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НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
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PROFESSIONAL ENGLISH FOR FUTURE THERMAL POWER ENGINEERS (PART I)

Навчальний посібник

Рекомендовано Методичною радою КПІ ім. Ігоря Сікорського
як навчальний посібник для здобувачів ступеня магістра
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Навчальний посібник призначений для навчання професійної англійської мови студентів п'ятого курсу Навчально-наукового інституту енергозбереження та енергоменеджменту, спеціальності 144 «Теплоенергетика». Видання складається з п'яти розділів, які охоплюють спеціалізовані теми, актуальні для майбутніх інженерів-теплоенергетиків: «Теплоенергетика», «Альтернативні джерела енергії», «Енергоефективність», «Теплові насоси» та «Теплообмінники». Розроблені вправи спрямовані на вдосконалення умінь та навичок студентів у читанні, усному мовленні, аудіюванні, письмі та перекладі. Посібник розроблено з метою підвищення ефективності організації занять з іноземної мови в аудиторний і позааудиторний час. Посібник спрямований на розширення професійного тезаурусу студентів, формування соціокультурної компетенції та інтересу до вивчення англійської мови та культури.

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PREFACE

The study and practice book *Professional English for Future Thermal Power Engineers (Part I)* is purposed for future thermal power engineers who study English as a foreign language at a tertiary level. It is intended to help learners improve their communicative competencies with focus on listening, speaking, reading, writing, and translation skills.

Professional English for Future Thermal Power Engineers (Part I) consists of five units and six appendices. The authentic texts cover the basic topics for thermal power engineers: thermal engineering, alternative energy sources, heat efficiency, heat pumps, and other equipment and technologies. Each section includes authentic texts and a set of different exercises for developing speaking, listening, writing and translation skills. The appendices contain a grammar guide, recommendations for scientific essay writing, texts for individual reading, group projects and video scripts. Each unit includes a supplementary text for the development of sociocultural competence. All the texts are taken from up-to-date specialised textbooks, technical journals and online sources. The exercises and creative tasks are developed by the authors. Information-rich cognitive material and a variety of lexical tasks will help to increase students' motivation to learn English during in-class activities, group projects and self-studying.

While developing the material, we have shared a lot of experience with students, colleagues and friends. We appreciate their participation, suggestions and comments, and hope that you will also share that pleasure working on the course.

Recommended for classroom activities and self-study work for the graduate thermal power engineering students of the Energy Saving and Energy Management Institute at Igor Sikorsky KPI.

We hope that this book will be practical and motivating for your students.

semyda.oksana@lll.kpi.ua for questions.

UNIT 1. THERMAL ENGINEERING

LEAD-IN

1. Look at the picture. What branch of engineering is it? What made you decide so?



Read an excerpt about the profession of thermal engineer. What difficulties do they meet?

The original thermal engineers came out of the shops of the early satellite makers, where vacuum testing was (and still is) very expensive. The value of thermal analysis was clear in that industry: any mistakes discovered after launch couldn't be fixed. But even that industry didn't know what to do with thermal engineers. Were we mechanical engineers? We sure aren't like *normal* mechanical engineers. Were we designers? Except for the occasional heat pipe or radiator, we sometimes didn't have any hardware associated with us. Were we systems engineers? We certainly tended to focus on the entire system in order to calculate energy flows and balances. Were we analysts? Well yes ... except for all the testing and the aforementioned heat pipes and radiators. Sometimes thermal engineers were placed in systems engineering, sometimes with materials folks. Most often thermal engineers were located where there was more overlap: with propulsion or environmental control ("climate control" in other industries).

2. Think about the responsibilities and skills of a modern thermal engineer and discuss them with you classmates. Complete the table with the given list. Add more responsibilities and skills.

- To analyse heat transfer and energy conversion systems;
- To know about heat transfer and energy conversion systems;
- To maintain commercial and residential refrigeration systems;
- To provide customer solutions in energy saving;
- To provide consultancy and advice on heating and cooling projects;
- To learn independently new engineering analysis tools and apply them to projects;
- To have strong technical skills;
- To have IT skills.

Responsibilities and skills of a thermal engineer

Responsibilities	Skills

Think about the qualities you have and about the qualities you should develop as a future engineer. What are they. Share the idea with your friend.

READING and VOCABULARY

1. Study the words given below and make sure you know their meaning.

encompass	coolant	vehicle	refine
transfer	fluid dynamics	substance	industrial settings

2. Read the text.

WHAT IS THERMAL ENGINEERING?

Thermal engineering is a broad field of engineering that encompasses technologies dealing with heating and cooling systems, transfer of heat, and fluid mechanics. Instruments that control temperature are essential in many areas, including the electric power industry; the automobile industry; and the heating, ventilation, and air conditioning industry. The principles of thermal engineering are also crucial to the operation of vehicles and other machines.

Heat transfer is a major concern within the field. The transfer of energy, in the form of heat, across different physical regions is heat transfer. When an area of high temperature is next to an area of lower temperature, heat naturally flows from the higher-temperature region to the lower-temperature region. This principle, known as conduction, is used in many thermal engineering settings to increase or decrease the temperature of a system. Insulation, for example, minimizes the conduction of heat and keeps temperature regions relatively distinct.

The heating and cooling of liquids is important in many industrial settings, and constitutes another branch of thermal engineering. An engineer in this field must also understand fluid dynamics. Coolant, a cooling substance, is used to reduce the temperature of processes and prevent overheating. Boiling is another method used to create vapour which may be condensed in refining a chemical product. The study of these processes helps thermal engineers determine the optimal regulation of temperature in each case.

Thermal engineering has applications outside industrial plants as well. An example is the HVAC industry, which deals with refrigeration, ventilation, and temperature regulation within buildings. An office building in a hot, humid climate may need more ventilation and air conditioning to promote cooling than the same building in a cold climate. Commercial establishments such as restaurants may require extensive refrigeration systems for the storage of food. All of these technical considerations would be within the realm of this type of engineering.

On a smaller scale, vehicles such as cars use thermal engineering in their everyday function. The heating and cooling of the car are controlled by thermal management systems integrated into the design. Heat transfer, fluid dynamics, and other principles of engineering are at work in cooling the engine and maintaining oil flow.

Thermal engineering is important to the design of almost any machine. Mechanical elements and electric circuits generate heat during operation, and the build-up of heat can often threaten the device. Cooling mechanisms, usually fans or liquid circulators, are added to compensate and help regulate the machine's internal temperature. Devices that use this principle include computers and car batteries.

Thermal engineers must know about the economics of the components and processes they design to make sure they not only provide an improvement over the existing solutions but also don't lose the company money. Thermal Engineers are not limited in areas of specialisation and can work in numerous fields. Below is only a brief example of areas a Thermal Engineer can work in:

- Heating, Ventilation and Air Conditioning (HVAC) systems in small and large-scale residential, commercial or industrial buildings.
- Renewable energy systems.
- Military and defence equipment.
- Electronics and electrical component and systems.
- Aerospace components.
- Boiler, heat exchanger, and pump design, amongst others.

Common industries that regularly employ Thermal Engineers include power companies, the automotive industry and commercial construction. While Thermal Engineers will generally spend most of their time working in an office they are often required to travel to the site of their current project.

Adapted from <https://www.wise-geek.com/what-is-thermal-engineering.htm>

3. Answer the questions after the text.

1. Who is a thermal engineer?
2. What branches can thermal engineering be applied in?
3. What is heat transfer?
4. What are the main principles of thermal engineering?
5. What thermal engineering principles are used in modern cars?
6. What are the expertise areas of a thermal engineer?

IMPROVE YOUR VOCABULARY

1. Match the synonyms.

1)	field	a)	manage
2)	encompass	b)	endanger
3)	control	c)	considerable
4)	transfer	d)	branch
5)	threaten	e)	encourage
6)	extensive	f)	carry
7)	humid	g)	encircle
8)	promote	h)	damp

2. Match the words with their definitions.

1)	heating system	a)	space or a place for storing;
2)	cooling system	b)	is a phenomenon of rising temperatures that can cause damage and fire;
3)	overheating	c)	the study of fluids and how forces affect them;
4)	storage	d)	a system or means of providing fresh air;
5)	ventilation	e)	is a mechanism for maintaining temperatures at

			an acceptable level;
6)	vehicle	f)	means an establishment used for commercial purposes, such as a bar, restaurant, private office, fitness club, oil rig, retail store;
7)	heat transfer	g)	a system that keeps air cool and <u>dry</u> ;
8)	fluid dynamics	h)	to keep from happening or existing;
9)	commercial establishment	i)	the flow of heat (thermal energy) due to temperature differences;
10)	prevent	j)	a means of carrying or transporting something.

3. Find and match collocations.

1)	field of	a)	circuit
2)	ventilation	b)	transfer
3)	humid	c)	flow
4)	electric	d)	settings
5)	industrial	e)	establishment
6)	heat	f)	engineering
7)	commercial	g)	climate
8)	oil	h)	system

4. Complete the text with the given phrases.

electricity customers	transmission and distribution	fossil fuels	rapid increase
power generation	located in	reduced demand	radical change

The European power sector is undergoing **1** _____. The decades-old architecture of large generators **2** _____ relatively few locations and mainly run on **3** _____, nuclear and hydro is being transformed as renewable power generation, distributed generation and demand response come to play an increasing role. **4** _____ are becoming presumers, and emerging value pools further down the electricity value chain – that is, closer to customers – are becoming increasingly central to the business. In the meantime, the system has witnessed a **5** _____ in renewables with low variable cost, while the economic crisis has **6** _____.

Taken together, these two developments have seriously affected the business case for **7** _____. Wholesale prices have fallen and running hours of thermal generation have decreased. Efficient **8** _____ of electricity is a fundamental requirement for providing societies and economies with essential energy resources.

IDIOMATIC LANGUAGE

1. Match two parts of the idiom and complete the sentences below using these expressions.

1)	acid test	a)	to put an end to an activity
2)	blow a fuse	b)	one part of a large system
3)	pull the plug	c)	a decisive test whose findings show the worth or quality of something
4)	a cog in the wheel	d)	it is not difficult to understand
5)	rocket science	e)	become uncontrollably angry

1. Our team's next match will be the first real _____ in this competition

2. Hey! Don't _____!

3. They are going to _____ on the new TV show because it didn't get any sponsors.

4. He was just an important _____ of organized crime.

5. You don't have to be _____ to figure out the solution.

TRANSLATION PRACTICE

1. Translate the following sentences into English.

1. З кожним роком зростає вартість енергоресурсів.
2. Найкращим способом економії є енергозберігаючі системи.
3. Теплоізоляція приміщення дозволить заощадити на опаленні.
4. Однією з важливих порад є встановлювати охолоджувальні прилади подалі від опалювальних.
5. Теплоенергетика переважає серед традиційних видів електроенергетики
6. Розвиток теплової енергетики сприяє підвищенню енергозабезпечення промисловості та інших галузей господарства
7. Ціна електроенергії для промисловості в Україні є на 33% нижчою, ніж у середньому по країнах ЄС,
8. Вентиляція громадських будівель має велике значення і повинна відповідати встановленим нормам.
9. Принцип дії вентиляційної системи заснований на заміні відпрацьованого повітря в приміщення повітрям з вулиці.
10. Вентиляційні установки з рекуператором є найбільш ефективнішими на сьогоднішні, адже вони мають досить високий ККД.

2. Read the text.

WHAT IS THE BIGGEST MISTAKE ENGINEERING STUDENTS MAKE

The biggest mistake students make is sitting in the grey area of indecision in regards to their degree. The common predicaments for students are that when faced with the heavy workload and inherent difficulties in the early stages of Engineering, many will drop out before they even get to see what it is about. The first 6-12 months is the most painful as you are still unsure of where you fit and you don't really see the

big picture of where Engineering will fit in your life. As you progress through the subsequent years the subjects become more interesting and your skillset develops to a point that you can start to grab hold of real problems and situations to apply your skills. But you have to get to that stage first.

The other position that is common for some students is completely following through with their Engineering Degree when they know that they will not practice as an Engineer or put this skill set to use. There are some skills that are transferable to other areas of life, but going through 4-5 years of intense learning when your commitment to the Engineering craft is only lukewarm is not a wise choice. If you know that it's not for you then you should move on quickly. Both you and Engineering will be happier for it!

<https://whatisengineering.com/topic/what-is-the-biggest-mistake-engineering-students-make/?portfolioCats=88>

3. Answer the questions.

1. What difficulties did you encounter after entering the engineering department?
2. How did you handle these problems?
3. What would you recommend to the would-be students?

GRAMMAR REVISION

1. Complete each sentence by putting the words in brackets into the correct form (see Appendix A for grammar references “The Complex Object and Complex Subject”).

1. My boss told (I/do) the reports before Friday.
2. My colleague asked (I/send) a fax to the customer.
3. Tom wanted (I/help) him prepare his presentation.
4. I warned (he/not/drive) too quickly because of the bad weather.
5. Please remind (I/call) Mr Jones tomorrow morning.
6. Please tell (he/not/smoke) here – it's not allowed.
7. Marta didn't feel too good but we persuaded (she/come) to the party.

8. Nobody wanted to go to the conference but our boss forced (we/go) to it.
9. I asked (she/not/call) so late in the evening. I go to bed early.
10. We showed (they/how/use) the new equipment.

2. Translate into English using the Complex Subject.

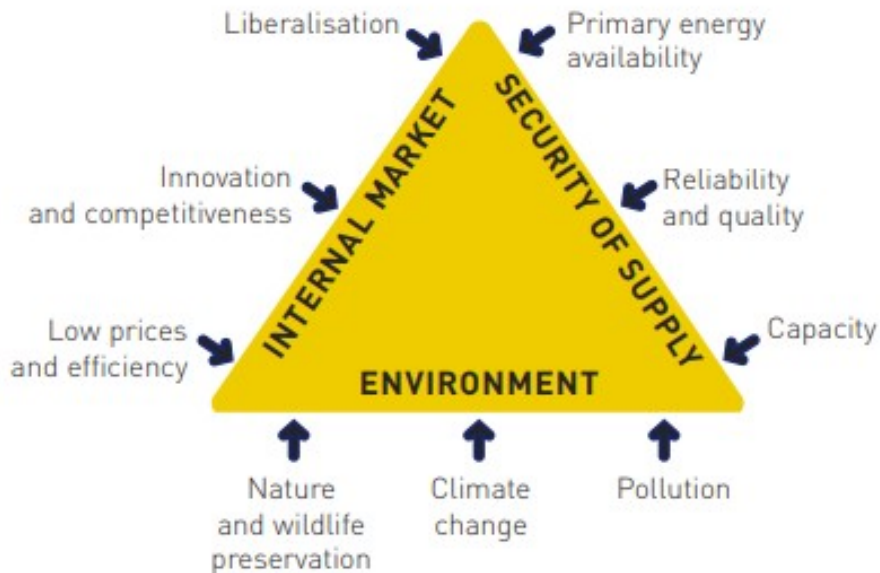
1. Вона хоче, щоб нове обладнання використовували якомога частіше.
2. Він хотів, щоб його про його відкриття дізналися у всіх країнах.
4. Вона хотіла, щоб її угоду підписали відразу.
5. Я не хочу, щоб це устаткування пошкодили.
6. Він не хотів, щоб йому допомагали з ремонтом.
7. Я хочу, щоб вони використовували сучасні досягнення в галузі енергетики..
8. Я хочу, щоб цю угоду підписали.
9. Необхідно, щоб встановили запобіжник.
10. Він не хотів, щоб чіпали його речі.

