b)** practical ability or skill in a particular area of activity;
- **c)** a new idea, method, or invention.

8 Dawn (of) (line 102):
- **a)** the time of day when light first appears;
- **b)** the beginning or first appearance of a new period, idea, feeling etc;
- **c)** at the first light of day.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 These two companies are …… in the computer industry.
2 Over the years the solar industry has been able continuously to reduce the cost of silicon-based …… .
3 Samsung and LG, a South Korean conglomerate, more often link their appliances with cables and …… than with wireless technology.
4 …… are used in making transistors.
5 As the billions of transistors on the …… get smaller, there is more room to add extra functions.
6 In Japan, where electricity is expensive, solar power is now fully cost competitive with power from the …… .
7 "Thin film" solar cells use little or no …… .
8 …… for building the bridge were invited from British and American firms.
9 As prices for silicon have gone up, so have prices of solar …… .
10 People on high incomes will be the main …… of these changes in the tax laws.

D Collocations

Match these verbs and nouns as they occur in the text.

1	convert	**a)**	efficiency
2	institute	**b)**	a bid
3	reduce	**c)**	solar power
4	generate	**d)**	a process
5	use	**e)**	cost
6	improve	**f)**	light
7	employ	**g)**	an electric current
8	protect	**h)**	a subsidy
9	place	**i)**	a power line
10	solicit	**j)**	wellheads

E Words with similar or related meanings

1 Two words are used many times with the meaning of 'force that can be used for doing work, driving a machine, or producing electricity'. What are these?
2 What other word is used in the text (para 2) with the same meaning as 'sunlight' ?
3 The collocation 'manufacturing improvements' is used in paragraph 8. What word is used in the same paragraph with a similar meaning?
4 What phrase is used in paragraph 5 with a similar meaning to 'innovations' (line 154)?
5 What phrase (para 5) could replace the phrase 'at the torrid pace' (line 159)?
6 The phrase 'infusion of capital' is used in line 153. What word with a similar meaning is used earlier in the text (para 4)?
7 The phrase 'produce electricity' is used in line 39. What other phrase is used in paragraph 5 with the same meaning?
8 The verb 'invent' is used in line 32. What word with a similar meaning is used in paragraph 6?

F Words that seem similar

1 The words **1)** 'economical '(line 123) and **2)** 'efficient' (line 118) have slightly different meanings. Match these words with their definitions:
   a) using money, time, goods etc, carefully and without waste;
   b) working well, quickly, and without waste.

2 The adjectives **1)** 'significant '(line 19) and **2)** 'enormous' (line 20) which describe the noun 'amounts' have completely different meanings. Match these definitions to the two words:
   a) of noticeable importance, effect, or influence;
   b) extremely large.

3 The verb **1)** 'devise' (line 117) and the noun **2)** 'device' (line 117) are confusingly related words. Match these words with their meanings:
   a) an invention or plan;
   b) invent, create, contrive.

4 The adjectives **1)** 'conventional'(line 122), **2)** 'typical' (line 48) and **3)** 'traditional' (line 97) have slightly different meanings. Match these definitions to the three words:
   a) produced, done, or used in accordance with tradition;
   b) following accepted customs and standards, sometimes too closely and without originality;
   c) exhibiting the qualities, traits, or characteristics that identify a kind, class, group, or category.

5 The phrasal verbs **1)** 'profit from' and **2)** 'benefit from' (para 8) have different meanings. Match them with their meanings:
   a) to make a profit from something;
   b) to get help or an advantage from something.

G Phrasal verbs

Find phrasal verbs in the text that match these definitions:

a)	to supply (para 1);	p ……. f …….
b)	to refrain from (para 2);	h ……. b ……
c)	to distribute (para 4);	h ……. o ……
d)	to direct one's attention to something (para 5);	f …….. o ……
e)	to risk (money) on the result of a future event (para 5);	b ……. o ……
f)	to rely on (para 6);	d ……. o ……
g)	to gain advantage (as a result of something) (para 8).	b …….. f ……
h)	to begin doing something.	e …….. o……

H Understanding meanings

Choose the right definition of the word 'room' in the phrase 'there is a lot of room for growth' as it is given in the text (line 165):

a) space available for something;
b) opportunity for doing something;
c) the people present in a room;
d) a part or division of a building enclosed by walls, floor, and ceiling.

UNIT 6 WIND POWER

Text A: WHERE THE WIND BLOWS

A grandiose plan to link Europe's electricity grids may recast wind power from its current role as a walk-on extra to being the star of the show

WIND power has two problems. You don't always get it where you want it and you don't always get it when you want it. According to Dr Schmid, the head of ISET, an alternative-energy institute at the University of Kassel, in Germany, continent-wide power distribution systems in a place like Europe would deal with both of these points.

The question of where the wind is blowing, would no longer matter because it is almost always blowing somewhere. If it were windy in Spain but not in Ireland, current would flow in one direction. On a blustery day in the Emerald Isle it would flow in the other.

Dealing with when the wind blows is a subtler issue. In this context, an important part of Dr Schmid's continental grid is the branch of Norway. It is not that Norway is a huge consumer. Rather, the country is well supplied with hydroelectric plants. These are one of the few ways that energy from transient sources like the wind can be stored in grid-filling quantities. The power is used to pump water up into the reservoirs that feed the hydroelectric turbines. That way it is on tap when needed. The capacity of Norway reservoirs is so large, that should the wind drop all over Europe–which does happen on rare occasions–the hydro plants could spring into action and fill in the gap for up to four weeks.

Put like this, a Europe-wide grid seems an obvious idea. That it has not yet been built is because AC power lines would lose too much power over such large distances. Hence the renewed interest in DC. Dr Schmid calculates that a DC grid of the sort he envisages would allow wind to supply at least 30% of the power needed in Europe. Moreover, it could do so reliably–and that means wind power could be used for base-load power supply.

A group of Norwegian companies have already started building high-voltage DC lines between Germany, Scandinavia and the Netherlands though these are intended as much to sell the country's power as to accumulate other people's. And Airtricity–an Irish wind-power company–plans even more of them. It proposes what it calls a Supergrid. This would link offshore wind farms in the Atlantic ocean and the Irish, North and Baltic seas with customers throughout northern Europe.

Airtricity reckons that the first stage of this project, a 2,000 turbine-strong farm in the North Sea, would cost about $2.7 billion. That farm would generate 10 gigawatts. An equivalent amount of coal-fired capacity would cost around $2.3 billion. Such offshore farms certainly work. Airtricity already operates one in the Atlantic, and though it currently has a capacity of only 25 megawatts, increasing that merely means adding more turbines.

Text B: TRAPPED WIND

Compressed air might help to make wind power more reliable

Wind-power turbines have played an important step in renewable energy but now the future of wind power may be underground. By using compressed-air energy storage plants, air is pumped into large underground formations where it can be used later to deliver a large amount of energy that it received.

Pumping water into the reservoir of a hydroelectric power plant may be a good way of storing energy captured by wind farms–but what if there are no such plants to hand and no high-tension lines to reach them? One answer is to use the energy to compress air, which can be squirrelled away in hermetically sealed underground caverns. Then, when electricity is needed, the air can be released and used to turn a generator. Compressed air energy storage involves converting electrical energy into high-pressure compressed air that can be released at a later time to drive a turbine generator to produce electricity.

At the moment, however, there are only two compressed-air-energy-storage plants in the world (one in America and one in Germany), and neither was built to make use of wind power. Instead, they are designed to take advantage of variations in the price of electricity. When power is cheap, it is used to run their compressors. When it is expensive, the valves are opened and the generators turn.

Compressed-air plants are inefficient, and so they are commercially viable only in places where the price of power varies dramatically. But the intermittent nature of wind power can cause just that sort of variability. By 2011, a wind-powered compressed-air plant had been built in Iowa.

Meanwhile, General Compression, a small firm based in Attleboro, Massachusetts, is taking another approach. Its windmill compresses air directly. This has the advantage of eliminating two wasteful steps: the convertion of the mechanical power of a windmill into electricity and its subsequent reconversion into mechanical power in a compressor. But an air-compressing windmill, while fine for storing energy, cannot transmit electricity directly to the grid. The firm will not produce its first prototype until 2020, but sceptics already worry that what it gains on the swings, it will lose on the roundabouts –or, in this case, on the turbines.