3. Paraphrase each sentence using the Subjective or Objective Infinitive Complex.

1. People consider the pollution there to be a very serious problem.
2. It was announced that the Ukrainian delegation was arriving next week.
3. It is expected that the performance will be a success.
4. It is believed that the first power station was opened in 1967.
5. It is supposed that the managing director is going to get a pay rise.
6. It is reported that the flood has caused much damage to the crops.
7. It was supposed that the crops would be rich that year.
8. It has been found that this mineral water is very good for the liver.
9. Scientists consider that electricity exists throughout space.
10. It is said that the weather in Europe was exceedingly hot last summer.

SPEAKING

Have a look at the triangle of power supply. Analyse the constituents of each triangle side. Share your ideas in small groups.



LISTENING

Nuclear Power Was Supposed to Solve Climate Change...What Happened?

1. You are to take a quiz about nuclear power. You can consult the Internet to find out the answers.

1. What country uses the most nuclear power?

a	Russia	b	France	c	The USA	d	China
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2. What country opened the first civilian nuclear power plant in 1954?

a	The USA	b	France	c	The UK	d	The Soviet Union
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3. The International Nuclear Event Scale rates nuclear accidents on a scale of 0 to 7, with 0 meaning "no safety significance" and 7 meaning "major accident." How many accidents before the year 2011 have merited a 7 rating?

a	one	b	two	c	three	d	five
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4. Nuclear power is produced by splitting uranium atoms. The heat from the chain reaction that follows then boils water, which powers turbines that create electricity. Burning coal does the same thing, but how much coal would you need to rival one pound of uranium in terms of energy production?

a	300 pounds	b	1million pounds	c	2.5million pounds	d	3million pounds
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5. Since uranium can provide a large amount of steady power, known as "base-load" power, without carbon dioxide emissions, some look to increasing nuclear energy as a global warming solution. A Massachusetts Institute of Technology study projected that 25 per cent of expected future carbon emissions could be eliminated by what amount of increase in worldwide nuclear electricity?

a	25 per cent	b	twofold	c	threefold	d	fourfold
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2. Before watching the video, make sure that you know the translations of the following words.

Back-up power, carbon-free, fuel rods, safety, decommissioning, nuclear proliferation, radioactive wastes, tackle, eliminate, meltdown.

3. Watch the video *Nuclear Power Was Supposed to Solve Climate Change...What Happened?* (<https://www.youtube.com/watch?v=7liXT4T9XJA>)

4. Answer the questions to the video.

1. What is the global part of nuclear power production?
2. What made the developed countries reduce the share of nuclear energy?
3. What are the reasons against nuclear power?
4. How do nuclear reactors influence indigenous people, climate?
5. What are the disadvantages of using fossil fuels?

WRITING

You are an HR manager at a thermal power plant and you are looking for the right candidate for the plant. What qualities do you want to see in your candidate? What skills should he have? Write an essay (200-220 words).

PROJECT WORK

Project A. Job Interview (see Appendix C)



1. Read recommendations from an HR manager.

The thing to remember when getting interview questions such as "What two or three things are most important to you in your job?" is that when hiring managers ask about these personal motivations. They are assessing how you might respond to different management strategies. By learning what you value and what motivates you, they know whether or not you will fit in and feel motivated in your prospective employer's corporate culture and in the role you are interviewing for.

Usually, it is a great idea to match your answers to an employer's expectations of valuable things in the workplace and for this kind of question that means relating what you loved about your old job (or current job) to what you expect to find in the new one.

<https://www.mypertectresume.com/career-center/interviews/questions/what-is-most-important-to-you-in-a-job>

2. What is the most important for you in a job? Think and put the following factors in order of importance. Also you can add more items that might be important.

- A good salary
- Flexible working hours
- Contact with interesting people
- A chance to travel
- Long holidays
- Nice, quite, attractive atmosphere
- An interesting and varied work

2. What would an interviewer think of you?

Complete the table and make your psychological portrait (or your friend's one).

	You	St 1	St 2
1. Are you punctual?			
2. Do you speak clearly?			
3. Are you sociable?			
4. Are you bad-tempered?			
5. Do you like meeting people?			
6. Are you talkative?			

3. Role-play the interview.

One of the students is an HR manager, another student is a candidate for the position of a leading engineer for the company. Read the role-cards with the hints and expressions in Project A (See Appendix C for the task and for the role cards).

SUPPLEMENTARY TEXT

You are going to read about the role of engineering in a modern society. Before reading it, think why the author calls engineering “the liberator of our society”.

Do you agree with this statement?

Discuss it with your classmates then read and check your ideas.

WITHOUT ENGINEERING, CIVILIZATION DOES NOT EXIST

Vocabulary

Advent – прихід, поява

coercion – примушування

advancement – прогрес

impetus – поштовх, імпульс

embroidery – орнамент, вишивка

tributary – притока

flock of birds – зграя пташок

school of fish – зграя риб

sustain – підтримувати

propel – просувати, стимулювати

contrivance – винахід

explosive – вибухівка

Until the advent of the Industrial Revolution, agriculture and industry were powered by animal and human muscle, generally under various degrees of coercion. Engineers can point to steam power as their contribution toward the end of slave labour. The power of engineering is that that provides the foundation for further advancements. It enables access to natural resources, the access increases the potential for human freedom and creativity, and that freedom allows for the creation of new engineering advances.

First, nothing moves unless it is driven. That driving impetus can come from natural forces such as gravity or from food for animals and humans or fuel for machines. Once a natural system begins to move, it continually evolves its configuration toward flowing more and more easily. A stream cuts its way through impeding rocks and, just as naturally, changes occur in organisms to make them more ergonomically efficient.

As systems evolve to become more efficient, they also become more complex and more hierarchical in how they flow and move. It turns out that joining and moving together requires less power than moving individually. This principle underlies any number of phenomena. It explains why river systems evolve into embroideries of small tributaries flowing into a major river and why flocks of birds and schools of fish move as one. The bigger stream, animal, and vehicle is a more efficient mover than the smaller, though also more complex, with hierarchy in its architecture. What's true of flocks and schools – that it is easier to move across the Earth as a member of a group than to move alone – is also true of people.

People have intuitively structured societies to make the best use of this “social physics.” Over time, we have found that society moves more, produces more, and lasts longer when it is endowed with freedom, hierarchy, and allowed to flow, as it were, in a free-questioning and self-correcting way. When the human activity is projected on a global map, we can see the physical flow that carries all the human material and concerns, and this flow follows the same laws as rivers and the branching architecture of blood vessels. Activity from the far reaches flows together,

running to large streams and then to the central pools of human creativity and productivity.

Engineering is a science of what is useful to human life and social organization. Engineering is the body of science that sustains the muscular activity that propels the world today.

The first branch of engineering that was widely recognized was what is now called civil engineering (the constructing of city living). Other kinds of engineering emerged as natural add-ons, because of dramatic changes in the technology and availability of power. Mechanical engineering, for instance, was the new science of “machines,” driven by heating from burning fuels or the captured motion of water or wind. In addition to being used directly, mechanical power could also be converted into electrical power so that it could be tapped by users far from the source, and those myriad uses necessitated the development of electrical engineering.

Chemical and petroleum engineering became distinct disciplines at the turn of the 20th century, as the demand for explosives and new fuels in large quantities became dominant. Aeronautical engineering gained attention during the First World War, again because of the military importance of human flight. Nuclear engineering also was born out of military need, during World War II and the decades after.

Today, biomedical engineering is all the rage in university education and modern hospitals, primarily because wealth and many new technologies have made it easier to improve the human body by design. Still, biomedical engineering is as old as civil engineering and traces its roots to military applications: Shields, helmets, bandages, and prostheses.

Without fruits of engineering – without power derived from engines and chemicals produced in factories – we would perish. We are so dependent on power, devices, and products that we have become a “human + machine” species. Thanks to engineering, humans have gained the kind of sensory abilities over the course of one century that have taken millions of years in animal evolution. These new abilities enable us to answer the urge, explained by constructal law, to move more easily and farther into the world.

The fruits of engineering empower us in many ways, not just through enhanced vision. These engineered contrivances are diverse – coming in many sizes and configurations, being as ancient as rope or as new as self-driving vehicles – and at first sight appear complicated, disorganized.

Access to more power – that is, the ability to move across space, in opposition to the forces that oppose motion – due to the application of engines touched off an explosion in new contrivances, similar to the explosion of new animal senses and body plans seen in the Cambrian strata of the fossil record.

Most of the people who have access to electric power today have no idea how it got there except as the output of the electrical outlet. It is only when access to the fruits of engineering is severed, due to earthquakes and hurricanes or accidents and acts of despotism, that most people become aware of the monumental role that engineering plays in our lives today.

We, engineers, can point with pride at who we are and at the work we do. We are developing new contrivances and improving old ones, all with the goal of making each of us a more powerful and longer living member of the “human + machine” species. The old man in 2018 who is aided by hip implants, hearing aids, and trifocal glasses is more capable than the young man of 1518, whose body was ground down by physical labour and who struggled against disease.

Think of such comparisons, and recognize your own great fortune. You carry with you both the contrivances derived from centuries of work and the knowledge that came to you from the science of useful things: Engineering. They came to you not because you are deserving, but simply because you were lucky to be born in the advanced society that was built by others, humble and modest, and hungry, too.

Adapted from <https://doi.org/10.1115/1.2018-MAY-3> Adrian Bejan Without Engineering Civilization does not exist. Mechanical Engineering. May 2018, 140(05): 42-47

1. Think and answer the questions to the text.

1. What is the connection between human freedom and creativity and engineering advances?

2. How does the author of the article estimate the principle of “moving together”?
3. What is meant by “social physics”?
4. What engineering branches are mentioned in the text?
5. Why does the author call us “human + machine species”?

2. Choose one of the topics given below and write an essay (200 – 250 words). See Appendix B for Essay writing.


1. *Engineering has always been a liberating force.*
2. *Advances in engineering know-how have made humanity freer, wealthier, and longer living.*
3. *The most important engineering invention of the XXI century.*


WORKING WITH VISUAL INFORMATION

Describing graphs

1. Complete the table with the words below.

considerably	dropped	growth	increased	sharp	steep
decreased	gradually	increase	moderately	slowly	went up

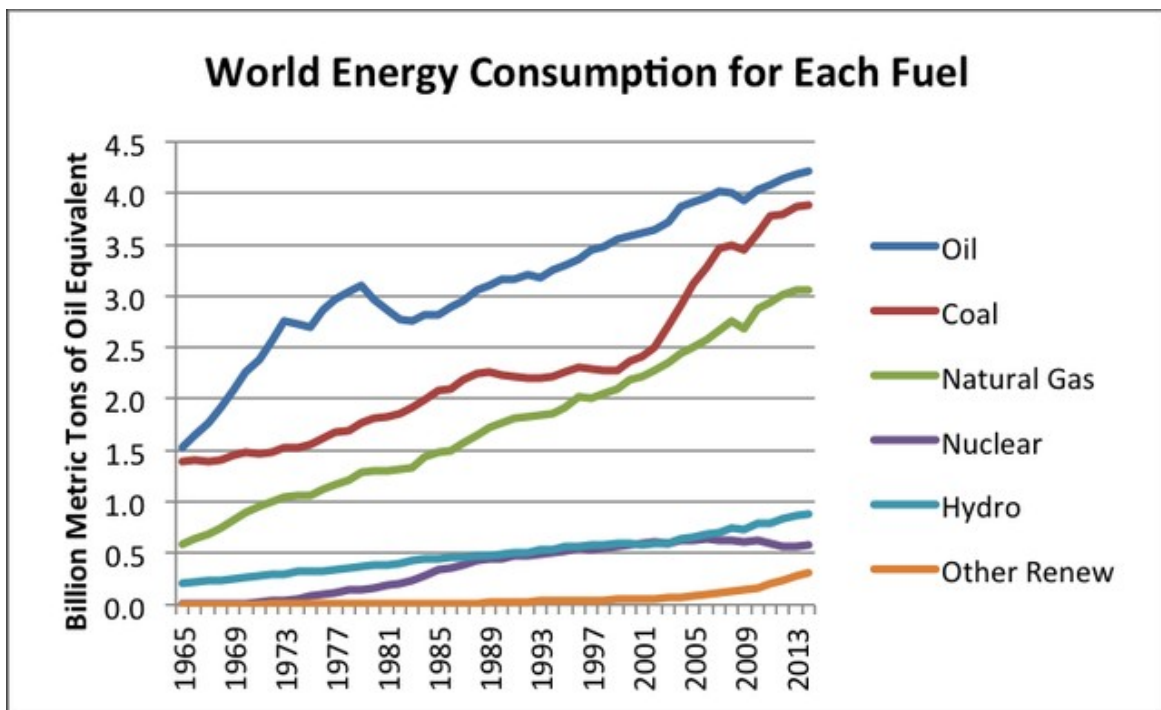
	The production	rose	slightly.

	There was	dramatic	rise	in wind energy production

	Pulp production	fell	significantly

2. Study the graph of energy consumption and answer the questions.

1. What information do X and Y axes give?
2. What fuel is in peak demand?
3. What is the consumption of renewable energy sources?
4. How did the consumption change with years?



3. Work in pairs and discuss the changes in the world fuel consumption. Write a short description for each kind of fuel using information from the graph (5 – 7 sentences).

SMILE


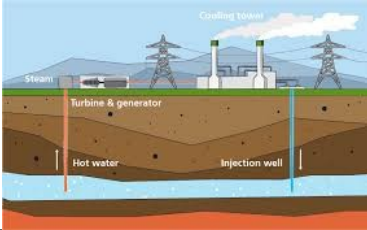

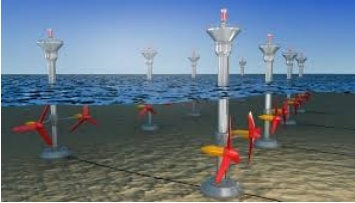


What is the difference between Mechanical and Civil Engineers? Mechanical engineers build weapons, Civil Engineers build targets.

Two antennas got married, the wedding was lousy, but the reception was outstanding!

UNIT 2. ALTERNATIVE ENERGY SOURCES

LEAD-IN

1. Match the pictures with the titles:

<p>1. _____</p> 	<p>3. _____</p> 	<p>5. _____</p> 
<p>2. _____</p> 	<p>4. _____</p> 	<p>6. _____</p> 

- | | | |
|-------------------|----------------------|-----------------|
| a) wind energy | b) solar energy | c) hydropower |
| d) biomass energy | e) geothermal energy | f) tidal energy |

What do you know about each type of energy? What is the most efficient type?

2. Compare traditional and alternative energy sources. Complete the table and compare different aspects of these sources.

Traditional Sources	Cost	Efficiency	Pollution Level	Availability

Alternative Sources				

3. Read the text.

Renewable energy: a better, greener future

Why are renewables a better source? The energy from wind and solar is able to be used and reused without the requirement of an exhaustible element. Beyond the source is the product after electricity is produced. The waste of coal or natural gas requires environmental mitigation and an excess of energy. Because of this, the total efficiency of usable energy for coal (the least efficient energy source) is just 29% of its original energy value. Wind, on the other hand, has the efficiency rating of 50% and beyond in some cases. And, no pollution.

Do you agree that renewables are absolutely environmentally friendly?

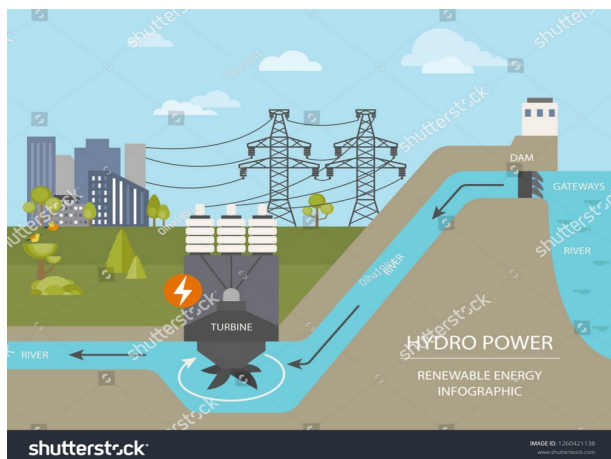
READING and VOCABULARY

1. Study the words given below and make sure you know their meaning.

rely on	capacity	algal bloom
efficiency	utility	chute
convert	pollutant	outage

2. Read the text.

Text A. THE MOST POWERFUL RENEWABLE ENERGY



The world's most relied-upon renewable energy source isn't wind or sunlight, but water. Hydroelectric power (hydro) is classed as renewable energy due to the fact that it relies on the Earth's natural water cycle's kinetic energy to generate electricity. With its 90% efficiency in converting the kinetic energy to electricity, and the fact that no fuels are burnt and no direct emissions are released into the atmosphere, it is often considered a very clean form of electricity generation. Last year, the world's hydropower capacity reached a record 1,308 gigawatts (to put this number in perspective, just one gigawatt is equivalent to the power produced by 1.3 million race horses or 2,000 speeding Corvettes). Utilities throughout the globe rely upon hydropower to generate electricity because it is cheap, easily stored and dispatched, and produced with no fuel combustion, meaning it won't release carbon dioxide or pollutants the way power plants burning fossil fuels such as coal or natural gas do.

As with other energy sources, however, hydropower is not without an environmental cost. Beyond the profound ecosystem impact of damming and diverting huge waterways, hydropower can wreak havoc on native aquatic species and their ecosystems. The majority of watersheds around the world – some of which have operated on hydropower for more than a century – are highly degraded, with polluted waterways and outmoded technology. Traditional reservoirs are often

stagnant bodies of water; because of this, they are frequently sites of harmful algal blooms, or HABs, which are toxic to people, fish, shellfish, marine mammals and birds.

Traditional hydropower plants work by harnessing the force and pressure of water flowing from a high point to a lower point through chutes in a dam. Near the bottom of the chute sits a turbine; water spins the turbine, which creates the power that can be transmitted to businesses and homes. But this is also the main passage for migrating fish such as salmon or eel, which can get caught in the mechanism's thin, sharp blades.

Because hydropower plants can generate power to the grid immediately, they provide essential back-up power during major electricity outages or disruptions (water power has in fact been in high demand during the Covid-19 crisis, as electricity generation has been little affected due to the degree of automation in modern facilities).

As companies throughout the world look to transition to a low or zero-carbon grid, better-designed turbines can help achieve high reliability and power storage, enhancing climate resilience while keeping salmon happily swimming upstream.

Adapted from <https://www.bbc.com/future/article/20200713-the-most-powerful-renewable-energy>

3. Answer the questions after the text

1. Why is hydroelectric power considered as a renewable energy source?
2. Why is hydropower an environmentally friendly source?
3. How can hydropower usage save the utility bills?
4. What is the impact of hydropower on the environment?
5. What are the recent perspectives for hydropower energy?

IMPROVE YOUR VOCABULARY

1. Match the synonyms.

1)	reach	a)	harmful
----	-------	----	---------

2)	degrade	b)	discharge
3)	toxic	c)	control
4)	be affected	d)	break
5)	harness	e)	attain
6)	relied-upon	f)	convey
7)	release	g)	obsolete
8)	transmit	h)	deteriorate
9)	disruption	i)	counted on
10)	outmoded	j)	Suffer

2. Match the words with their definitions.

1)	pollutant	a)	found in the Earth's crust and contain carbon and hydrogen, which can be burned for energy;
2)	carbon dioxide	b)	the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate;
3)	fossil fuel	c)	change the form, character, or function of something;
4)	disruption	d)	a substance or energy introduced into the environment that has undesired effects;
5)	climate resilience	e)	an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir;
6)	efficiency	f)	electricity produced from generators driven by turbines that convert the potential energy of falling or fast-flowing water into

			mechanical energy;
7)	convert	g)	a greenhouse gas;
8)	utilities	h)	disturbance or problems which interrupt an event, activity, or process;
9)	hydropower	i)	a service that is used by the public, such as an electricity or gas supply;
10)	watershed	j)	the quality or degree of being efficient.

3. Find and match collocations.

1)	renewable	a)	cost
2)	generate	b)	the turbine
3)	environmental	c)	combustion
4)	electricity	d)	electricity
5)	spin	e)	species
6)	fuel	f)	energy
7)	aquatic	g)	plant
8)	zero-carbon	h)	outage
9)	hydropower	i)	mammals
10)	marine	j)	grid

4. Complete the text with the given phrases.

pressure	blunt-edged	turbine	engineers
wildlife	turbine blades	environmental	harness

As well as profoundly altering the watercourse, large hydro dams can be a death-zone for fish. As well as obstructing their migratory routes, the fast-spinning **1**

_____ can cut them. If they make it past the blades, sudden changes in 2 _____ can kill the fish, as can shear forces during passage through the 3 _____.

Is it possible to make clean, renewable energy from rivers while actually restoring 4 _____ and the wider habitat? 5 _____ have been looking to change the future of hydropower through fish-safe turbines. The California-based company Natel Energy has partnered with Microsoft founder Bill Gates’ investment firm Breakthrough Energy Ventures to create a new, 6 _____ turbine that improves fish survival. As well as saving fish, Natel’s turbine aims to create climate-resilient hydropower that can withstand the vagaries of unpredictable rainfall.

“The challenge we address is how to 7 _____ the great attributes of hydropower as a renewable energy resource – its reliability and dispatchability – while reducing 8 _____ impact and cost,” says Abe Schneider, chief technology officer of Natel and a mechanical engineer by training. “A fish-safe, compact, high-performance turbine does exactly that; when paired with better information about how much water will flow and when, the whole solution works together to create a modern hydropower system.”

Text B. GEOTHERMAL ENERGY

1. Before reading the text, make sure, you know the words.

derive from	drill into	inexpensive
crust	drive a turbine	fluid
take advantage of	fossil fuels	transfer

2. Read the text and match the titles.

- A. Advantages and Disadvantages.
- B. How it is Used.
- C. Production of Geothermal Energy.

1. _____

Geothermal energy has been used for thousands of years in some countries for cooking and heating. It is simply power derived from the Earth's internal heat. This thermal energy is contained in the rock and fluids beneath Earth's crust. It can be found from the shallow ground to several miles below the surface, and even farther down to the extremely hot molten rock called magma.

These underground reservoirs of steam and hot water can be tapped to generate electricity or to heat and cool buildings directly.

A geothermal heat pump system can take advantage of the constant temperature of the upper ten feet (three meters) of the Earth's surface to heat a home in the winter while extracting heat from the building and transferring it back to the relatively cooler ground in the summer.

Geothermal water from deeper in the Earth can be used directly for heating homes and offices, or for growing plants in greenhouses. Some U.S. cities pipe geothermal hot water under roads and side-walks to melt snow.

2. _____

To produce geothermal-generated electricity, wells, sometimes a mile (1.6 kilometres) deep or more, are drilled into underground reservoirs to tap steam and very hot water that drive turbines linked to electricity generators. The first geothermally generated electricity was produced in Larderello, Italy, in 1904.

There are three types of geothermal power plants: dry steam, flash, and binary. Dry steam, the oldest geothermal technology, takes the steam out of fractures in the ground and uses it to directly drive a turbine. Flash plants pull deep, high-pressure hot water into cooler, low-pressure water. The steam that results from this process is used to drive the turbine. In binary plants, the hot water is passed by a secondary fluid with a much lower boiling point than water. This causes the secondary fluid to turn to vapour, which then drives a turbine. Most geothermal power plants in the future will be binary plants.

Geothermal energy is generated in over 20 countries. The United States is the world's largest producer, and the largest geothermal development in the world is The

Geysers north of San Francisco in California. In Iceland, many of the buildings and even swimming pools are heated with geothermal hot water. Iceland has at least 25 active volcanoes and many hot springs and geysers.

3. _____

There are many advantages of geothermal energy. It can be extracted without burning a fossil fuel such as coal, gas, or oil. Geothermal fields produce only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces. Binary plants release essentially no emissions. Unlike solar and wind energy, geothermal energy is always available, 365 days a year. It's also relatively inexpensive; savings from direct use can be as much as 80 per cent over fossil fuels.

But it has some environmental problems. The main concern is the release of hydrogen sulfide, a gas that smells like a rotten egg at low concentrations. Another concern is the disposal of some geothermal fluids, which may contain low levels of toxic materials. Although geothermal sites are capable of providing heat for many decades, eventually specific locations may cool down.

<https://www.nationalgeographic.com/environment/global-warming/geothermal-energy/>

3. Answer the questions to the text.

1. What is geothermal energy?
2. How does the heat pump system work?
3. How is geothermal-generated electricity produced?
4. What are the advantages of geothermal energy?
5. What is a geothermal impact on the climate?

IMPROVE YOUR VOCABULARY

1. Match the words and word combinations with their definitions.

1)	Earth crust	a)	a device that transfers heat energy from a source of heat to what is called a thermal
----	-------------	----	---

			reservoir;
2)	Magma	b)	a container or apparatus, as an insulated chest, in which something may be cooled or kept cool;
3)	Heat pump system	c)	a rotary mechanical device that extracts energy from a fluid flow and converts it into useful work;
4)	Extract	d)	temperature at which the pressure exerted by the surroundings upon a liquid is equaled by the pressure exerted by the vapour of the liquid;
5)	Greenhouse	e)	a thin shell on the outside of Earth, accounting for less than 1% of Earth's volume;
6)	Cooler	f)	the space occupied by the installation of geothermal system, wells are dug in the ground at a regular interval;
7)	Turbine	g)	remove or take out, especially by effort or force;
8)	Boiling point	h)	a colourless chalcogen hydride gas with the characteristic foul odour of rotten eggs;
9)	Geothermal field	i)	hot fluid or semi-fluid material below or within the earth's crust from which lava and other igneous rock is formed on cooling;
10)	Hydrogen sulfide	j)	a glass building in which plants that need protection from cold weather are grown.

2. Match the opposites.

1)	internal	a)	solid
2)	advantage	b)	absorption
3)	fracture	c)	gathering
4)	producer	d)	external
5)	emission	e)	deposit
6)	disposal	f)	thick
7)	extract	g)	drawback
8)	vapour	h)	consumer

3. Match the types of the plants with the translation then complete the text.

1	Dry steam plants	Електростанція з бінарним циклом
2	Flash steam plant	Електростанція, що працює на родовищах сухої пари
3	Binary cycle power plants	Електростанція, що працює на родовищі гарячої води під тиском

TYPES OF GEOTHERMAL PLANTS

Geothermal power plants, like their traditional counterparts, feature standard power-generating equipment including turbines, generators and transformers. The first commercial geothermal station was built in Tuscany in 1911 and Italy was the world's only industrial producer of geothermal electricity until 1958, when the Wairakei plant was commissioned in New Zealand.

There are three main types of geothermal power plants:

1 _____ utilise steam directly from a geothermal reservoir in order to power turbines and generate electricity. The first geothermal power plant ever built (in 1904 in Tuscany, Italy) was a dry steam plant.

2 _____ are the most common type of geothermal power plants. They work by converting high-pressure hot water from deep inside the Earth into steam, which, when it cools, condenses to water and is injected back into the ground to be used again.

3 _____ transfer the heat from geothermal hot water into another liquid. This then turns to steam used to drive a generator turbine.

Until recently, geothermal power stations had to be built in areas with naturally occurring high-temperature heat and water sources, and where the rock was suitable for drilling. However, enhanced geothermal systems (EGS) have the potential to extend the use of geothermal resources. The technique works by injecting water into rock systems, creating cracks to increase the rock's permeability. This allows fluid to circulate in the fractured rock and transport heat to the surface, where electricity can be generated.

IDIOMATIC LANGUAGE

1. Match two parts of the idiom and complete the sentences below using these expressions.

1)	hit the panic button	a)	to lose the energy, enthusiasm or interest
2)	to reinvent the wheel	b)	something that operates well
3)	run out of steam	c)	to waste one's time doing something that has already been done satisfactorily
4)	well-oiled machine	d)	to immediately like someone or something
5)	to click with someone or something	e)	to panic suddenly

1. Relax! Don't _____ it's just the wind.
2. Just use our guide book to _____ and don't try to _____.
3. After having worked for twenty years as a manager of the company, he seems to _____.
4. Their office ran like a _____.
5. His idea _____ Leila at once.

TRANSLATION PRACTICE

1. Translate the following sentences into English.

1. Найбільша гідроелектростанція в Україні, Дніпровська ГЕС, введена в експлуатацію у 1968 році.
2. Будівництво гідроелектростанцій вирішило проблему безперебійного забезпечення електроенергією і водою населення, промисловості та сільського господарства.
3. Українські ГЕС технічно застарілі, а зношені механізми можуть спричинити аварії.
4. Геотермальна енергія — це енергія, що отримується від природного тепла Землі з її глибинних шарів.
5. На початку ХХ століття, зростання попиту на електроенергію призвело до розгляду геотермальної енергії як джерела для генерування електричної енергії.
6. Геотермальні електростанції до недавнього часу будувались виключно у місцях де високотемпературні геотермальні ресурси були доступні біля поверхні
7. Підвищення ефективності роботи геотЕС вимагає вищої температури геотермальних ресурсів та розробки спеціалізованих термодинамічних циклів
8. Геотермальні станції мають відносно простий рівень автоматизації.
9. Техніко-економічні показники таких електростанцій зазвичай перевищують показники електростанцій такої ж потужності, що працюють на рідкому паливі чи вугіллі.

10. Основні обсяги української електроенергії виробляють на атомних (близько 50%) і теплоелектростанціях (близько 40%).

2. Render the meaning of the text in Ukrainian.

GEOTHERMAL ENERGY AND THE ENVIRONMENT

Geothermal energy is a renewable resource. The Earth has been emitting heat for about 4.5 billion years and will continue to emit heat for billions of years into the future because of the ongoing radioactive decay in the Earth's core. However, most wells that extract the heat will eventually cool, especially if heat is extracted more quickly than it is given time to replenish. Re-injecting water can sometimes help a cooling geothermal site last longer. However, this process can cause "micro-earthquakes." Although most of these are too small to be felt by people or register on a scale of magnitude, sometimes the ground can quake at more threatening levels and cause the geothermal project to shut down, as it did in Basel, Switzerland.