Most other compressed air energy storage plants operate under the same principle, although to increase efficiency they are more focused on retaining the heat associated with compression. One of the major issues with compressed air energy storage is that when you compress air it heats up. When the electricity is required it needs to be expanded, which requires heat. In addition, the cooler the air, the more you can store. Companies are therefore trying to find ways to store the heat generated during compression, so it can then be used to heat the air for the expansion helping drive more efficiency in the overall process.

READING

A Understanding main points

Read the text and answer these questions.

1 What is wind energy?
2 What are the advantages of wind-generated energy?
3 What are the economic obstacles to greater wind power usage?
4 Are there environmental problems facing wind power?
5 Why do we need energy storage?
6 What countries produce the most wind energy in the world?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Compressed air energy storage is a way to store energy generated at one time for use at another time using compressed air.
2 Wind power consists of converting the energy produced by the movement of wind turbine blades driven by the wind into mechanical energy.
3 Wind energy is a source on non-renewable energy**.**
4 Wind energy has the potential to become the backbone of a future secure global energy supply.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The cost of the first stage of the Supergrid. ……
2 The sum of money equivalent to €2 billion. ……
3 The capacity of the farm to be built in the North Sea. ……
4 The cost of an amount of coal-fired capacity equivalent to that of the capacity of the farm. ……
5 The capacity of the offshore farm which operates in the Atlantic. ……
6 The number of turbines to be built in the North Sea. ……

D How the text is organized

These phrases summerise the main idea of each paragraph. Match each phrase with the correct paragraph:

Text A

1 advantages of a dc grid;
2 perspectives of the airtricity's project;
3 designation of dc lines in northern europe;
4 problems of wind power;
5 how hydroelectic plants work in norway;
6 where the wind is blowing.

Text B

1 attempts of companies to store heat;
2 the way of storing energy;
3 how a compressed-air energy storage plant operates;
4 the approach of general compression;
5 building a compressed-air plant in theamerican midwes;
6 the future of wind power.

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1	wind power (A, line 1)	**a)**	a place where liquid is stored;
2	voltage (A, line 55)	**b)**	a part of a machine, for compressing gas or air;
3	hydroelectric turbine (A, line 32)	**c)**	a structure with large sails or similar parts which are turned round by the wind, used to produce power for electricity;
4	reconvertion (B, line 57)	**d)**	a large wire carrying a powerful electrical power;
5	reservoir (A, line 31)	**e)**	power produced by wind;
6	current (A, line 15)	**f)**	a doorlike part of a pipe or tube which opens and shuts so as to control the flow of liquid, air, gas etc through it;
7	capacity (A, line 33)	**g)**	the amount that something can hold or contain;
8	valve (B, line 38)	**h)**	a continuously moving mass of liquid or gas, especially one flowing through slower-moving liquid or gas;
9	prototype (B, line 63)	**i)**	the first form of something, especially of a machine or industrial product, from which all later forms develop, sometimes with improvements;
10	compressor (B, line 37)	**j)**	electric force measured in volts;
11	windmill (B, line 52)	**k)**	an engine or motor in which the pressure of water, usually at very high temperatures, drives a special wheel, producing a circular movement;
12	high-tension line (B, line 15)	**l)**	conversion back to a previous state.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Generator (B, line 22):
- **a)** a piece of machinery with moving parts which changes power from steam, oil etc;
- **b)** a machine that generates something, especially electricity;
- **c)** a small machine for crushing or grinding the stated solid material.

2 Power supply (A, line 52):
- **a)** a steep downward movement of an aircraft with the engines working;
- **b)** the flow of electricity to a building, machine etc;
- **c)** (a system for) the supplying for something needed.

3 Alternative energy (A, line 6):
- **a)** the energy that is different from usual or traditional one;
- **b)** the energy produced by conventional power stations;
- **c)** the energy produced by underground sources of steam.

4 Grid (A, line 22):
- **a)** the power which is produced by various means, which is carried by wires;
- **b)** the wires and other equipment that work an electrical apparatus;
- **c)** a network of electricity supply wires connecting power stations.

5 Alternating current (AC) (A, line 42):
- **a)** a flow of electricity that regularly changes direction at a very fast rate
- **b)** the flow of electrons in one direction around a circuit
- **c)** the direction of a current of water

6 Current (A, line 45):
- **a)** something flowing or moving forward continuously;
- **b)** a natural flow of water moving across country between banks of a river;
- **c)** the flow of electricity past a fixed point.

7 Power line (A, line 43):
- **a)** a long mark used as a limit or order;
- **b)** a large wire, carrying electricity over land or underground from where electricity is produced to where it is used;
- **c)** (a piece of) string or cord.

8 Direct current (DC) (A, line 45):
- **a)** the flow of electrons back and forth;
- **b)** a flow of electricity that moves in one direction only;
- **c)** the flow of neutrons in a wire.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 The fuel tank has a …….. of 12 gallons.
2 High …….. is the best way to transmit power.
3 Power is transmitted along …….. .
4 The ……. is strongest in the middle of the river.
5 When ……. of water into ice occurs, it freezes.
6 In a ……. a wheel of special blades is driven round at high speed by water.
7 The ……. of the heart and blood vessels allow the blood to pass in one direction only.
8 A ……. forces substances into less space.
9 The first ……. were used for crushing grain.
10 The volume of this ……..... is 100,000 cubic meters.

D Collocations

Match these verbs and nouns as they occur in the text.

1 store	**a)** a valve
2 pump	**b)** air
3 supply	**c)** an approach
4 link	**d)** mechanical power
5 convert	**e)** electricity
6 turn	**f)** a generator
7 open	**g)** energy
8 take	**h)** power
9 compress	**i)** water
10 transmit	**j)** wind farms

E Words search

Find a word in the text that has a similar meaning:

a) power (B, para 2);
b) mean (A, para 2);
c) operate (A, para 6);
d) wind farm (A, para 5);
e) problem (A, para 2, para 3);
f) quantity (A, para 6);
g) huge (A, para 3);
h) high-tension (A, para 5);
i) underground cavern (B, para 2);
j) capture (B, title).

F Words that seem similar

1 The words 'variation'(B, line 35) and 'variability' (B, line 46) have slightly different meanings. Which of the following definitions fits the word **1)** 'variation' and which fits the word **2)** 'variability'?

a) having the tendency to vary, not to stay the same or steady;
b) (an example or degree of) varying.

G Prepositions

Complete these sentences with a suitable preposition.

1 When a windmill compresses air, it converts a mechanical power ……electricity.
2 In direct current electrons flow …… one direction.
3 At present, power is mostly supplied …… traditional power stations.
4 Wind power can be used …… the production of electric power.
5 The Global Network Institute, based in California, reckons that wind and geothermal power could be gathered …… places like South America and Siberia.
6 Edison was right to argue that DC is the best way to transmit electricity …… any given voltage.
7 Wind power gives power which is very consistent from year …… year.

H Questions

Below you will find answers to five different questions. Read the Text B and try to supply the missing questions.

1 ……?
They are designed to take advantage of variations in the price of electricity.
2 ……?
They decided to build a wind-powered compressed-air plant in Iova.
3 ……?
Two wasteful steps.
4 ……?
$2.3 billion.
5 ……?
By 2011.

I Culture note

1. Emerald Isle, the name for Ireland, used in literature, often humorously.
2. Iowa, a state in the Midwestern United States.
3 Massachusetts, a state in the northeast of the US which has Boston as its capital city.

UNIT 7 GEOTHERMAL ENERGY

Text A: BLOWING HOT AND COLD

Geologists are getting more juice out of the ground

GOLDILOCKS, the fussy, blonde, larcenous heroine of an English children's story, liked her porridge neither too hot, nor too cold, but just right. Most engineers looking for underground sources of steam to generate geothermal power have similar tastes. If the steam is much colder than 150°C, it will start to condense into water before it can be used to turn a turbine. On the other hand, steam hotter than 400°C, although richer in energy, is harder to find and to handle. Two new projects, however, aim to push back both these limits.