Geothermal systems do not require enormous amounts of fresh water. In binary systems, water is only used as a heating agent, and is not exposed or evaporated. It can be recycled, used for other purposes, or released into the atmosphere as non toxic steam. However, if the geothermal fluid is not contained and recycled in a pipe, it can absorb harmful substances such as arsenic, boron, and fluoride. These toxic substances can be carried to the surface and released when the water evaporates. In addition, if the fluid leaks to other underground water systems, it can contaminate clean sources of drinking water and aquatic habitats.

Adapted from <https://www.nationalgeographic.org/encyclopedia/geothermal-energy/#:~:text=Magma%20heats%20nearby%20rocks%20and,be%20used%20to%20generate%20electricity.>

GRAMMAR REVISION

1. Fill in the gaps with the Modal verbs and expressions must, mustn't, needn't, don't have to, needn't have (see Appendix A "Modal Verbs" for grammar references).

1. You _____ study hard to pass the exam.
2. You _____ be late for the job interview.
3. We ran all the way to work but we _____ as we were the first to come.
4. You _____ (buy) any tools. We have everything available.
5. I _____ (ask) the way to construction area as I had been there before/
6. You _____ remember to put safety equipment.
7. They went to the university today but they _____ as the lectures were cancelled.
8. You _____ interrupt while a specialist is working on the rig.
9. They _____ (buy) any additional equipment for this research.
10. You _____ to put away this problem.

2. Rephrase the following sentences using all possible variants (may, might, must).

1. Perhaps he will be home soon.

He _____

2. It is possible she will have finished this research by the end of the week.

She _____

3. It's likely they have gone to the nuclear power plant.

They _____

4. It's likely he has not been promoted.

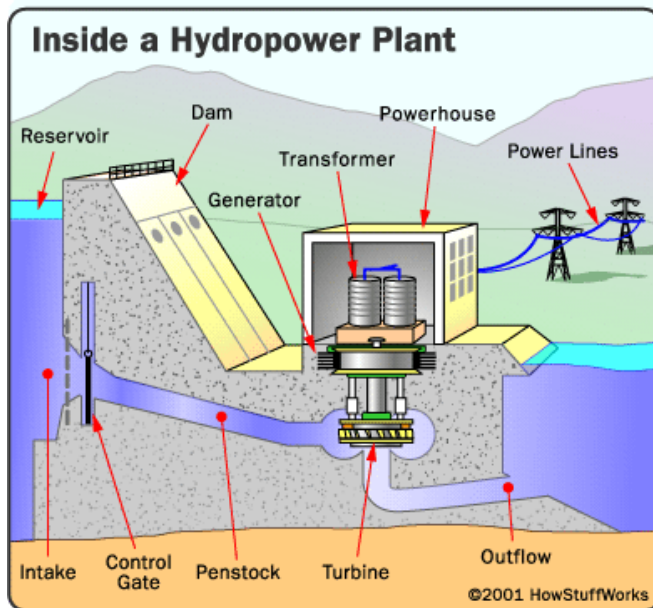
He _____

5. It's possible she called while we were out.

She _____

SPEAKING

Look at the picture of a hydropower plant. Make an excursion for your business partner around the hydropower plant, explain each point of the plant and how it functions. You can also include information about its efficiency, advantages and disadvantages.



LISTENING

What If We Burned ALL the Fossil Fuels?

1. Take a quiz on energy and fossil fuels. Decide if the statements are true or false.

1. Rocket fuel does not need air to burn.
2. A rubber band stores potential energy when stretched.
3. Kerosene is sometimes used as rocket fuel.
4. Walking upstairs uses more energy than walking on level ground.
5. Sweet oil is called that because it contains sugar.
6. Burning fossil fuels is a clean source of energy

2. Explain the meaning of the following terms. Basing on this vocabulary try to predict what this video will be about.

Float around, govern, trap, scratch out, soar, intolerable heat, run out, prosperous, appealing, scale up.

3. Watch the video_What If We Burned ALL the Fossil Fuels?

<https://www.youtube.com/watch?v=fxJc2csvpLY>

4. Complete the text with the words you hear in the audio.

But burning this coal, oil and gas is releasing **1** _____ into the atmosphere, where it's rapidly building up and heating our planet. So far, we've burned our way through some 600 billion tons of this carbon. That's about the same weight as Mount **2** _____. It's a lot, but we can easily get our hands on way more because there are 30 Everest's worth of carbon still **3** _____ the ground - enough for us to keep burning at our current rates for another 400 years.

Today, out of every million molecules **4** _____ our air, 400 are carbon-dioxides. That may sound like a small amount, but it's more carbon dioxide than Earth's atmosphere has seen in the last **5** _____ years. And if we burned all the carbon still underground, carbon dioxide levels **6** _____ around 2000 parts per million. That's higher than they've been for the past 50 million years, which is so far back that Earth didn't even look like it does today. A future world with this much carbon dioxide in the air **7** _____ different from today, but the same physical laws would still **8** _____ how that world operated. Like, gravity would still make things fall, and carbon dioxide molecules would still **9** _____ heat.

So, we can use these physical laws to **10** _____ what the world might look like with 5 times as much carbon dioxide as today. It would be a hot mess.

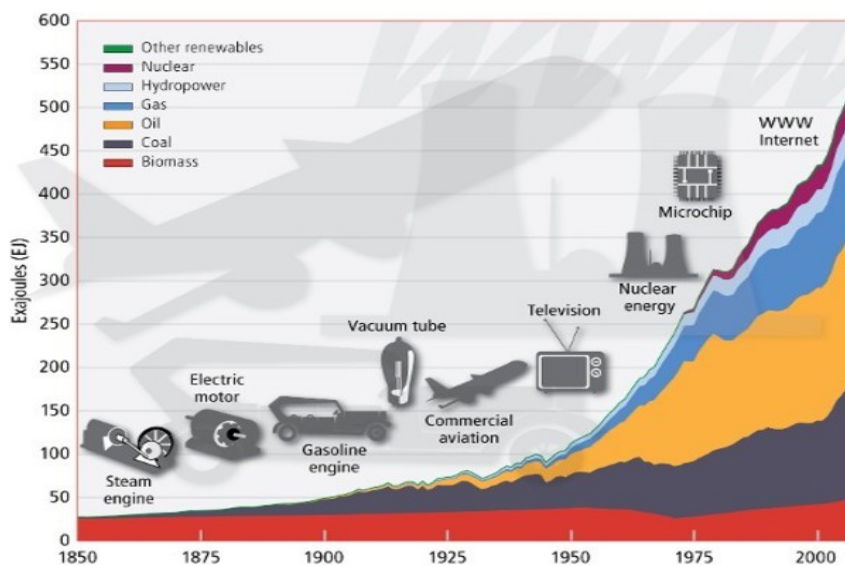
5. Discuss in groups what problems the running out of fossil fuels can cause. Suggest your ideas on how to handle these issues. Compare your suggestions with your peers in the group.

WRITING

You are a representative of TechAdvance group and you are meeting with the representatives of the local environmental organization. Persuade the representatives that the thermal power plant you are going to open in this region will comply with all safety regulations. Write an essay (200-220 words).

SUPPLEMENTARY TEXT

You are going to read about the role of engineering in a modern society. Before you read the text, remember what you know about the energy history. Study the picture below. It might help you brainstorm your ideas. Discuss with your classmates then read and check your ideas.



A SHORT HISTORY OF ENERGY

Vocabulary:

Modest – скромний

Dung – перегній;

To harness – приборкувати, використовувати;

Steam engine – паровий двигун;

To contaminate – забруднювати;

Internal combustion engine – двигун внутрішнього згорання;

Starter crank – рукоятка стартера;

Sprawl – розростання.

THE OLD DAYS

Before the industrial revolution, our energy needs were modest. For heat, we relied on the sun – and burned wood, straw, and dried dung when the sun failed us. For transportation, the muscle of horses and the power of the wind in our sails took us to every corner of the world. For work, we used animals to do jobs that we couldn't do with our own labour. Water and wind drove the simple machines that ground our grain and pumped our water.

Simple machines based on the ability to harness the power of steam have been dated by some sources as far back as ancient Alexandria. The evolution of the steam engine continued over time and significantly ramped up in the 17th and 18th centuries. But it was the significant adaptations of Thomas Newcomen and James Watt in the mid-1700s that gave birth to the modern steam engine, opening up a world of possibility. A single steam engine, powered by coal could do the work of dozens of horses.

More convenient than wind and water, and less expensive than a stable full of horses, steam engines were soon powering locomotives, factories, and farm implements. Coal was also used for heating buildings and smelting iron into steel. In 1880, coal powered a steam engine attached to the world's first electric generator. Thomas Edison's plant in New York City provided the first electric light to Wall Street financiers and the New York Times.

Only a year later, the world's first hydroelectric plant went on-line in Appleton, Wisconsin. Fast-flowing rivers that had turned wheels to grind corn were now grinding out electricity instead. Within a few years, Henry Ford hired his friend Edison to help build a small hydro plant to power his home in Michigan.

By the late 1800s, a new form of fuel was catching on: petroleum. For years it had been a nuisance, contaminating wells for drinking water. Initially sold by hucksters as medicine, oil became a valuable commodity for lighting as the whale oil industry declined. By the turn of the century, oil, processed into gasoline, was firing internal combustion engines.

Horseless carriages were a rich man's toy until Henry Ford perfected the assembly-line method of mass production for his Model T. Interestingly enough, electric cars were a rich woman's toy at the same time. Quiet and clean, electric cars started without a starter crank, an exertion that would have overtaxed the gentle ladies of the day. When gas cars adopted electric starters, their superior range quickly drove the electrics out of the market.

Energy takes off

With the low-cost automobile and the spread of electricity, our society's energy use changed forever. Power plants became larger and larger, until we had massive coal plants and hydroelectric dams. The cheap car made suburbs possible, which in turn made cheap cars necessary, feeding the cycle of suburban sprawl.

Energy use grew quickly, doubling every 10 years. The cost of energy production was declining steadily, and the efficient use of energy was simply not a concern.

After World War II unleashed nuclear power, the government looked for a home for "the peaceful atom." They found it in electricity production. Over 200 nuclear power plants were planned across the country, and homes were built with all-electric heating systems to take advantage of this power that would be "too cheap to meter."

The Great Energy Crash

In 1973, US support for Israel in the Arab-Israeli War led the Arab oil-producing nations to stop supplying oil to the United States and other western nations. Overnight, oil prices tripled. In 1979, when the Shah of Iran was forced out by Ayatollah Khomeini, oil prices leaped again, rising 150 per cent in a matter of weeks. Motorists lined up at gas stations to buy gasoline, and President Carter went on television to declare that energy conservation was "the moral equivalent of war." By 1980, the average price of a barrel of oil was almost \$45.

Only three months after the fall of the Shah, the Three Mile Island nuclear power plant suffered a partial meltdown after a series of mechanical failures and operator mistakes. After years of hearing that a nuclear accident could never happen, the US public was shocked. The accident added to the sense of crisis.

But the accident at Three Mile Island was only the latest in a long line of problems plaguing the nuclear industry. New plant orders had already ceased, because of multibillion-dollar cost overruns, high inflation, and a slowdown in electricity demand growth due to the early effects of energy conservation. No new plants were ordered after 1978, and all those ordered since 1973 have been cancelled.

Adapted from <https://www.ucsusa.org/resources/short-history-energy>

1. Answer the questions to the text.

1. How did the energy needs change with time?
2. What are the factors influencing society development?
3. What inventions caused changes in people's lives?
4. What energy resources are discussed in the paper?

2. You are a student of engineering department and you are working on your research topic "Engineering Innovations". Find on the Internet information about different innovations in your field and think how they improved our lives. Write an essay on the topic "Advances in engineering know-how have made humanity

freer, wealthier, and longer living” (200 – 250 words). See Appendix B for Essay writing.

WORKING WITH VISUAL INFORMATION

1. Study useful vocabulary and a typical structure for a pie chart description.

1.1. The first paragraph – **an introduction** (1 or 2 sentences, where you introduce your chart).

- what your graph shows
- for what period of time

1.2. The second paragraph – **a general overview** (briefly describe 2 – 4 key features of your chart).

- find the biggest and smallest slices of each pie chart
- find which slices became bigger/smaller or didn't change
- identify the biggest/smallest slices

1.3. **Specific details** – give the specific details of your chart in 2 or 3 paragraphs.

1.4. You can group data in such way:

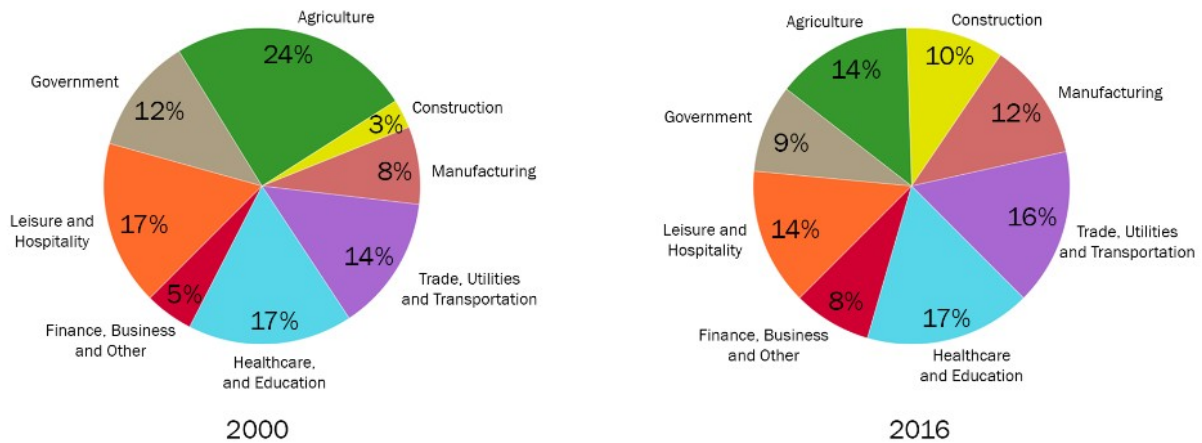
- Sectors that had an increase (construction; trade utilities & transportation; manufacturing; finance, business and other services)
- Sectors that had a decrease or didn't change (agriculture; government; leisure and hospitality; healthcare and education)

1.5 **Useful vocabulary to write a percentage of a certain sector:**

- sector X was 3%
- sector X made up 3%
- sector X accounted for 3%
- sector X comprised 3% of [the whole chart]

2. Study the pie charts and fill in the gaps.

The given pie charts show information about contribution to the economy of different industrial sectors.



Fill in the gaps in the text with appropriate words.

overall	threefold	comparison	respectively
growth	pie chart	comprised	constant

The two **1** _____ illustrate how different industry sectors contributed to the economy of Turkey percentagewise in the years 2000 and 2016.