Geothermal power stations tap aquifers heated by contact with hot rocks in volcanic regions–or, in hot but dry spots, they pump water past such rocks to heat it up. The temperature of the steam produced varies, depending on how hot the source is and how much heat it loses on its way to the surface.

Not all geothermal activity is hot enough to bring water to the boil. The Chena hot springs, in Alaska, for example, are just right for bathers, at a porridge-like 43°C, but not much use for traditional geothermal power generation. Even within the spa's wells, the water is only 74°C. Nonetheless, its owners, in conjunction with United Technologies, an engineering conglomerate, have worked out how to generate power from the tepid flow—the coldest ever used in a geothermal plant.

The power station at Chena uses the spring water to heat up R134a, a fluid hitherto employed mainly as a refrigerant. Since R134a has a relatively low boiling point, the water is hot enough to convert it into a gas. This gas is used to drive the turbine just as steam would be. Icy water from a nearby river then cools the gas back to liquid form, to start the cycle again. The idea of using a liquid with a lower boiling point than water to drive a turbine is nothing new—it has simply not proved worthwhile in the past.

In Iceland, meanwhile, consortium of utilities is teaming up to do just the opposite: harness steam that is much hotter than the norm. The wells of most geothermal plants are about 2km deep. But the Icelandic outfit hopes to drill to depths of 4km or more, to get closer to the magma that rises towards the surface along local faultlines. In such areas the steam might be as hot as 600°C.

Tapping this steam would be expensive, since it would require not only extra building materials, but also more durable ones, to cope with the higher pressures and temperatures. But Olafur Flovenz, of Iceland Geosurvey, believes that although the costs might increase, the amount of electricity generated could rise by as much as ten times. If the project succeeds, it would bring the costs down even further. Better yet, it could be replicated in any country with a volcano.

Text B: BENEATH YOUR FEET

Geothermal could be hot

THE Phillipines are not generally associated with the cutting edge of technological change. In one respect, though, the country is ahead of its time: around a quarter of its electricity is generated from underground heat. Such heat is free, inexhaustible and available day and night.

It is also a part of geology that sees parts of the country devastated by volcanic eruptions from time to time. The geysers that turn the generators are merely the gentlest manifestations of this volcanism. The question that exercises Jefferson Tester, a researcher at MIT, is whether it is possible to have the one without the other. The Earth's depths are, above all, hot everywhere. So if there is no natural volcanism around to bring this heat to the surface, his answer is to create controlled, artificial volcanism–what is known as an engineered geothermal system (EGS). Instead of relying on natural hot springs, you make your own.

In principle, this is easy. Drill two parallel holes in the ground, a few hundred metres apart, and carry on drilling until the rock is hot enough (say 200º). Then pump cold water down one hole and wait for it to come back the other at a suitably elevated temperature. The superheated water turns to steam which you use to power a generator. In Dr Tester's view, the reason this source of power is neglected is that it is invisible. Everybody feels the wind and the sun, but only miners notice that the Earth's interior is hot, so no one thinks of drilling for that heat.

Dr Tester reckons that spending about $1 billion on demonstration projects over the next 15 years would allow 100 gigawatts-worth of EGSS to be created in America by 2050, at a commercially acceptable price.

Rock-hard

Extracting this subterranean energy is not as easy as it sounds. Until the term EGS was coined, the field was known as hot-dry-rock geothermal energy. A century of data collected by oil companies suggest it is impermeable rocks such as granite that are the most effective reservoirs of heat. Their very dryness increases their heat capacity. But to get the heat out you have to make them permeable. Hence the "engineered" is the new name.

The Cooper Basin in South Australia has the hottest non-volcanic rocks of any known place in the world, and Australia leads the field in exploiting subterranean heat, with seven firms snooping around the area. One of them, Geodynamics, recently completed what it claims is a commercial-scale well. And the turbines will also turn soon at an experimental non-commercial project at Soultz, in France.

If it can be made to work, EGS has got the lot. No unsightly turbines. No need to cover square kilometres of land with vast mirrors. And it is always on. Anybody got a billion dollars handy?

READING

A Understanding main points

Read the text and answer these questions.

1 What is geothermal energy?
2 Why is geothermal energy "environmentally friendly"?
3 Why is geothermal energy considered a renewable resource?
4 How does geothermal energy work?
5 What is the future of geothermal energy?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Geothermal energy is thermal energy generated and stored in the Earth.
2 Geothermal energy is renewable because the Earth has retained a huge amount of the heat energy that was generated during formation of the planet.
3 The source of geothermal power is the sand contained inside the Earth.
4 Geothermal energy refers to the production of energy using the internal heat of the Earth's crust.
5 There are many advantages of geothermal energy.

C Information search

Scan the text quickly and find the figures, percentage or sums of money that correspond to the following pieces of information.

1 The degree of heat of steam at which it starts to condense into water. ……
2 The temperature of steam at which it is richer in energy. ……
3 The temperature of water within the spa's wells at Chena. ……
4 The supposed temperature of steam according to "IDDP". ……
5 The depth of wells of most geothermal plants. ……
6 The sum of money to be spent on demonstration projects. ……
7 The amount of electricity the EGSS will generate in America by 2050. ……

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1	geothermal energy (B, line 57)	**a)**	the most advanced position, where important action is taken;
2	geothermal plant (A, line 40)	**b)**	something that produces power, such as electricity, gas, or petrol;
3	cutting edge (B, line 2)	**c)**	the energy produced from the heat found deep inside the earth;
4	boiling point (A, line 52)	**d)**	a place where water can be taken from underground;
5	well (A, line 60)	**e)**	the temperature at which a liquid boils;
6	juice (A, subtitle)	**f)**	a hydroelectric power station which transforms the Earth's interior heat into power;

7	refrigerant (A, line 44)	**g)**	a set of things needed for a particular purpose a set of things needed for a particular purpose;
8	spa (A, line 33)	**h)**	the line of crack in the Earth's surface along which one band of rock has slid against another;
9	source (A, line 6)	**i)**	(of a volcano) outpouring of fire, lava etc;
10	faultline (A, line 65)	**k)**	a place with a spring of mineral water where people come for cures of various diseases;
11	eruption (B, line 12)	**l)**	a place from which something comes;
12	subterranean (B, 54)	**m)**	being, lying, or operating under the surface of the earth;
13	outfit (A, line 62)	**n)**	a substance that is used to refrigerate.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Steam (A, line 6):
- **a)** water in the state of a gas produced by boiling;
- **b)** substabce like air, which is not solid or liquid and usually cannot be seen;
- **c)** a very small drop of liquid.

2 Spring (A, line 28):
- **a)** the place where a river enters a lake, larger river, or the ocean;
- **b)** a place where water naturally flows out from the ground;
- **c)** a stream or river that flows into a larger one.

3 Rock (A, line 19):
- **a)** a very high hill, usually a bare or snow-covered one;
- **b)** solid mineral material used in the building industry;
- **c)** the solid mineral material forming part of the surface of the earth and other similar planets.

4 Magma (A, line 63):
- **a)** a set of substances mixed together so as to give a combined effect;
- **b)** hot melted rock found below the solid surface of the earth;
- **c)** (a) liquid containing a solid or gas mixed into it, usually without chemical change.

5 Flow (A, line 39):
- **a)** a large amount of ice, snow, dirt, or rock falling suddenly down the side of a mountain;
- **b)** movement of something in one direction;
- **c)** an overflow of a large amount of water beyond its normal limits.

6 Granite (B, line 60):
- **a)** a hard solid substance found in the ground and often used for building houses;
- **b)** a type of rock containing calcium and other substances;
- **c)** a very hard usually grey rock, used for building and making roads.