2 _____, at the beginning of the period construction contributed the least to the economy of Turkey and agriculture was the most significant economic sector. In **3** _____, at the end of the period healthcare and education became the largest economic segment and the lowest contribution was made by financial, business and other services.

Construction sector accounted for 3% of Turkey's economy in 2000, and experienced a more than **4** _____ increase to one-tenth in 2016. Economic income from trade, utilities and transportation was 14% in 2000 and experienced a slight **5** _____ of 2% in 2016. At the beginning of the period, manufacturing and

finance, business and other services made up 8% and 5% of Turkey's economy, respectively, and these figures rose to 12% and 8% in 2016.

Agriculture, which **6** _____ almost a quarter of Turkey's economy in 2000, fell to 14% in 2016. In 2000 economic outputs from government and leisure and hospitality sectors were at 12% and 17%, **7** _____, and both decreased by 3% after 16-year period. In contrast, contribution from healthcare and education sector remained **8** _____ in both years at 17%.

Information is taken from <https://ielts-up.com/writing/pie-chart.html>

3. Find interesting and up-to-date information on the Internet about industrial sector in your country. Draw a pie chart basing on this data and describe it (5 -7 sentences).

SMILE

The engineer spent one day with the huge machine. He did nothing to the machine, just spent hours observing and examining. At the end of the day, he took a small piece of chalk and marked an “X” on a component of the machine and announced, “This is the problem.”

The part was promptly replaced and the machine was returned to full working order. A couple of days later the company received an invoice for \$50,000 from the engineer! They (somewhat angrily) demanded the invoice to be itemized.

A one-line email appeared in their inbox:

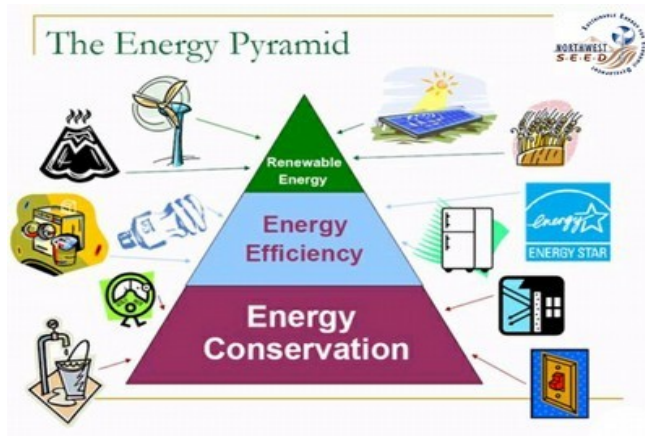
“One chalk mark: \$1, Knowing where to put it \$49,999.”

It was paid in full and the engineer returned to a happy retirement.

UNIT 3. ENERGY EFFICIENCY

LEAD-IN

1. Look at the picture of the energy pyramid. What problems does it concern? Explain the connection between the parts of the pyramid: renewable energy – energy efficiency – energy conservation.



2. You are given the tips for saving energy below. Put these tips in the correct column under the titles.

Tips for energy efficiency

- optimize start-up time, power-down time, and equipment sequencing;
- turn off lights when not in use or when natural daylight is sufficient;
- maximize daylighting;
- enable the power management function which automatically puts monitors to sleep when not in use;
- visually inspect insulation on all piping, ducting and equipment for damage;
- plug electronics into a "smart" power strip;
- adjust thermostats for seasonal changes;
- control direct sun through windows depending on the season and local climate;

- clean the evaporator and condenser coils on heat pumps, air-conditioners, or chillers; repair leaks and adjust the pressure in compressed air systems;
- make the best use of natural daylight and take advantage of skylights or other natural daylight sources to reduce lighting during daytime hours;
- use task lighting where feasible.

Operations and maintenance	Lighting	Office equipment	Heating and cooling

READING and VOCABULARY

1. Study the words and expressions in the table and explain their meaning.

sustain	incentivise	employment	retrofit
fiscal burden	phase out	competitiveness	emission reduction

2. Read the text and be ready to answer the questions after the text.

WHY ENERGY EFFICIENCY MATTERS

Global energy demand is increasing at a steady pace. To meet that demand and sustain economic development, trillions of dollars will be invested over the coming decades. As demand grows, energy subsidies, government transfers, guarantees to state-owned utilities, and energy imports will also increase, placing enormous fiscal burdens on governments. But phasing out energy subsidies and introducing new energy and environmental taxes to curb demand will provoke social tensions and

adversely affect the poor and most vulnerable. Concerns over energy security have led to a growth in domestic resource exploitation, including fossil fuels.

Energy efficiency should be the “first fuel” of energy policymakers and governments around the globe. It can help meet growing energy demands cleanly and cheaply, increase competitiveness, generate employment, secure energy, reduce poverty, and benefit development. Harnessing energy efficiency can facilitate a more efficient allocation of resources across the global economy, potentially boosting economic output by US\$18 trillion through 2035. Improved energy efficiency in industry modernizes factories, increasing productivity and competitiveness. This fosters economic growth and creates and protects long-term employment opportunities. In the urban and public infrastructure sectors, energy efficiency can help local governments provide more reliable public services, such as heating, power, public lighting, and water, while reducing costs. Freed up fiscal resources can then be used for socioeconomic development and for programs benefitting people living in poverty. Energy efficiency mitigates the impact of ongoing tariff reforms, which adversely affect poorer households, and it is a relatively inexpensive method for reducing global and local pollution.

Back in 2017, energy efficiency campaigners had reasons to be cheerful. The government’s new Clean Growth Strategy adopted their aspirations to significantly upgrade the efficiency of existing homes, establish green mortgages to incentivise enhancements, and raise energy standards for all new developments.

The strategy outlined an overall approach to linking emissions reductions in buildings, industry, power and transport while growing jobs and the economy. Energy efficiency was a key part of the plan.

Energy use in the home accounts for 20% of the UK’s carbon emissions, according to the government, meaning that improving energy efficiency has huge potential in helping reach its target of net-zero emissions by 2050. It would also help the estimated 2.55 million people in the UK who live in fuel poverty.

But the challenge is huge. The UK has 28 million homes that need retrofitting, many of which are at a very low standard, earning the country the reputation of

having some of the least efficient homes in Europe. In addition, the government has a target to build 300,000 homes a year by the mid-2020s to house a growing population. Without stronger standards, the risk is that these new homes will add to the volume of houses that will eventually need retrofitting.

In order to start ramping up to this, the government wants to bring in some measures covering energy efficiency and ventilation later this year. It has proposed two options: a 20% reduction in carbon emissions, largely achieved through very high fabric standards such as glazing, walls, floors, and roof materials to limit heat loss; and a 31% reduction through the use of additional technologies such as solar PV panels and heat pumps.

The government has stated a preference for the second option. However, this is problematic for the industry as the UK lacks manufacturing and installation skills for heat pumps. In a market-based economy, the most pain-free and effective way to achieve objectives is to create incentives for actions that support our objectives. To encourage a reduction in fossil fuel use, we need to set specific carbon reduction targets and outline an array of actions needed to reach the objectives. Offering a range of potential actions allows businesses and the public to choose a set of actions they can implement, consistent with their economic and personal situations. Finally, we need to be sure the actions have a positive return on investment. For example, if we want farmers to rebuild their soils to store significant amounts of carbon, they need to be economically rewarded to make this transition. If we want homeowners to install solar panels, their return on investment needs to be not only positive, but rapid. Incentives can be extrinsic (coming from outside), based on regulations, taxes, subsidies, favourable financing, and tax breaks, or intrinsic (coming from within), based on a positive return on investment, or other less tangible benefits such as improved health and comfort. In most cases, all that is needed to get people and businesses to take action based on intrinsic incentives is to provide education and motivational appeal – a commonly recognized strength of the marketplace. Combining small extrinsic incentives to support intrinsic incentives may create the quickest and most effective road to significant change. State and local governments

and utilities have a long history of creating successful financial rebates and educational programs that utilize this strategy to reduce energy use.

<https://zeroenergyproject.org/2019/05/17/incentivizing-the-free-market-to-get-to-zero-carbon-while-enhancing-equity-and-creating-jobs/>

3. Answer the questions to the text.

1. What modern tendencies are the fiscal burden for the government?
2. Why is energy efficiency considered the first fuel?
3. What are the modern incentives for the energy sector development?
4. What energy-efficient technologies are proposed by the government?
5. What incentive for goal reaching are suggested?

IMPROVE YOUR VOCABULARY

1. Match the synonyms.

1)	phase out	a)	performance
2)	provoke	b)	cutback
3)	efficiency	c)	impetus
4)	extrinsic	d)	put into action
5)	incentive	e)	eliminate
6)	reduction	f)	fast
7)	target	g)	payback
8)	implement	h)	exterior
9)	rebate	i)	raise
10)	rapid	j)	objective

2. Match the words with their definitions.

1)	Strategy	a)	negotiated return of a portion of the interest earned by the lender of stock to a short seller;
2)	Incentive	b)	a device that transfers heat from a colder area to a hotter area by using mechanical energy, as in a refrigerator;
3)	Financial rebate	c)	a rule or directive made and maintained by an authority;
4)	Efficiency	d)	a thing that motivates or encourages someone to do something;
5)	Employment	e)	a plan of action designed to achieve a long-term or overall aim;
6)	Tax	f)	an economic system in which production and prices are determined by unrestricted competition between privately owned businesses;
7)	Heat pump	g)	the state of having paid work;
8)	Regulation	h)	a compulsory contribution to state revenue, levied by the government on workers' income and business profits, or added to the cost of some goods, services, and transactions;
9)	Market economy	i)	the ratio of the useful work performed by a machine or in a process to the total energy expended or heat taken in;
10)	Implement	j)	put (a decision, plan, agreement, etc.) into effect.

3. Find and match collocations.

1)	steady	a)	tensions
2)	state-owned	b)	economy
3)	social	c)	friendly
4)	energy	d)	pace
5)	meet	e)	investments
6)	environmentally	f)	demand
7)	reduce	g)	program
8)	market-based	h)	security
9)	educational	i)	utilities
10)	positive return on	j)	pollution

4. Read the text and be ready to answer the questions.

ENVIRONMENTAL ISSUES



It is a common belief that adults are responsible for 'big issues' such as environmental protection and conservation, and youths can do nothing but focus on their studies or have fun. However, the stories of the young people in the Young Voices for the Planet show that even at a young age, people are able to do something for their communities and can really contribute to the care and preservation of the environment. Kids can also do things to make a difference, given the chance. And

though their skills and talents may vary, they can use their unique gifts to help to preserve the environment and save the world. One of the children in the stories, Olivia, says:

‘Every one of us has a great gift we can use to help the earth. Everyone, at any age, can do something, whether it is picking up rubbish along the side of the road, filling a bird feeder, or bringing reusable bags to the grocery store. For me, I used my artwork. Find your cause and use your talents. The quality of our world is counting on you.’

It is remarkable that someone as young as Olivia can understand so well the connection between society, the environment, and the problems we are facing today. It has been proved that every small act of kindness we show can make a great impact on the world around us.

For some people, environmental protection and conservation mean stopping the growth and development of technology and society. But this is a popular belief that is not true. Protecting the environment isn't about stopping progress. It's about changing our consumption habits and taking care of the environment. Just by doing simple things, every one of us including the youths can do their share in making this world a better place to live.

5. Answer the questions to the text.

1. What do most people believe?
2. What do the stories of the young people in the Young Voices for the Planet show?
3. According to Olivia, what are the things that people can do to help the earth?
4. How did she manage help the environment
5. What does the writer find extraordinary and unusual about Olivia?

6. Decide whether the statements are true or false.

		T	F	NG
1.	According to Olivia, only young people can use their talents to help the Earth			
2.	If you don't have talents, you can't help to preserve the environment and save our world.			
3.	Even a small act of kindness can make a great impact on the world around us.			
4.	If we want to preserve the environment, we should stop the growth and development of technology and society.			
5.	The future of our world depends on young people only.			
6.	People should change their consumption habits to preserve the environment.			

7. Use the words and phrases from the box to complete the sentences.

greenhouse gases	vehicle emissions	ecological balance
catastrophic	heat-related	diversity

1. The effects of climate change on humans and nature are _____.
2. We need to preserve the _____ of wildlife because each species has an important role to play.
3. The increase in the earth's temperature can cause _____ illnesses which can be dangerous to people.
4. Carbon dioxide is one of the primary _____ that cause global warming.

5. Planting trees can contribute to reducing global warming as trees _____ and absorb CO₂ in the air.

6. Climate change may lead to the extinction of many species and upset the _____

IDIOMATIC LANGUAGE

1. Match two parts of the idiom and complete the sentences below using these expressions.

1)	in tune with something	a)	when a society or person realizes they must work harder to surpass their competitors
2)	on the same wavelength	b)	have a good understanding of someone or something
3)	sputnik moment	c)	it means that it happens predictably, without any problems.
4)	bright as a button	d)	thinking in the same pattern or in agreement
5)	like clockwork	e)	intelligent

1. He was _____ new technologies.

2. They've done a good job because they were on the _____.

3. This generation's _____ has arrived, President Barack Obama declared in his State of the Union address, referring to the United States' need to invest in research and development to revive the economy and ensure future stability.

4. He has a daughter who is _____.

5. The launching of the new product went _____.

GRAMMAR REVISION

1. *Using your knowledge of Participles and Participle Constructions, fill in the gaps in the sentences below. See Appendix A “Participle and Participle Constructions” for grammar references.*

1. _____ by the changing information, they thought the plane was canceled.

a) confusing	b) confused	c) having confused
--------------	-------------	--------------------

2. _____ at a low temperature, these jeans will keep their original colour for a long time.

a) washing	b) having washed	c) washed
------------	------------------	-----------

3. _____ the paper, he saw the news about his hometown.

a) reading	b) having read	c) read
------------	----------------	---------

4. _____ by a local architect and artist, the house combines traditional materials with original design.

a) building	b) having built	c) built
-------------	-----------------	----------

5. _____ in India for two years, Kaleem could speak some Hindi.

a) living	b) having lived	c) lived
-----------	-----------------	----------

6. _____ in prisons throughout her twenties, she wrote her first play about life behind bars.

a) after working	b) working	c) having been worked
------------------	------------	-----------------------

7. _____ for the final interview, the candidates were asked to prepare a short presentation

a) selecting	b) selected	c) having been selected
--------------	-------------	-------------------------

8. _____ the documentary about wildlife, I made a donation to an environmental society.

a) watched	b) watching	c) having watched
------------	-------------	-------------------

9. _____ water resources irresponsibly, the authorities had to deal with water shortages _____ in _____ the _____ region.

a) managing	b) having managed	c) having been managed
-------------	-------------------	------------------------

10. _____ about the dangers of chemical fertilizers, the farmers turned to bio-fertilizers.

a) being told	b) having told	c) told
---------------	----------------	---------

2. Write the sentences using the words and phrases given below.

1. global warming / increase / earth's average surface temperature / due to / warming effects / greenhouse gases /.
2. main cause / global warming / burning of fossil fuels / natural gas, oil, and coal /.
3. even slight increases / levels / carbon dioxide / atmosphere / can / cause significant / rise / temperature /.
4. there / connection / between / recent droughts / and / climate change /.
5. farming / contribute / more than / 30 percent / total greenhouse gas emissions /.