7 Geyser (B, line 13):
- **a)** a large area of water, surrounded by land;
- **b)** a natural spring of hot water which from time to time rises suddenly into the air from the earth;

8 Volcano (A, line 80):
- **a)** (a loud noise caused by) an act of exploding;
- **b)** a sudden shaking of the earth's surface, which may be violent enough to cause great damage;

c) water of a stream, river, etc, falling straight down over rocks, sometimes from a great height.

c) a hot spring in which water intermittently boils, sending a tall column of water and steam into the air.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 Oil has a low …….. .
2 Our car uses a lot of …….. .
3 We'll have to find a new …….. of income.
4 There have been several volcanic …….. this year.
5 …….. became very fashionable places in the UK and Europe in the 18th and 19th centuries.
6 Before drilling they tested all their …….. .
7 Electricity generated by …….. is much cheaper than that generated by hydroelectric power stations.
8 The old …….. in the village had a wall round it and a bucket that could be lowered for water.
9 This new model is at the …….. of computer technology.
10 Magma rises towards the earth surface along local …….. .

D Collocations

Match these verbs and nouns as they occur in the text.

1 drive	**a)** steam
2 generate	**b)** subterranean energy
3 pump	**c)** information
4 require	**d)** artificial volcanism
5 replicate	**e)** a generator
6 harness	**f)** a turbine
7 turn	**g)** a project
8 create	**h)** building material
9 provide	**i)** water
10 extract	**j)** geothermal energy

E Words with similar or related meanings

1 The phrase 'is available day and night' is used in paragraph 1 (B). What other phrase is used in the last paragraph of the text with a similar meaning?
2 What word (A, para 1) could replace the word subterranean' (B, para 5)?
3 The noun 'well' is used several times in the text. What other word has a similar meaning in the text (B, para 3)?
4 The verb 'harness' is used in the text (A, line 58). What other words are used there (A, para 4) with a similar meaning to 'harness'?
5 The slang 'juice' (A, subtitle) has its equivalent in the text B (para 1). What is it?
6 The word 'reservoir' is used in line 62 (B). What word with a similar meaning is used earlier in the text

F Words that seem similar

The words **1)** 'source '(A, line 6) and **2)** 'spring' (A, line 28) have different meanings. Match these definitions to the two words:

a) a place where water comes up naturally from the ground;
b) a place from which something comes.

G Phrasal verbs

Find phrasal verbs in the text that match these definitions:

a)	to change into another form, substance, or state (A, para 4).	c …… i …..
b)	to make or become warm or hot (A, para 2).	h …… u …..
c)	to work together for a shared purpose (A, para 5).	t …… u …..
d)	to try to find (A, para 1).	l …… f …..
e)	to deal successfully with a difficult situation (A, para 6).	c …… w …..
f)	to cause to fall or come down (A, para 6).	b …… d …..
g)	to continue, especially in spite of difficulties (B, para 3).	c …… o …..
h)	to use as a base for future action (B, para 6).	g …… o …..
i)	to find by reasoning or calculating (A, para 3).	w …… o …..
j)	to depend on (B, para 2).	r …… o …..

H Word search

Find a word in the text that has a similar meaning:

a) hard (A, para 1)
b) heat (up) (A, para 3)
c) region (A, para 5)
d) convert (into) (A, para 4)
e) elevate (B, para 3)
f) plant (A, para 2)
g) create (B, para 2)
h) price (A, para 6)
i) coin (B, para 2)
j) company (A, para 3)
k) energy (A, para 1)
l) let (A, para 4)
m) force (B, para 6)
n) land (B, para 3)

I Opposites

Find a word in the text that has an opposite meaning.

a) lose (A, para 1)
b) high (A, para 4)
c) permeable (B, para 5)
d) hard (B, line 3)
e) natural (B, para 2)
f) increase (A, para 6)
g) hot (A, para 1)
h) without (A, para 2)

F Culture note

1 Alaska, the largest state in the US, which is northwest of Canada.
2 Goldilocks, the main character in the children's story *Doldilocks and the Three Bears*.
3 Iceland, an island country in the Atlantic Ocean south of the Arctic Circle.
4 MIT, *abbrev.* for Massachusetts Institute of Technology: an important and respected US university in Cambridge, Massachusetts.
5 Phillipines, a country made up of over 700 islands off the southeast coast of Asia. Capital: Manila.

UNIT 8 **BIOFUEL**

Text: WOODSTOCK REVISITED

Energy: Could new techniques for producing ethanol make old-fashioned trees the biofuel of the future?

MANKIND has used trees as a source of fuel for thousands of years. But now the notion of exploiting trees for fuel is being updated with a high-tech twist. The idea is to make ethanol, a biofuel that usually comes from maize (corn) or sugar cane, from trees instead. Politicians and environmentalists are embracing ethanol for a number of reasons. Unlike oil, ethanol is renewable: to make more of it, you grow more crops. And blending ethanol into ordinary petrol, or burning it directly in special "flex-fuel" engines, reduces greenhouse-gas emissions.

Why use trees, rather than maize or sugar cane, as a feedstock for ethanol? Because "treethanol" has the potential to be much more energy efficient. The ratio of the energy yielded by a given amount of ethanol to the energy needed to produce it is called the "energy balance". The energy balance for ethanol made from maize is the subject of much controversy, but America's energy department puts it at 1.3; in other words, the ethanol yields 30% more energy than was needed to produce it. For ethanol made from sugar cane in Brazil, the energy balance is 8.3, according to the International Energy Agency.

But for ethanol made from trees, grasses and other types of biomass the energy balance can be as high as 16. Producing such “cellulosic” ethanol is much more difficult and expensive than producing it from other crops. But the science, technology and economics of treethanol are changing fast. Researchers are racing to develop ways to chip, ferment, distil and refine wood quickly and cheaply.

Trees are a particularly promising feedstock because they grow all year round, require vastly less fertiliser and water and contain far more carbohydrates (the chemical precursors of ethanol) than food crops do. Ethanol is the result of the fermentation of sugars, which is why it can be so simply and efficiently made from sugar cane. Making ethanol from maize is a bit more complicated: the kernels are ground into flour and mixed with water, and enzymes are added to break the carbohydrates from the maize down into sugars, which can then be fermented into ethanol. Making ethanol from cellulosic feedstocks is harder still, however, since it involves breaking down the tough, winding chains of cellulose and hemicellulose from the walls of plant cells to liberate the sugars. This can be done using a cocktail of five or six enzymes. The problem is that although such enzymes exist, they are expensive.

The lure of bioprospecting

So if cellulosic ethanol is to live up to its promise, researchers will have to find cheaper and more efficient

enzymes. Grass, trees and other biomass feedstocks consist of a mixture of cellulose, hemicellulose and lignin, a tough material that helps plants keep their shape. Two large producers of industrial enzymes are Genencor, an American firm, and Nowozymes, from Denmark.

Treethanol has particular appeal in countries that have a lot of trees and import a lot of fossil fuel. Top of the list is New Zealand, which is planning to produce ethanol from a type of willow, and Sweden, which is relying heavily upon wood-based solid as part of its plan to wean itself off oil by 2020.

Even if the right cocktails of enzymes can be found, sceptics say treethanol will still have several problems to overcome. In particular, trees take much longer to grow than grass or food crops—so it might make more sense to make cellulosic ethanol from fast-growing grasses, or the leftover biomass from food crops. Some environmentalists worry that having struggled for years to protect forests from overexploitation, demand for biofuels could undermine their effort.

And now for Frankentreethanol The idea is to create new, fast-growing trees to address this problem, either through careful breeding or genetic modification. A team led by Vincent Chiang, a biologist at North Carolina State University, is investigating the production of ethanol from genetically modified trees. Their preliminary results clearly point out that transgenic wood can drastically improve ethanol-production economics.

A tree's rate of growth is limited by its lignin structure, which is what determines the tree's strength and form. Trees containing less lignin and more cellulose would both grow faster and also produce more ethanol. Some transgenic trees of this kind are being tested in America. Scientists are looking at ways to modulate the genes that determine the structure of a tree's sugar-containing hemicelluloses in order to make the breakdown and fermentation processes more efficient.

But Steven Strauss, a forest biologist at Oregon State University, says that because of the great genetic variation in willows and poplars, genetic modification may not be necessary. By screening existing varieties it ought to be possible to identify those well suited to ethanol production. Conventional breeding and cloning are very efficient when there is such a variety of species and hybrids to choose from and the tight regulation of genetically modified organisms makes using the technology expensive and time consuming.

Hundreds of thousands of years ago, when man first gained mastery over fire, wood was his primary fuel. In the past few centuries fossil fuels have risen to prominence, with calamitous consequences for the world's climate. A diversity of new fuels and energy sources seems the most likely future. It would be fitting if humanity's portfolio of new energy technologies had a place for wood, the oldest of them all.

READING

A Understanding main points

Read the text and answer these questions.

1 Why has interest in biomass energy resources from forests been rapidly increasing in recent years?
2 Is ethanol energy-efficient?
3 What is the ethanol fuel energy balance?
4 How does the production of biomass and ethanol affect the environment?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Biofuel is a type of energy source derived from renewable plant and animal materials.
2 The common method for converting biomass into ethanol is called gasification.
3 Enzymes can be used to break down biomass into liquid sugars.
4 Trees containing more lignin and less cellulose would both grow faster and also produce more ethanol.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The energy balance for ethanol made from trees, grasses and other types of biomass containing a lot of cellulose. ……
2 The energy balance for ethanol made from sugar cane. ……
3 The energy balance for ethanol made from maize. ……
4 The cost of a gallon of ethanol produced from trees. ……
5 The percentage by which the ethanol yields more energy than was needed to produce it. ……

LANGUAGE FOCUS

A Definitions

Match these terms with their definitions:

1	ethanol (line 6)	**a)**	the material from which the cell walls of plants are made, used in making paper, plastic etc;
2	cellulose (line 68)	**b)**	ordinary alcohol found in alcoholic drinks. It is also used for removing fat and oil;
3	enzyme (line 61)	**c)**	any of several substances, such as sugar, which consist of oxygen, hydrogen, and carbon, and which provide the body with heat and power;
4	carbohydrate (line 62)	**d)**	catalyst produced by certain living cells, which can cause chemical change in plants or animals or can make these changes happen more quickly;
5	biomass (line 37)	**e)**	matter from dead or living plants or animals;

6	kernel (line 59)	**f)**	a living thing produced from parents of different breeds;
7	species (line 152)	**g)**	the business of keeping animals or plants for the purpose of obtaining new and better kinds;
8	hybrid (line 152)	**h)**	the part of a nut, large grain, or seed, inside its hard covering;
9	breeding (line 116)	**i)**	a division of animals or plants below a genus, which can breed together to produce young of the same kind;
10	cell (line 70)	**j)**	that can be renewed, especially by natural processes or good management;
11	genetically modified (line 154)	**k)**	crops, seeds developed by changing the plant's genetic structure to produce larger crops;
12	renewable (line 12)	**l)**	a very small division of living matter, with one centre of activity (nucleus).

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Biofuel (line 6):
- **a)** a substance that is burnt to produce heat or power that is solid;
- **b)** a type of heavy oil used instead of petrol etc in diesel engines;
- **c)** the fuel made from maize (corn), sugar cane, or trees.

2 Cane (line 19):
- **a)** the hard smooth thin, often hollow, stem of certain plants;
- **b)** a plant with pink flowers and fine hairs on its stem and leaves;
- **c)** a plant with red, white, or blue flowers.

3 Engine (line 16):
- **a)** a machine which generates something, especially electricity;
- **b)** an apparatus used for discovering the presence of a particular effect, such as light, heat, sound etc;
- **c)** a piece of machinery with moving parts which changes power from steam, electricity, oil etc, into movement.

4 Energy balance (line 25):
- **a)** a number that measures some quality or process;
- **b)** the ratio of the energy yielded by a given amount of ethanol to the energy needed to produce it;
- **c)** a figure showing the number of times one quantity contains another, used to show the relationship between two amounts.

5 Gene (line 135):
- **a)** a very small division of a living matter, with one centre of activity (nucleus);
- **b)** any of the structures shaped like rods that are found in living cells and contain the chemical patterns which control what an animal or plant is like;

6 Cloning (line 150):
- **a)** cutting a piece from one plant and tying it to place inside a cut of another, so that it could grow there;
- **b)** producing a single plant or animal in a nonsexual way from any one cell, and exactly the same form as the parent;

c) any of several small parts of the material at the nucleus of a cell, that control the development of all qualities in a living thing.

7 Environmentalist (line 10):

a) someone who scientifically studies weather conditions and says what the weather is likely to be in the future;

b) a person who tries to prevent the environment from being spoilt;

c) a person who studies plants or animals.

c) the process of producing genetically identical individuals of an organism either naturally or artificially.

8 Petrol (line 15):

a) a liquid obtained especially from petroleum, used mainly for producing power in the engines of cars, aircrafts etc;

b) a substance in a state between solid and liquid;

c) (a) liquid able to turn a solid Substance into liquids.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 There is a lot of disagreement among scientists and ordinary people about the advantages and disadvantages of ……. food.

2 The ……. from a donkey and a horse is called a mule.

3 Most energy experts reckon that using maize-based …….. as a substitute for petrol can reduce America's demand for petrol by 10-15% at best.

4 This rare bird has become an endangered ……. .

5 Sun, wind, and waves are …….. sources of energy.

6 We must encourage research on ……..… feedstocks, tomorrow's energy crops.

7 Fifty-three years after their invention, silicon-based solar ……. still make Up more than 90% of the market.

8 ……. are linked together in cell nuclei on structures called chromosomes.

9 Diversa, a biotech firm based in San Diego, is developing …….. .capable of breaking down hemicellulose.

10 Trees use the carbon thus sequestered to make molecules like ……., and thus more tree.

D Collocation

Match these verbs and nouns as they occur in the text.

1 exploit	**a)** crops
2 produce	**b)** enzyme
3 reduce	**c)** problems
4 protect	**d)** transgenic trees
5 ferment	**e)** genes
6 test	**f)** forests
7 find	**g)** ethanol s
8 grow	**h)** trees
9 overcome	**i)** greenhouse-gas emissions
10 modulate	**j)** wood
11 undermine	**k)** efforts

E Words with similar or related meanings

1 The phrase 'use trees' is met in paragraph 1. What other phrase is used in the same paragraph with a similar meaning?

2 What other adjective is used in the text with the same meaning as 'difficult' (para 4)?

3 The collocation 'produce ethanol' is used in paragraph 3. What other phrase is used in paragraph 4 with a similar meaning?

4 Ethanol is made from maize, sugar cane, trees, and grass. What is a general word for all of them (para 4)?

5 What word from the text (para 2) could replace the word 'yielded' (line 23?

6 The word 'cocktail' is used twice (paras 4 and 7) to describe the process of making ethanol. What other word is used in the article (para 5) with a similar meaning?

7 The word 'diversity' is used in line 163. What word with a similar meaning is used earlier in the text (para 10)?

F Words that seem similar

1 The words **1)** 'tree'(line 1) and **2)** 'wood' (line 47) have slightly different meanings. Match these words with their meanings:

a) a tall plant with a wooden trunk and branches, that live for many years;

b) the substance of which the trunks and branches of trees are made, which is cutand used for various purposes.

2 The adjective **1)** 'tough' (line 68) and the adjective **2)** 'tight' (line 153) have quite different meanings. Match these definitions to the two words:

a) well ordered or firmly controlled;

b) strong.

3 The nouns **1)** 'mankind' (line 1) and **2)** 'humanity' (line 166) have slightly different meanings. Match these words with their meanings:

a) the human race, both men and women;

b) human beings generally.

G Phrasal verbs

Find phrasal verbs in the text that match these definitions:

a)	to have confidence in (para 6);	r ……	u ……
b)	to (cause to) separate into different kinds or divide into types (para 4);	b ……	d ……
c)	to crush into small pieces by pressing between hard surfaces (para 4);	g ……	i ……
d)	to cause to gradually leave (an interest, habit, companion etc, that one disapproves of) (para 6);	w ……	o ……
e)	to keep to the high standards of (para 5)	l …….	u ……
f)	to become combined, especially so as to produce a pleasing effect (para 1);	b ……	i ……
g)	to direct someone's attention to (para 8);	p ……	o ……
h)	to have as a place or point of origin (para 1).	c ……	f ……

UNIT 9 ALTERNATIVES TO PETROL

Text: THE END OF THE PETROLHEAD

Tomorrow's cars may just plug in

Nothing ages faster than the future. A few years ago there was general agreement that if the internal-combustion engine ever was replaced by something clean, that something would be the fuel cell. A fuel cell is a way of reacting hydrogen and oxygen together in a controlled way and extracting electricity from the process. It was to be the precursor of what was known as the hydrogen economy, in which that gas would replace fossil fuels and power almost everything.