6. overuse / chemical fertilizers / serious threat / environment /.
7. warming / earth's atmosphere / cause / sea-level rise /.
8. many animal species / in / danger of extinction / due to / loss / habitat / and / inability / adapt / climate change /.
9. global warming / may lead / extreme weather events / , / include / heat waves / floods / powerful storms / which / affect / people's lives /.

TRANSLATION PRACTICE

1. Translate the sentences into Ukrainian paying attention to the usage of Participles and Participle Constructions.

1. The bomb exploded, destroying the building.
2. Having finished their training, they will be fully qualified doctors.
3. Having been made redundant, she started looking for a new job.
4. Instead of complaining about it, they should try doing something positive.
5. On arriving at the hotel, he went to get changed.
6. While packing her things, she thought about the last two years.
7. In spite of having read the instructions twice, I still couldn't understand how to use it.
8. Having found the door locked, an employee left.
9. I talked to several people participating in the project.
10. Asked to explain what happened, he said that he didn't know.

SPEAKING

Look at the picture. Discuss in groups how energy efficiency improvement can influence different spheres of life. Share your ideas with the groupmates.



LISTENING

What is a Zero Energy Building?

1. Take a quiz “How green savvy are you?” Compare your answers with a friend.

1. Does the CO₂ that you produce each year – through your daily activities like driving a car, washing the dishes, heating your home, etc. – weigh more than you do?

- a. true
- b. false

2. Recycling actually costs more than it saves.

- a. true
- b. false

3. Enough sunlight falls on the earth in one minute to power the world’s entire energy needs for (choose one)

- a. one minute
- b. one day
- c. one month
- d. one year

4. What do you think uses the most household water?

- a. car washing

- b. dish washing
- c. showers and bath
- d. toilet flushing

5. The mantra that is the heart and soul of green living is “Reduce, Reuse and:

- a. recycle
- b. refrain
- c. repair
- d. restore

2. Explain the meaning of the following terms. Basing on this vocabulary try to predict what this video will be about.

Zero-energy building, energy load, electrical grid, excess energy, reliable, affordable, to consume, competitive

3. Watch the video What is a Zero Energy Building?

<https://www.youtube.com/watch?v=FysJKq5yCfg>

4. Answer the questions to the video.

1. What is the principle of a zero-energy building?
2. How much does it allow us to save?
3. What conditions are suitable for zero-energy building?

5. Complete the text with the words and words phrases you hear.

Most buildings today use a lot of energy – to keep the lights on, cool the air, heat water, and **1** _____ personal devices. Even installing solar systems will not significantly counter the heavy **2** _____. There are, however, some buildings that strike a balance; or even **3** _____ the scales the other way!

These are called **4** _____ buildings. They manage this feat by being extremely energy efficient – saving 50% – 70% more energy than typical buildings! In these

5 _____ buildings, the amount of energy used can be completely offset by renewable energy produced on or around the building.

When conditions are not suitable for energy 6 _____, the building will draw energy from the electrical grid to 7 _____. When conditions improve, the on-site renewable energy systems will 8 _____ the building's energy need and send excess energy back into the grid to 9 _____ the balance. Over the course of a year, the building gives back as much energy as it takes. When zero-energy concepts are applied to groups of buildings, the benefits are 10 _____ within that zero-energy community.

SUPPLEMENTARY TEXT

THE PRACTICAL WAYS TO REDUCE YOUR CARBON FOOTPRINT

Vocabulary:

Carbon-chugging entity – тут: вуглецеві сполуки

flexitarian – flexible+vegetarian – флексітаріанець (вегетаріанець, який інколи їсть м'ясо)

carbon footprint – вуглецеві викиди

seep in – просочитися

pick apart – критикувати, руйнувати

mockery – насміхання, жарти

murmur – шепотіти

carbon emission – вуглецеві викиди

temper – гартувати

voracious consumerism – ненаситна тенденція до споживання

In the fight for climate preservation, a growing number of people are planning to relieve the earth of more carbon-chugging entities by abstaining from reproduction

– saving the planet a tidy 58.6 tonnes of carbon a year in the process. But we hear comparatively less extreme recommendations all the time: go vegan (or at the very least, flexitarian), take trains instead of planes, browse the rails of secondhand shops.

But on a smaller scale, do the most hyped environmentally-friendly lifestyle changes really make an impact – and to what degree? Here, we pick apart some of the most common recommendations.

Fly less

There's a good reason why flights take the brunt of environmentalists' ire. They can account for a huge proportion of your annual carbon footprint – particularly if you're a habitual or long-haul flyer. Research from *The Guardian* has found that one long-haul flight can produce more carbon emissions than the average citizen produces in a year in a number of countries. For example, a long-haul return flight from London to New York produces around 986kg of CO₂ per passenger, more than the annual carbon emissions of citizens in 56 countries, including Burundi and Paraguay.

Boats are another mode of transport where counter-intuitive logic can seep in. While boats might generally be considered fairly environmentally friendly, this isn't always the case. In fact, a study found that a certain type of boat, the Large RoPax passenger ferry, was actually more polluting than taking a first-class flight (0.39kg of CO₂ per Km per person compared to 0.32kg CO₂ per km per person).

Go vegan (or at least flexitarian)

Veganism has come full circle from its hippy, cold mushy lentil roots: transiting from target of merciless internet mockery to aspirational Instagram aesthetic, to its final resting place in the quasi-mainstream today. But while the vegan diet still represents the pinnacle of piety (in food terms anyway), there are increasing murmurs about another, more achievable eating pattern – the hiss of 'flexitarianism'.

What would happen if the whole world went vegan? A study from Oxford University estimated there would be a 49 per cent reduction in greenhouse gas emissions from food production if we all followed our vegan friend's advice. On an individual basis, research showed that a vegan's diet is the most carbon light (creating 6.4 pounds CO₂ per day), while a diet heavy in meat is also the heaviest in carbon

(15.8 pounds CO₂-eq per day). While different estimates vary, it's generally agreed that you could cut your carbon footprint by around 20 per cent by switching to a vegan diet. But if you can't face going fully meat-free, the best meats to cut down on are from sheep and cows, the animals that produce the most atmosphere frying methane.

Optimise your home

Solar panel installations fell by 94 per cent in the UK this year as the government withdrew the offer of subsidies. But are there any other home improvements you can make to reduce your house's carbon footprint? Most important is making sure your home is well insulated. Trapping heat effectively is the best way to trim down your energy usage – the biggest producer of carbon emissions in the home.

Make sure heat drains like gusty lofts and window frames are fully stoppered up. Beyond this, you can make additional efforts to drought-proof your house – by blocking the edges of doors and windows for example. Replacing an inefficient gas boiler can yield important energy gains, and another tip is replacing halogen bulbs with more energy-efficient LED bulbs.

Drive less – or switch to electric

Nowadays, people consider alternative means of travel. When it comes to short distances, defaulting to the car quickly racks up your carbon output. While for people based in more rural areas, or those underserved by public transport, a car might be the most sensible option, for city dwellers, there is generally always a better, more carbon-friendly alternative. Weigh up your options: can you take a bus, tube or tram? Walk? Cycle? Or at the very least, carpool? If you are in ownership of a car, you can also spread your carbon burden by inviting people to share your commute.

If you are a frequent car user, then switching to an electric car is the greener option. Although the electricity you feed into your vehicle will be partly produced by non-renewable energy, these vehicles are much more efficient meaning overall CO₂ emissions will fall.

Buy secondhand clothes

Fast fashion – exemplified by the likes of £5 dresses from Primark and Zara’s weekly stock rotation – is hugely harmful to the planet. Aside from the production process itself – which expels 1.2bn tonnes of CO₂ a year (more than the aviation and shipping industries combined) – the wear-once-then-toss attitude permeating high street fashion means that racks of flimsy clothes are quickly transformed into one million tonnes of waste a year, much of which will be incinerated or added to landfill.

This doesn’t even take into account the vast number of microplastics contained in artificial materials, which are released into the water supply each time it’s washed.

Reuse and reduce

Beyond clothing, any new purchase comes with an embedded carbon price tag. “The embodied carbon in everything we buy, particularly single use or throw away stuff, has a real, big impact on our climate,” says Reay. This is especially pertinent for items we only use sporadically, for example, lawnmowers or power drills.

“If you think about your phone, it’s all the components – all those metal and plastic parts – and all of the energy that’s got into it,” Reay says. “It has quite a big carbon footprint, and we’re buying a new one each year.” Indeed, Apple has released figures showing that 80 per cent of a product’s carbon footprint is wrapped up in its production process, rather than the energy it consumes once it’s completed. Planned obsolescence means that we’re cycling through new handsets faster than ever before, with many of the discards simply being thrown in the bin.

To combat this, neighbourhood collectives that share rarely used items are on the rise. For example, Oxford’s Library of Things offers a range of items that are only occasionally needed – ladders, saws, and of course, disco balls. Reuse and reduce should form the pillars of your sustainable ideology. Recycling can only go so far, it’s tempering our voracious consumerism that can make the biggest impact.

Adapted from <https://www.wired.co.uk/article/reduce-carbon-footprint>

2. Answer the questions to the text.

1. What are the main recommendations for protecting the Earth?

2. How can changing the transportation means influence environmental situation?
3. What habits should we change to diminish our impact on the environment?
4. What is an embedded carbon price tag?
5. How can the *reuse and recycle* processes contribute to the environmental protection?

PROJECT WORK

Project B. SOLVING ECOLOGICAL PROBLEM (see Appendix C)

1. Take a quiz *How Green Are You?*



1. Do you read the of ingredients on the food you buy?
2. Do you take a shower instead of bath?
3. Have you planted at least one tree?
4. Do you feed birds or squirrels in winter?
5. Do you insulate your house in winter to save heat?
6. Do you switch off lights if nobody needs them on?
7. Do you use recycled paper?
8. If you ever organized a campaign on environmental issues, score.
9. For slier journeys, do you regularly walk if you can?
10. For long journeys, do you regularly use a bike or public transport?
11. If your family has a car, does it run on unleaded petrol?
12. If your family doesn't have a car, score 2.
13. Do you buy ozone friendly aerosols?

- 14.If you don't buy aerosols at all, score 5.
- 15.If you have ever written a manufacture to complain about their products, score
- 16.Do you belong to any environmental organization?
- 17.Can you name at least one endangered species?
- 18.Do you take bottles to the bottle bank?
- 19.Do you collect aluminium cans for recycling?
- 20.Do you collect paper for recycling?
- 21.If you are a non-smoker, score 3.
- 22.Coming back from the forest or home from the beach, do you al- ways take your litter with you?

Answers to the quiz

Light Green (1 -16)

You have begun to notice that some parts of your lifestyle aren't very environmental friendly, but you wouldn't think twice about throwing away paper, cans and bottles. You are a bit curious about all the fuss over environmental problems and definitely want to find out more as long as it is not too difficult. You realize that it is a good move to be green and should read on and go greener.

Mid-Green (17-27)

You are really thinking about the way that planets operate and you know that everything you do (good or bad) will return to us sooner or later. You have made some changes to your lifestyle already. You are aware of the most common environmental problems and you feel strongly about some endangered species. Sometimes you eat fast food, but wonder what's in it. You often watch environmental programs on television. You may be thinking about joining an environmental group. Now it's time to take the leap and become an active green!

Dark Green (28-38)

You try to live in a way that does not damage the environment. You like to plant trees and take care of birds. You use recycled paper but constantly frustrated with the lack

of recycling facilities in your area. You might be a member of an environmental organization and you have already taken part in some actions. Your friends think you are a bit obsessive but you have noticed that recently they have been coming around to your way of thinking. Be cheerful by the fact, that people are becoming more aware and there will be changes. What you do does count!

<https://studfile.net/preview/5612787/page:6/>

2. Role-play the situation.

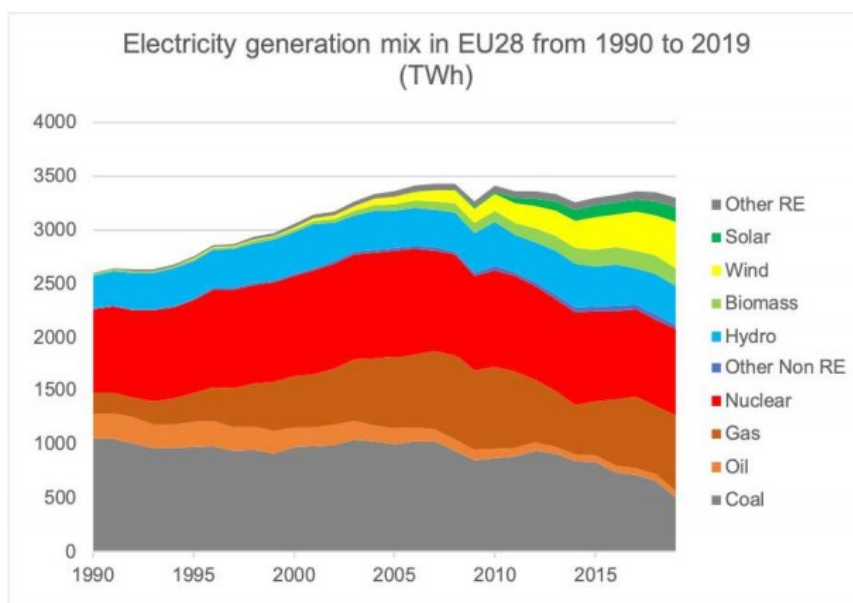
As a representative of a local ecological monitoring institution, you are having a meeting with governmental officers. Your task is to present them a report on the current ecological state of matters at the local mining industry. You can present a report with some figures and illustrate them with the diagram.

Suggest possible solutions to renew an ecological balance in your region. You may include information about employees and their health problems, about environmental issues and advanced technologies etc. Use the role-cards.

(See Appendix C, Project B for the role-cards and useful expressions)

WRITING

Study the graph about the mix of energy sources in energy generation. Compare the results given in the picture. Write an essay of about 200 - 250 words (see Appendix B for essay writing).



SMILE

For anyone that doesn't study engineering, the answer to $1+1$ will always be "2". Ask an engineer, and you will hear "I'm pretty sure the answer is 2, but we'd better make it 3 just to be safe."

A mathematician, physicist and engineer were all asked to figure out the volume of a blue rubber ball. The mathematician measured the diameter of the ball and calculated a triple integral.

The physicist placed the ball in a beaker full of water and measured the amount of water that was displaced.

The engineer looked up the answer in his Blue Rubber Ball Volume Table

SELF-CHECK FOR UNITS 1 – 3

1. Choose an appropriate word to fill in the gap.

1. Heat **1** _____ is the major concern for a thermal engineer.
2. Thermal engineers are **2** _____ in areas of specialisation and can work in numerous fields.
3. The majority of watersheds around the world are highly **3** _____ with polluted waterways and outmoded technology.
4. Geothermal fields produce only about one-sixth of the **4** _____ that a relatively clean natural-gas-fuelled power plant produces.
5. To encourage a reduction in **5** _____ use, we need to set specific carbon reduction targets and outline an array of actions needed to reach the objectives.

- | | | | |
|----|-------------------|-----------------|------------------------|
| 1. | A. reduction | B. transfer | C. transformation |
| 2. | A. not limited | B. restricted | C. engaged |
| 3. | A. developed | B. modified | C. degraded |
| 4. | A. carbon dioxide | B. oxygen | C. nitrogen |
| 5. | A. energy | B. fossil fuels | C. renewable resources |

2. Decide whether the sentences are true (T) or false (F).

1. Thermal engineering has applications only inside industrial plants which deal with refrigeration, ventilation, and temperature regulation within buildings.
2. Hydroelectric power is classed as the most efficient source and cost-effective source of renewable energy.
3. Traditional hydropower plants work by using the force and pressure of water flowing from a high point to a lower point through chutes in a dam.
4. A geothermal heat pump is a closed loop that takes the heat from the soil to heat the house in winter and extracts heat from the building and transferring it back to the relatively cooler ground in summer.

5. Environmental protection and conservation means stopping the growth and development of technology and society.

3. Choose the correct modal verb to complete the sentences: *must, need not have done, don't have to, mustn't, to be (un)likely*.

You may find grammar material about modal verbs in Appendix A “Modal Verbs”.

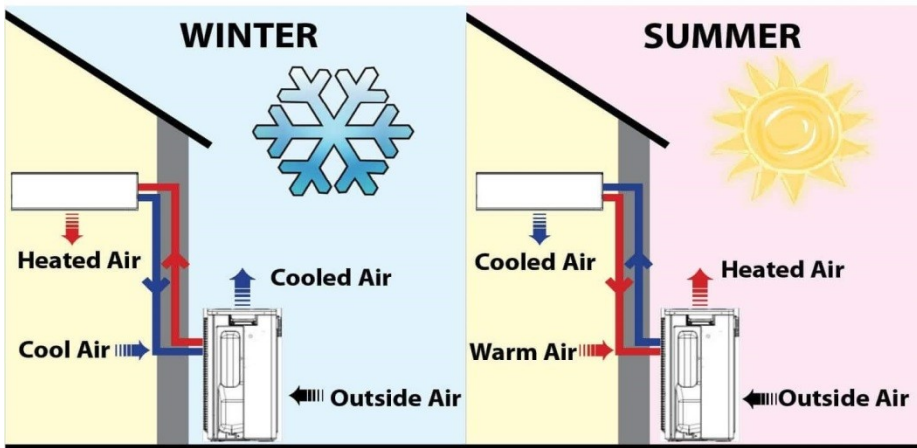
1. You _____ follow the instructions to avoid the accident.
2. You _____ all these tasks for him.
3. You _____ participate in this research program.
4. You _____ reveal the project details to the third parties.
5. He _____ to win grant money.

UNIT 4. HEAT PUMPS

LEAD-IN

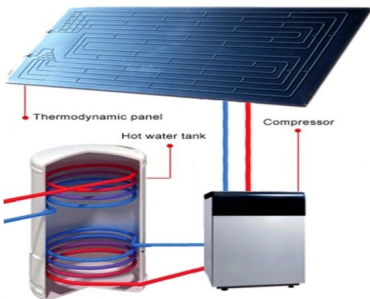
Look at the picture. What device is shown on the picture?

1. *What do you know about the heat pump?*
 2. *Find more information about the heat pump on the Internet.*
- Discuss pros and cons of heat pumps in pairs or in small groups.*

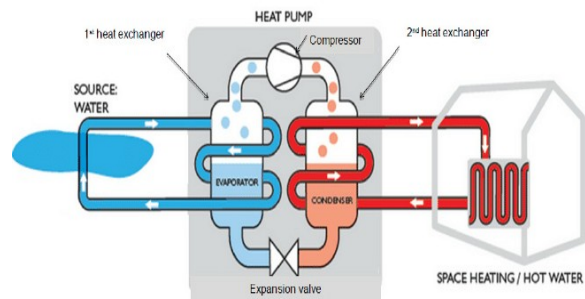


3. *Match the pictures with a particular type of the pump.*

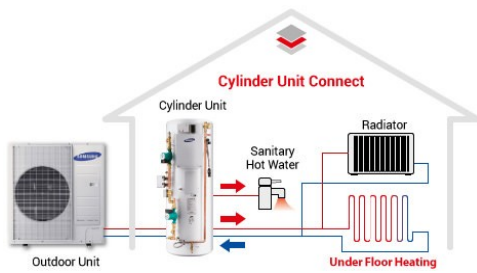
a	solar heat pump	2.	hybrid heat pump	3.	absorption or gas-fired heat pump
b	air source heat pumps	5.	geothermal heat pumps	6.	water source heat pumps



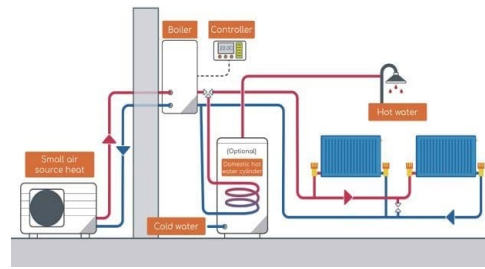
1 _____



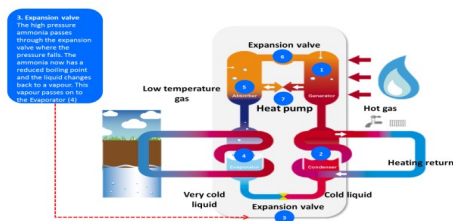
2 _____



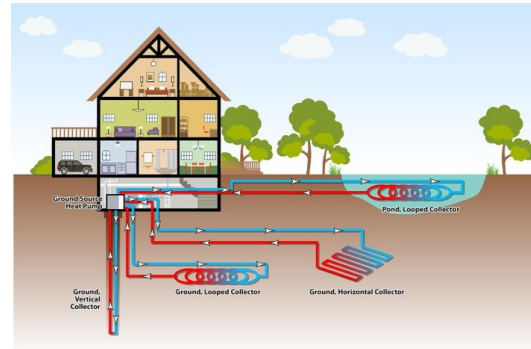
3 _____



4 _____



5 _____



6 _____

READING and VOCABULARY

1. Before reading the text, discuss the necessity of heat pump installing.

Describe the process of heat generation.

2. Study the following words in the box and make sure you know them.

energy-efficient alternative	conventional heating	baseboard heater
furnace	air-to-air pump	dehumidify
cool outdoor	air-source heat pump	mini-split heat pump
generate	transfer	radiant floor heating system
provide	electric resistance heating	zone control system

3. Read the text about heat pumps and be ready to answer the questions.

HEAT PUMPS

For climates with moderate heating and cooling needs, heat pumps offer an energy-efficient alternative to furnaces and air conditioners. Like your refrigerator, heat pumps use electricity to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. During the heating season, heat pumps move heat from the cool outdoors into your warm house and during the cooling season, heat pumps move heat from your cool house into the warm outdoors. Because they move heat rather than generate heat, heat pumps can provide equivalent space conditioning at as little as one quarter of the cost of operating conventional heating or cooling appliances.

There are three types of heat pumps: air-to-air, water source, and geothermal. They collect heat from the air, water, or ground outside your home and concentrate it for use inside.

The most common type of heat pump is the air-source heat pump, which transfers heat between your house and the outside air. Today's heat pump can reduce your electricity use for heating by approximately 50% compared to electric resistance heating such as furnaces and baseboard heaters. High-efficiency heat pumps also dehumidify better than standard central air conditioners, resulting in less energy usage and more cooling comfort in summer months. Air-source heat pumps have been used for many years in nearly all parts of the United States, but until recently they have not been used in areas that experienced extended periods of subfreezing temperatures. However, in recent years, air-source heat pump technology has advanced so that it now offers a legitimate space heating alternative in colder regions.

For homes without ducts, air-source heat pumps are also available in a ductless version called a mini-split heat pump. In addition, a special type of air-source heat pump called a "reverse cycle chiller" generates hot and cold water rather than air, allowing it to be used with radiant floor heating systems in heating mode.

Geothermal (ground-source or water-source) heat pumps achieve higher efficiencies by transferring heat between your house and the ground or a nearby water source. Although they cost more to install, geothermal heat pumps have low operating costs because they take advantage of relatively constant ground or water temperatures. Geothermal (or ground source) heat pumps have some major advantages. They can reduce energy use by 30%-60%, control humidity, are sturdy and reliable, and fit in a wide variety of homes. Whether a geothermal heat pump is appropriate for you will depend on the size of your lot, the subsoil, and the landscape. Ground-source or water-source heat pumps can be used in more extreme climates than air-source heat pumps, and customer satisfaction with the systems is very high.

A new type of heat pump for residential systems is the absorption heat pump, also called a gas-fired heat pump. Absorption heat pumps use heat as their energy source, and can be driven with a wide variety of heat sources.

Advanced Features to Look for in a Heat Pump

A number of innovations are improving the performance of heat pumps. Unlike standard compressors that can only operate at full capacity, two-speed compressors allow heat pumps to operate close to the heating or cooling capacity needed at any particular moment. This saves large amounts of electrical energy and reduces compressor wear. Two-speed heat pumps also work well with zone control systems. Zone control systems, often found in larger homes, use automatic dampers to allow the heat pump to keep different rooms at different temperatures.

Some models of heat pumps are equipped with variable-speed or dual-speed motors on their indoor fans (blowers), outdoor fans, or both. The variable-speed controls for these fans attempt to keep the air moving at a comfortable velocity, minimizing cool drafts and maximizing electrical savings. It also minimizes the noise from the blower running at full speed.

Many high-efficiency heat pumps are equipped with a desuperheater, which recovers waste heat from the heat pump's cooling mode and uses it to heat water. A desuperheater-equipped heat pump can heat water 2 to 3 times more efficiently than an ordinary electric water heater.

Another advance in heat pump technology is the scroll compressor, which consists of two spiral-shaped scrolls. One remains stationary, while the other orbits around it, compressing the refrigerant by forcing it into increasingly smaller areas. Compared to the typical piston compressors, scroll compressors have a longer operating life and are quieter. According to some reports, heat pumps with scroll compressors provide 10° to 15°F (5.6° to 8.3°C) warmer air when in the heating mode, compared to existing heat pumps with piston compressors.

Although most heat pumps use electric resistance heaters as a backup for cold weather, heat pumps can also be equipped with burners to supplement the heat pump. Back-up burners help solve the problem of the heat pump delivering relatively cool air during cold weather and reduces its use of electricity. There are few heat pump manufacturers that incorporate both types of heat supply in one box, so these configurations are often two smaller, side-by-side, standard systems sharing the same ductwork. The combustion fuel half of the system could be propane, natural gas, oil, or even coal and wood.

In comparison with a combustion fuel-fired furnace or standard heat pump alone, this type of system is also economical. Actual energy savings depend on the relative costs of the combustion fuel relative to electricity.

Adapted from <https://www.energy.gov/energysaver/heat-and-cool/heat-pump-systems/geothermal-heat-pumps>

4. Answer the following questions.

1. Why are heat pumps so essential in modern industry?
2. How many types of heat pumps exist?
3. What are the main functions of heat pumps?
4. Why are heat pumps so efficient in comparison to standard compressors?
5. What advanced features are typical for modernized samples of heat pumps?

5. Find English equivalent in the text.

1.	тепловий насос з джерелом	6.	працювати на повну потужність
----	---------------------------	----	-------------------------------

	повітря		
2.	автоматичні заслінки	7.	осушувати
3.	працювати на повну швидкість	8.	бути оснащеним пальниками
4.	температура замерзання	9.	типовий поршневий компресор
5.	холодоагент	10.	виробляти тепло

6. Explain the meaning of the following expressions.

1.	scroll compressor	6.	dual-speed motors
2.	desuperheater-equipped heat pump	7.	at any particular moment
3.	comfortable velocity	8.	to improve the performance of heat pumps
4.	automatic dampers	9.	residential systems
5.	reduces compressor wear	10.	absorption heat pump

IMPROVE YOUR VOCABULARY

1. Match the words with their definitions.

1.	reliable	a)	to break the back of the problem
2.	to reduce	b)	ventilator
3.	customer	c)	supply
4.	capacity	d)	work/run
5.	to operate	e)	absorb
6.	fans	f)	client
7.	to provide	g)	be contingent on
8.	to solve	h)	dependable
9.	to incorporate	i)	volume
10.	to depend on	j)	to lessen

2. Choose the word or word combination from the text above to fill in the gaps.

Air-source heat pumps are also available in a ductless version called a **1** _____ pump. The most common type of heat pump is the **2** _____, which transfers heat between your house and the outside air. There are three types of heat pumps: **3** _____, water source, and geothermal. Heat pumps use **4** _____ to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. Air-source heat pump technology **5** _____ so that it now offers a legitimate space heating alternative in colder regions.

Geothermal (or ground source) heat pumps can **6** _____ energy use by 30%-60%, control **7** _____, are sturdy and reliable, and fit in a wide variety of homes.

3. Choose the most suitable word to fill in the gaps.

ELECTRIC CHARGES

Normally, everybody contains equal numbers of protons and **1** _____. It is possible to remove electrons from a body or **2** _____ electrons to it. A body that contains unequal numbers of electrons and protons is said to be electrically **3** _____. A body that contains more than its normal **4** _____ of electrons is said to be negatively charged. A body that contains less than its normal number of electrons is said to be positively charged. The charging is almost invariably accomplished by the addition or **5** _____ of electrons. For example, if a glass rod is rubbed with a piece of silk, the silk will rub electrons off the surface of the glass and therefore leave it **6** _____ charged. The silk will be negatively charged, since it carries the electrons that it removed from the glass.

Two pieces of silk treated in this way will repel each **7** _____ and so will two pieces of glass. But between the glass and the silk there is attraction. That is, like charges repel each other and unlike charges **8** _____ each other.

Repulsion between like charges and attraction between unlike charges made **9** _____ of the repulsions and attractions between individual excess protons and electrons. Bodies which are not electrically charged, that is, which contain equal

numbers of protons and electrons, neither attract nor repel each other in this way, because the forces of attraction and repulsion are in equilibrium.

The nucleus of an atom, since it contains all the protons of the atom, is always positively charged. The **10** _____ of electrons surrounding the nucleus constitutes a negative charge of electricity and is presumably held in place by the force of attraction between itself and the positively charged nucleus.

1	A. neutrons	B. electrons	C. protons
2	A. add	B. attach	C. match
3	A. loaded	B. inspired	C. charged
4	A. amount	B. sum	C. number
5	A. replacement	B. removal	C. substitution
6	A. negatively	B. positively	C. neutrally
7	A. other	B. another	C. different
8	A. catch	B. attract	C. capture
9	A. up	B. off	C. in
10	A. bouquet	B. bunch	C. cluster

TRANSLATION PRACTICE

Translate the following sentences into English.

1. Високоєфективні теплові насоси також краще осушують порівняно з стандартними кондиціонерами, що в свою чергу призводить до меншого споживання енергії та більшого комфорту при охолодженні в літній період.
2. Теплові насоси використовують електроенергію для того, щоб перемістити тепло з прохолодного місця в тепле, роблячи холодний простір ще холоднішим, а теплий теплішим.
3. Існує три типи теплових насосів: повітряний, водний та геотермальний.
4. Сучасний тепловий насос може скоротити споживання електроенергії приблизно на 50% .