Leaving aside the problems of transporting and storing a light and leaky gas, what no one was very clear about was where the hydrogen itself would come from. You would have to make it from something else. That something would either be a mixture of fossil fuel and water (fuels can be reacted with steam to make hydrogen and carbon dioxide, but you still have to get rid of the carbon dioxide), or just water itself, via electrolysis.

But why bother? Why not cut out the middlemen and plug your car directly into the electricity mains instead? And that, it seems, is what may happen. You don't hear much about the hydrogen economy these days. Nor fuel cells. The buzz-phrase now is "plug-in hybrid". Plug-ins should not be confused with existing hybrid vehicles, such as Toyota's Prius, which contains an internal-combustion engine as well as two electric ones. Either sort may Drive the wheels. The electric motors kick in when they can do a more efficient job than the petrol engine, but even then the electricity comes ultimately, via batteries, from burning petrol.

In a plug-in, the electricity comes from the mains, via an ordinary electrical socket. Some intermediate designs retain the idea of two sorts of engine, but the goal is that the car should be powered by electric motors alone. If the batteries run down, a petrol-powered generator will take over. But most cars, most of the time, are used for short journeys. Gerbrand Ceder, a battery scientist at MIT, reckons that if the first 50km of an average car's daily range were provided by batteries rather than petrol, annual petrol consumption would be halved. Given that the electrical equivalent of a litre of petrol costs about 25 cents, that is an attractive reduction.

The widespread adoption of plug-ins might also reduce carbon-dioxide emissions, depending on what sort of power station made the electricity in the first place. Even energy from a coal-fired station is less polluting than the serial explosions that drive an internal-combustion engine. If the energy comes from a source such as wind or nuclear, the gain is enormous.

Beyond that, the rise of plug-ins has implications for the electricity industry itself. If they succeed, they will put an unanticipated load on the

system. In fact, they may remake electricity as well as transport.

Don’t all recharge at once

That is certainly the view of Peter Corsell of Gridpoint, a company based in Arlington, Virginia. His firm hopes to make its living selling the load-management technology required for “smart grids”. Mr Corsell reckons it will become essential if plug-ins arrive in force. At the moment, the grid would be unable to cope if a large number of commuters arriving home plugged in their cars more or less simultaneously to recharge them. Yet if those same cars were recharged at three o’clock in the morning, when demand is low, it would benefit both consumer (who would get cheap power) and producer (who would be able to sell otherwise wasted electricity). Such cars might even act as micropeakers –reservoirs of electrical energy that a power company could draw on if a car were not on the road. Managing plug-ins, Mr Corsell thinks, will be the smart grid's killer application.

In sunny climes, plug-ins might also provide another use for solar cells. Google is already experimenting with photovoltaic car parks. These have awnings covered in solar cels which will shade its employees’ cars and simultaneously recharge them. That is an idea which could be spread. Supermarkets, for example, might find that car parks with plugs would attract customers who wanted to top up their cars. And the more opportunities there are for stationary cars to be recharged, the more likely they are to be bought.

Plug-ins are moving from idea to reality with amazing speed. General production of the Tesla, Elon Musk's new sports car, began in March. The Tesla is not even a hybrid. It draws all of its power from lithium-ion batteries (the sort that power laptop computers), and it has a range of 350km. It can manage that because its price of $109,000 buys a lot of batteries; Tesla owners are not the sort who count their pennies.

Mass-production plug-ins are not far away either, and the rising price of petrol makes them look more attractive by the day. General Motors intends to launch a plug-in hybrid called the Volt, and Toyota plans a plug-in version of the Prius. Only Honda and Mercedes seem to be sticking to fuel cells. It is all very encouraging. But what would really make a difference would be a breakthrough in battery technology.

At the moment, lithium-ion batteries are the favoured variety. This kind of battery uses lithium in its ionic form. When the battery is fully charged, these ions hang around one of its electrodes, the anode, which is usually made of graphite. During operation, the ions migrate within the battery from this electrode to the other one, the cathode, and electrons pass between the electrodes through an external circuit. It is that current of electrons which drives the motor. The cathode may be made of a variety of materials. Cobalt oxide is traditional but expensive. Manganese oxide is becoming popular. But the future probably lies with iron phosphate, which has less of a tendency to overheat, a problem that has resulted in battery recalls in the past.

READING

A Understanding main points

Read the text on page and answer these questions.

1 What are the effective alternatives for petrol?
2 Why do we need alternative fuels in cars?
3 Hydrogen has virtually no greenhouse gas emissions, hasn't it?
4 Are propane vehicles are typically more expensive than those running on petrol?
5 What are the advantages of electric motors over petrol engines?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 Electricity can be used to power plug-in electric vehicles, which are increasingly available.
2 Propane is a readily available gaseous fuel that has been widely used in vehicles throughout the world.
3 The major fossil fuel alternatives to petrol are: ethanol and hydrogen.
4 The major non-fossil alternative fuels are: liquid petroleum gas and compressed natural gas.
5 Petrol is a derivative of petroleum.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 An average car's daily range taken for the calculation of annual petrol consumption. ……
2 The cost in cents of the electrical equivalent of a litre of petrol. ……
3 The price of Tesla. ……
4 The number of electric engines Toyota's Prius contains. ……
5 The number of internal-combustion engines Toyota's Prius contains. ……
6 The range of the Tesla. ……
7 The time of the day when demand for recharging of cars' batteries seems to be low. ……

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1	internal-combustion engine (line 3)	**a)**	machine that changes electrical power into movement, and is used for working other machines;
2	mains (line 30)	**b)**	an apparatus for producing electricity consisting of a group of connected electric cells;
3	buzz-phrase (line 34)	**c)**	a liquid obtained especially from petroleum, used mainly for producing power in the engines of cars, aircrafts etc;

4	hybrid vehicle (line 37)	**d)**	a piece of machinery with moving parts which changes power from petrol into movement;
5	electric motor (line 41)	**e)**	an engine, such as a car engine, which produces power by the burning of a substance, such as petrol, inside itself;
6	petrol engine (line 45)	**f)**	a vehicle using two different forms of power, such as an electric motor and an internal combustion engine, or an electric motor with a battery and fuel cells for energy storage;
7	battery (line 47)	**g)**	especially *BrE* a supply of electricity produced centrally and brought to houses etc by wires;
8	electrical socket (line 51)	**h)**	a piece of plastic or other material with holes in it, which is fixed into a wall or on to the end of a wire, and to which electrical equipment can be connected for the electricity supply;
9	petrol (line 48)	**i)**	a phrase related to a specialized subject, which is thought to express something important but is often hard to understand;
10	solar cell (line 113)	**j)**	restore electrical energy in (a battery or a battery-operated device) by connecting it to a power supply;
11	plug (line 122)	**k)**	a conductor used to establish electrical contact with a nonmetallic part of a circuit;
12	stationary car (line 125)	**l)**	the car which is standing still, not moving;
13	recharge (line 85)	**m)**	a small plastic object with two or three metal pins that are pushed into an electric socket to connect with the electricity supply;
14	electrode (line 156)	**n)**	an apparatus for producing electric power from sunlight.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 Anode (line 156):

a) either of the points at the ends of a magnet where its power of pulling iron towards itself is strongest;

b) the part of an electrical instrument (such as a battery) which collects electrons, often a rod of wire represented by the sign (+);

c) the end of a magnet which turns naturally away from the Earth.

2 Cathode (line 160):

a) a very small piece of matter that is like an electron but is positively charged;

b) the part of an electrical instrument (such as a battery) from which electrons leave, often a rod of wire represented by the sign (-);

c) the end of a magnet which turns naturally towards the Earth.

3 Ion (line 155):

a) an atom or molecule with a net electric charge due to the loss or gain of one or more electrons;

4 Electrolysis (line 27):

a) the decomposition of an electrolyte by the action of an electric current passing through it;

b) a very small piece of matter that carries positive electricity and that together with the neutron forms the nucleus;

c) a very small piece of matter that moves round the nucleus of an atom and that by its movement causes an electric current in metal.

5 Generator (line 39):

a) a machine which generates something, especially electricity;

b) a part of a machine that turns round on a fixed point;

c) a machine for storing electricity, especially in a car engine.

7 Car park (line 79):

a) an open space where cars and other vehicles may be parked, sometimes for a small payment;

b) a shelter for a car; with only a roof and one or two sides, often built against a side of a house;

c) a place where motor vehicles are repaired and petrol and oil may also be sold.

b) the combining of separate substances into a complete whole;

c) the force, caused by the movement and exchange of positively and negatively charged bits of matter in atoms.

6 Grid (line 64):

a) the flow of electricity to a building, machine etc;

b) a network of electricity supply wires connecting power stations;

c) the wires and other equipment that work an electrical apparatus.

8 Load (line 57):

a) something that is being or is to be carried, especially something heavy that is carried by the vehicle, ship, person etc;

b) the amount of work that must be done by a member of a group, a machine etc;

c) the power of an electricity supply.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 The car won't start because the …… has gone flat (=has lost all its power).
2 We filled the car with …… before the long journey.
3 "Does your radio work off the …… or from a battery?"
4 Plug the iron into that ……., will you?
5 Chemists have discovered about 30,000 inorganic chemical compounds, almost any of which might theoretically be suitable material for an ……. .
6 "How did you manage to drive into a ……?"
7 In the UK, a …… can be also called a 'gas station'.
8 Traditional …… are made of silicon, like computer chips.
9 Petrol-electric ……... attain their fuel economy by using …….. in stop-start city traffic and …… when cruising on the highway.
10 Around 50% of cars sold in Europe today rely solely on conventional ……. .

D Collocations

Match these verbs and nouns as they occur in the text.

1 extract (para 1) **a)** cheap power

2 recharge (para 7)
3 attract (para 8)
4 launch (para 10)
5 reduce (para 5)
6 charge (para 11)
7 drive (para 11)
8 put (para 6)
9 get (para 7)

b) a load
c) a motor
d) a battery
e) carbon-dioxide emissions
f) a plug-in hybrid
g) customers
h) cars
i) electricity

E Phrasal verbs

Find phrasal verbs in the text that match these definitions.

a) (of a machine) to stop suddenly (para 3); c …… o ……
b) to gain the use of (a system) by making an electrical connection worth it (para 3); p …... i……
c) contribute; to (begin) to have an influence (para 3); k …... i……
d) to lose power and stop working (para 4); r …... d……
e) to gain control over and responsibility for (smth) (para 4); t …... o……
f) to rely; place trust on *or* upon (para 5); d …... o……
g) to connect to a supply or electricity with a plug (subtitle); p …... i……
h) to make use of a supply of something (para 7); d …... o……
i) to fill (a partly empty container) with liquid (para 8); t …... u……
j) to delay or move slowly (para 11). h …… a……

F Prepositions

Complete these sentences with a suitable preposition from Exercise F.

a) You can plug …… the national computer network.
b) The engine keeps cutting …… when I go up hills.
c) The coal industry is running …… .
d) "The television doesn't work." "Have you plugged it ……?"
e) I took a painkiller an hour ago, I wish it would kick …… .
f) Who do you think will take …… now that the governor has been dismissed?
g) I'll have to draw …… my savings to pay for the repairs.
h) "Your petrol tank is nearly empty; let me top it ……".

F Words that seem similar

1 The words **1)** 'variety'(line 152) and **2)** 'range' (line 62) have slightly different meanings. Match these words with their meanings:
   a) the area of variation between upper and lower limits on a particular scale;
   b) the quality or state of being different or diverse; the absence of uniformity or monotony.

2 The nouns **1)** 'mains' (line 30) and **2)** grid (line 91) have slightly different meanings. Match these words with their meanings:
   a) a system of wires through which electricity is connected to different power stations across a region;
   b) the source of electricity supply through cables.

UNIT 10 THE TECHNOLOGICAL FUTURE

Text: FLIGHT OF FANCY

The world of energy must change if things are to continue as before

AS SAMUEL GOLDWYN wisely observed, you should never make predictions, especially about the future. As far as predicting the technological future is concerned, people almost always either overshoot or undershoot. Holidays on the moon by 2000, as forecast in the 1960s? Not exactly. A quick hop out of atmosphere, courtesy of Virgin Galactic, is the limit of that vision for the moment. On the other hand, a seemingly boring way of linking computer files full of data on subatomic physics can turn into a world wide web of information in half a decade.

In retrospect, this special report will no doubt be proved to have been guilty of both over- and undershooting. It has begun from the premise that big changes are afoot in the energy field, and has tried to pick the technologies most likely to be important. Some outcomes are mutually exclusive. A truly electric car would eliminate the need for biofuels, except, perhaps, in aircraft. Truly cheap biofuels might price electric cars out of the market. A breakthrough in the capture and storage of carbon dioxide would bring coal back into play with a vengeance. Geothermal may be better than solar. Solar may be better than wind.

The report has ignored some technologies because they will not get anywhere. Fusion, that favourite of fantasists, is 30 years away, as it always has been and probably always will be. Giant satellites collecting sunlight and beaming the energy to Earth as microwaves are an idea of heroic proportions, but enough sunlight gets through the atmosphere to make them irrelevant. Other technologies may make a contribution, but only on a small scale. The idea of floating platforms that capture wave energy is technically feasible, but it seems more trouble than building wind turbines. Tidal power works, but even more than hydro, it depends on geography. And the idea of liberating hydro from geography with small, free-standing turbines may have local application, but maintaining such turbines is far more trouble than taking a spanner to a windmill.

All sorts of wacky but intriguing ideas are being looked into, such as flying turbines that would exploit the high winds of the jetstream. And so are perfectly sensible ones, such as ultracapacitors for storing electricity, that are now niche products but might suddenly blossom, to the embarrassment of prophets. Maybe, too, the hydrogen economy will rear its head again– but only if a way can be found of storing the gas easily and at high density. That would require a material that can absorb large volumes of it. One for Dr Gerber's materials genome project, perhaps.

This report has also ignored the

question of efficiency, except in the special context of small grids. The idea of "negawatts", as improvements in efficiency are sometimes known, has always been a favourite of greens. But there is too often a gleeful hairshirtedness to their pronouncements, which helps to explain why high-profile changes such as the introduction of energy-efficient light bulbs are viewed cynically by so many people.

In any case, a lot of efficiency improvements just happen in the background, as part of most businesses' continuous search for cost savings. Car engines, for example, are much more efficient than they used to be, and are likely to become still more so. The reason that American cars are such gas-guzzlers is not that their engines have got worse but that the cars themselves have got heavier.

Besides, as Robert Metcalfe, the networking guru, said at a recent conference: "You are not going to conserve your way out of the problem". The need to keep doing the same thing–consuming energy in ever larger quantities–is a force for change. How quickly that change will happen is hard to tell.

Sunlit uplands

In some fields, such as information technology, change happens suddenly or not at all. In others, such as energy, it can happen gradually to start with, but as the curve accelerates upward there comes a point where things move very fast. Ten years ago wind turbines were marginal. Now they are taken seriously, and in another decade they may contribute as much as a fifth of the world's electricity.

The same could happen to solar energy, which is ten years behind wind, and geothermal, with a 20-year lag. Whether it would happen faster if carbon emissions were charged for at an honest price is a moot point. Certainly, that is the only way to bring about the widespread adoption of carbon-dioxide capture and storage. But for the rest, the best way might, paradoxically, be what exists now: a threat that is real enough for electricity generators to price it into their future calculations without affecting their existing plants.

The lack of new coal-fired capacity creates a real opportunity for alternatives, among them renewables. But the lack of an actual carbon price still keeps the cost of existing electricity down, and thus the necessary incentives in place to make Google's cheaper-than-coal equation a reality.

If and when such cheaper alternatives arrive, the markets of Asia will open and Mr Khosla, an Indian-born American, will see the fruits of this adopted homeland roll out into his native country. It will be a long time before King Coal and Queen Oil are dethroned completely, but their reigns as absolute monarchs of all they survey are coming slowly to an end.

A large variety of new energy technologies are at various stages of development. Obviously, it is impossible to predict which of the options will win in the marketplace – this will be determined by future specific technological and economic developments.

READING

A Understanding main points

Read the text and answer these questions.

1 What do you think is the future of energy?
2 Why is solar energy called the energy of future.?
3 What is the future of nuclear energy?
4 Biomass has great potential to provide renewable energy, hasn't it?

B Understanding details

Mark these statements T (true) or F (false) according to the information in the text.

1 The energy system of the future won't look like today's: the scale of change over the next 10 to 20 years will be considerable.
2 Fossil fuels will remain invaluable global energy sources for humankind at least in the first half of the 21st century, however, their future is highly uncertain.
3 Geothermal, wind and solar energies will become the most important sources in future.
4 The algae will be one of the important energy sources in the future.

C Information search

Scan the text quickly and find the figures, percentages or sums of money that correspond to the following pieces of information.

1 The amount of electricity which wind turbines may contribute ……
2 The number of years solar energy is lagging behind wind energy ……
3 The number of of years geothermal energy is lagging behind wind energy ……
4 A period of time fusion is away ……
5 The number of years ago wind turbines were marginal ……

LANGUAGE FOCUS

A Definitions

Match the words from the text with their corresponding definitions:

1	niche product (line 48)	**a)**	a statement or idea on which reasoning is based;
2	pronouncement (line 61)	**b)**	(a) joining together by melting;
3	prophet (line 50)	**c)**	(the making of) an important advance or discovery often after earlier failures;
4	gas-guzzler (line 70)	**d)**	able to be carried out or done; possible and reasonable;
5	compound interest (line 82)	**e)**	a small piece of metal with a hollow through it for screwing onto a bolt in order to fix or fasten something;
6	with a vengeance (line 24)	**f)**	a greatly respected person whose ideas are followed;

7	breakthrough (line 22)	**g)**	a person who claims to be able to tell the course of future events;
8	premise (line 15)	**h)**	a product aimed at a particular group of people;
9	forecast (line 6)	**i)**	a statement of future events based on some kind of knowledge and judgement;
10	feasible (line 37)	**j)**	a large car or other motor vehicle that uses a lot of petrol;
11	spanner (line 43)	**k)**	interest calculated both on the original sum of money lent or borrowed and on the unpayed interest already earned or charged;
12	guru (line 74)	**l)**	to a high degree; with greater force than is usual;
13	fusion (line 27)	**m)**	a solemn declaration of statement.

B Understanding expressions

Choose the best explanation for each word or phrase from the text.

1 World wide web (line 11):

a) the international charity organization which supports conservation;

b) the system for making information available, anywhere in the world, to computer users who are connected to the internet;

c) an international organization that deals with the rules of trade between different nations.

2 Information technology (line 84):

a) the mathematical principles that deal with information and the sending of information between humans and machines;

b) the giving or selling of modern equipment such as computers, or the knowledge necessary to operate the equipment, by Western countries to developing countries;

c) storing, using and sending information by means of computer systems and telecommunications.

3 Carbon dioxide (line 23):

a) the gas produced when animals breathe out, when carbon is burned in air, or when animal or vegetable matter decays

b) a gas that is a simple substance, without colour or smell, that forms most of the earth's air

c) a strong gas with a sharp smell used in chemicals to help plants grow

4 Microwave (line 31):

a) a very short electric wave, used in sending messages by radio, in radar, and especially in cooking food;

b) radio broadcasting or receiving on waves of between about 150 and 550 metres in length;

c) radio broadcasting or receiving on waves of 1000 metres in length.

5 Hydrogen (line 50):

a) a gas present in the air that is a simple substance (element), is

6 Carbon (line 96):

a) a common silver-white metal that is a simple substance (element),

without colour, taste, or smell, and is necessary for all forms of life on Earth;

b) a gas that is a simple substance (element), without colour or smell, is lighter than air, and burns very easily;

c) a gas that is a simple substance (element) that is lighter than air, will not burn, and is used in airships and some kinds of lights.

7 Alternative (line 105):

a) a special right or advantage that only one person or group has;

b) something, especially a course of action, that may be taken or chosen instead of one or more others;

c) possession of, or control over, smth which is not shared by others.

burns with a bright white light, and is used in fireworks;

b) a simple substance (element) found in a pure form as diamonds, graphite etc, or in impure form as coal, petrol etc;

c) a silver-white metal that is a simple substance (element) and is found in bones, teeth, and chalk.

8 Greens (line 60):

a) people who try to prevent the environment from being spoiled;

b) green leafy vegetables that are cooked and eaten;

c) leaves and branches used for decoration, especially at Christmas.

C Complete the sentence

Use an appropriate word or phrase from Exercise A to complete each sentence.

1 It's simply not economically …… to stage such a lavish production.
2 British and American justice works on the ……. that an accused person is innocent until he's proved guilty.
3 The newspaper's …… that the government would only last for six months turned out to be wrong.
4 The wind's blowing ……; it's almost impossible to walk against it.
5 There is a major ……. in the treatment of cancer.
6 J.M. Keynes was the …….. of the new economics.
7 A ……. of doom is someone who always says that bad things will happen.
8 A ……. is an instrument which is held in the hands and used for doing special jobs.
9 The Pope made made a …….. on the subject of the war.
10 This metal is formed by the …… of two other types of metal.

D Collocations

Match these verbs and nouns as they occur in the text.

1	link (para 1)	**a)**	plants
2	predict (para 1)	**b)**	a contribution
3	pick (para 2)	**c)**	turbines
4	eliminate (para 2)	**d)**	energy
5	capture (para 3)	**e)**	electricity
6	store (para 4)	**f)**	wave energy

7 consume (para 7)
8 maintain (para 3)
9 make (para 3)
10 affect (para 9)

g) need for biofuels
h) technologies
i) technological future
j) computer files

E Words with similar or related meanings

1 The phrase 'improvements in efficiency' is used in paragraph 5. What other phrase is used in the same paragraph with a similar meaning?
2 The expression 'make a contribution' is used in paragraph 3. What verb is used in paragraph 8 with a similar meaning?
3 What word-combination from the text (para 11) could replace the word 'homeland' (para 11)?
4 What phrase from the text could replace the word 'predict' (para 1)?
5 The verb 'cost' is used in paragraph 10. What other word is used n the same paragraph that has a similar meaning?
6 Two nouns are used in paragraph 7 that are synonymous. What are they?

F Phrasal verbs

Find phrasal verbs in the text that match these definitions.

a)	to change in form or nature (para 1);	t …… i……
b)	to cause to return (para 2);	b …… b……
c)	to cause to come to a particular course of action (para 2);	b …… i……
d)	to make the price of (one's goods) so high that people are unwilling to pay (para 2);	p …… o……
e)	to (cause or help to) pass through, or come successfully to the end of (para 3);	g …… t……
f)	to vary according to; be decided by (para 3);	d …… o……
g)	to set free (from control, prison, duty etc) (para 3);	l …… f……
h)	to examine the meaning of causes of; investigate (para 4);	l …… i……
i)	at the beginning (para 8);	s …… w…
j)	to cause to happen (para 9);	b …… a……
k)	to control; prevent from increasing (para 10);	k …… d……
l)	to unroll (para 11).	r …… o……

G Opposites

Find a word or phrase in the text that has an opposite meaning.

a) overshoot (para 1)
b) reality(title)
c) slowly (para 7, para 8)
d) suddenly (para 8)
e) worse (para 2)
f) blossom (para 2)

F Culture note

1 Goldwyn, Samuel (1882-1970) a US film producer who started the company that became MGM and had an important part in the development of the Hollywood film industry.
2 Galactic, the large group of stars in which our own sun and its planets lie.

Майя Василівна Орел

ПЕРЕКЛАД У ГАЛУЗІ ЕЛЕКТРОЕНЕРГЕТИКИ
МЕТОДИЧНІ РЕКОМЕНДАЦІЇ ДО ПРАКТИЧНИХ ЗАНЯТЬ
З ДИСЦИПЛІНИ
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