5. Технологія повітряних теплових насосів вдосконалилася, тому в холодних регіонах пропонують уже законну альтернативу опаленню приміщень.
6. Установка геотермальних теплових насосів коштує дорожче, вони характеризуються низькими експлуатаційними затратами оскільки мають переваги при відносно постійній температурі води та повітря.
7. Поглинаючі теплові насоси використовують тепло як джерело енергії та можуть працювати з широким спектром теплових джерел.
8. Ряд певних нововведень служать для покращення роботи теплових насосів.
9. Системи управління зонами, які часто зустрічаються у великих будинках, використовують автоматичні заслінки, щоб дозволити тепловому насосу підтримувати в різних кімнатах різну температуру повітря.
10. Деякі моделі теплових насосів оснащено двигунами зі змінною швидкістю.

IDIOMATIC LANGUAGE

1	to run out of steam	a	to waste time and effort creating something that already exists
2	to push someone's buttons	b	to prevent something from continuing or happening
3	to reinvent the wheel	c	to provoke someone
4	to pull the plug	d	to panic or take emergency measures
5	to hit the panic button	e	to lose enthusiasm

1. The more George _____, the busier and more full of beans Alice seemed to get.
2. Noone will be able _____ like your children, but it's all a part of the adventure of parenthood.

3. Some of these ideas are worth pursuing, but there is no need _____.
4. The banks have the power _____ on the project.
5. Instead of _____ developing _____ a strategy to find and release the truth 'the media department _____ and went into lockdown.

GRAMMAR REVISION

1. Put the verbs in brackets into the correct Infinitive or Gerund form.

You can find grammar material about Infinitive and Gerund in Appendix A.

1. Simon was the last person _____ (arrive) at the office.
2. She can't get used to _____ (work) for such a large company.
3. Peter denied _____ (break) his invention.
4. She refused _____ (answer) the question during the conference.
5. It was kind of him _____ (help) me to install the heat pump.
6. The company doesn't mind _____ (exhibit) his latest invention.
7. We allow customers _____ (try) each of the devices available here.
8. He is too young _____ (be) an inventor of these neon lamps.
9. We offer you _____ (become) a member of our perspective business team.
10. I'll take an instruction _____ (read) an information about geothermal heat pumps.

2. Match phrases to make grammatically correct sentences.

1	Sue has decided to apply	a)	to write several companies
2.	Her mother advised her	b)	meet new people
3	She would like	c)	going on the interview because of illness
4	Working in a big company, she can	d)	for a new job

5.	She denied	e)	to understand the principle of engine's operation
6	She is reading a lot of books	f)	making her business more lucrative
7	She is thinking of	g)	to work for a large company

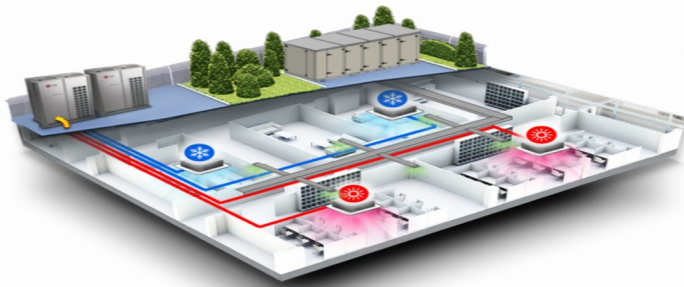
SPEAKING

You are going to participate in the international conference “Energy Matters”. Prepare a short presentation on the heat pumps use. You can include the following items in your presentation:

- *how heat pumps work*
- *types of heat pumps*
- *improving heat pumps efficiency*
- *cost and efficiency*

LISTENING

How a VRF Heat Pump works



1. Explain the meaning of the following words and expressions before watching a video.

evolve	pump systems	ductwork
--------	--------------	----------

system simplicity	refrigerant	air distributor
thermostat	provide heat	cooling system

2. Watch the video *How a VRF (Variable Refrigerant Flow) Heat Pump works* (https://www.youtube.com/watch?v=4YKrGEPg-Oo&ab_channel=GeorgiaPower) and say about challenges in meaning.

3. Watch the video again and fill in the gaps.

1. Over the last _____ years heat pump technology has continued to evolve and today homeowners can choose from a variety of systems that best fit their needs.
2. Today, homeowners can choose from a variety of systems that best _____ their needs.
3. Commonly known as a _____ heat pump or ductless heat pump, the VRF system uses a single outdoor condensing unit to connect with one or more indoor air handlers.
4. Each zone has its own _____ and when needed multiple air handlers can be controlled as separate cells providing the right amount of heat or conditioned air for that zone.
5. There is minimal energy _____ compared to thirty to forty per cent energy loss with traditional forced air systems.

4. Find the information in the video.

1. What is the reason for heat pump technology revolving?
2. Where can we install a VRF heat pump?
3. Explain the process of cooling or heating the room.

WRITING

You would like to get a job as a heat power engineer in “Energy EbCo” a leading company in the energy sector. You are asked to speak about your vision of the heat pump efficiency improvement. Try to make a great impression on a potential employer. Write a short essay (200 - 250 words).

SUPPLEMENTARY TEXT

10 GREATEST INVENTIONS OF NIKOLA TESLA

Vocabulary:

elaborate – розробляти

panned out – бути передовим

to receive the recognition of – отримати визнання з боку

chief rival – основний суперник

capacitor – конденсатор

electric currents – електричний струм

be obsessed with – бути одержимим

piston engine – поршневий двигун

spun – закручений

a chamber – камера

combustion – згорання

to rotate – обертати

a film – фотоплівка

contribution – вклад, внесок

look for – шукати

to spin – обертатися

feasible – здійснено

a rift – розкол

Nikola Tesla was a man with big ideas, if you couldn't tell by the 300 patents to his name. Unfortunately, he was way ahead of his time and while a lot of his more elaborate ideas theoretically worked, they never really panned out. Still, while he never received the recognition of his chief rival Thomas Edison, the man was a brilliant inventor who gave the world some amazing and pioneering innovations. Here are some of the most incredible creations of Nikola Tesla.

10. The Tesla Coil

The Tesla coil was invented in 1891 and uses two coils a primary and a secondary, with each coil having its own capacitor. A capacitor, like a battery, stores energy. The coils are connected to a spark gap, which is just open air where the spark can generate, and the result is that the Tesla Coil can shoot lightning bolts, send electric currents through the body and create electron winds.

9. The Magnifying Transmitter

Tesla became obsessed with transferring power without wires and thought it was possible to do it at higher altitudes, so after securing funding he set up a lab in Colorado Springs in 1899. There, he built the largest and most powerful Tesla Coil, called the Magnifying Transmitter. The Magnifying Transmitter had three coils and was 52 feet in diameter. It generated millions of volts of electricity and shot lightning bolts that were 130 feet long – the biggest man-made lightning at the time. The problem was that Tesla was a bit too ambitious for the era, and wireless electricity wouldn't be developed until the mid-2010s, and as of 2015, it's still not yet common in households.

8. The Tesla Turbine

In the early 20th century, the world saw the rise of the piston engine in automobiles. In an attempt to compete against the piston engine, Tesla developed his own turbine. It was bladeless and used smooth discs that spun in a chamber, and worked when fuel was combusted before entering the main chamber that contained the discs. The combustion would make the disks rotate, which ran the engine.

7. Shadowgraphs

In 1895, German scientist Wilhelm Conrad Röntgen discovered mysterious energy that he called X-rays. He noticed that when he placed a photographic film between his hand and a lead screen, it created an image of the bones in his hand on

the film. A short time later, Röntgen went public with his research and the picture of Röntgen wife's hand became famous. In the picture, you can see the bones in her hand and the wedding ring on her finger. There is some evidence that Tesla knew a little bit about X-rays before Röntgen made his research public. Tesla's own research was stopped when a fire destroyed his lab in 1895, shortly before Röntgen discovered the technology.

6. Radio

The inventor of the radio is a point of contention. In 1895, Tesla was getting ready to transmit a radio signal a distance of 50 miles but before he could do that, his lab burned down, delaying the test. Meanwhile in England, an Italian man named Guglielmo Marconi was working on wireless telegraphy, and was granted a patent in 1896 for his device. His system was much different than the one Tesla built, using only two circuits but unable to transmit over long distances. Tesla's invention would use multiple circuits, which would make it much stronger. Tesla submitted his patent in 1897 in the United States, and it was granted in 1900. When Marconi submitted his radio patent in 1900 to the U.S. Patent Office, it was turned down because it was too similar to Tesla's. Undeterred, Marconi opened his own company that had powerful backers, including Andrew Carnegie and Thomas Edison. In 1901, while using a number of Tesla's patents, including a Tesla oscillator, Marconi was able to transmit a signal across the Atlantic. In 1904, without giving a clear reason, the patent office reversed their decision and said that Marconi's patent was valid, making him the inventor of the radio. Marconi won the Nobel Prize in 1911 and in 1915, Tesla sued Marconi's corporation. Unfortunately, at that point in his life, Tesla was too poor to take on a major corporation. The case wasn't settled until a few months after Tesla's death in 1943, when the Supreme Court upheld Tesla's patent...

Adapted from <https://www.linkedin.com/pulse/10-greatest-inventions-nikola-tesla-sultan-zafar>

1. Answer the questions to the text.

1. What inventions is Nicola Tesla famous for?
2. What invention do you consider to be the most important?
3. Who was his chief rival in the field of innovations?
4. When was the first shadowgraph discovered?

2. Find information about Ukrainian great inventors of the 20th century. Make a short presentation.

WORKING WITH VISUAL INFORMATION

1. Read information about a bar graph description.

Tips

1. In the first paragraph, give basic details about the chart including what it shows, where it refers to and when.
2. When you describe chart data, be specific. Mention the category and figure, e.g. Online video streaming was the most popular format in 2017. US consumers spent \$9.8 billion ...
3. A trend is a change over time. To describe trends, focus on what is increasing or decreasing compared to some time in the past, e.g. ... which was a rise of 32 per cent from the previous year.
4. If several categories show the same trend, talk about them together, e.g. customers were moving away from the three physical formats in the chart.
5. State the units of measurement, e.g. US consumers spent \$9.8 billion.
6. Many of the verbs for up and down trends can also be used as nouns, e.g. Spending fell by 21 per cent = There was a 21 per cent fall in spending. (You can write % or per cent, but be consistent.)
7. Write a conclusion. Say what we learn from the data overall.

<https://learnenglish.britishcouncil.org/sites/podcasts/files/LearnEnglish-Writing-B1-Describing-a-bar-chart.pdf>

2. Put these words and expressions in the correct group in the table below.

to grow	to remain at (+ number)	to jump up	to drop
to fall	to increase	to decrease	to decline
to be steady	to be unchanged	to rise	to be constant

To go up	To go down	To stay the same

3. Complete the second sentence so that it has the same meaning as the first. Write a noun or verb related to the verb or noun in the first sentence.

1. There was a 31 per cent rise in spending.

Spending _____ by 31 per cent.

2. DVD sales dropped 14 per cent.

There was a 14 per cent _____ in DVD sales.

3. There was a 60 per cent fall in prices.

Prices _____ by 60 per cent.

4. The temperature increased by 15 degrees.

There was a 15-degree temperature _____.

5. There was no decline in sales revenue.

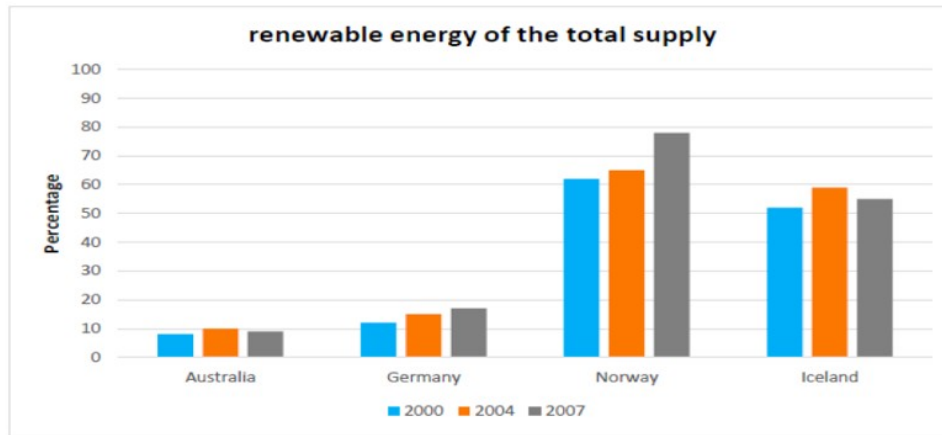
The sales revenue did not _____.

6. The population grew by 20 per cent.

There was population _____ of 20 per cent.

4. Describe the graph below that shows the proportion of renewable energy of the total supply of the total supply.

The graph below shows the proportion of renewable energy of the total supply in 2000, 2004 and 2007.



SMILE

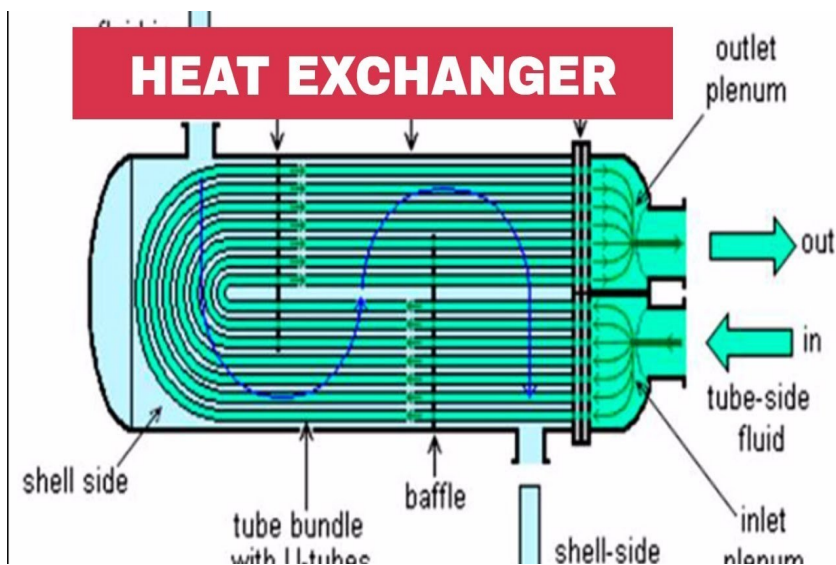
In order to get to the valves, a mechanic carefully removed the engine parts from a car while the car owner - a surgeon looked on.

Afterwards, the mechanic said to the surgeon: 'You know, I reckon my line of work is every bit as difficult and skilled as yours.' 'Perhaps,' said the surgeon, 'But I'd like to see you do it while the engine is running

UNIT 5. HEAT EXCHANGER

LEAD-IN

1. Look at the picture. What does it show?
2. What is a heat exchanger?
3. What is the purpose of heat exchanger usage?



READING and VOCABULARY

1. Before reading the text, discuss the efficiency of heat exchangers installing?
Classify heat exchangers by the flow configuration.
2. Study the following words in the box and explain their meaning/

to drift from	waste gases	a gas central heating furnace
smokestack	gas boiler	gas jet
to wonder	refrigerator	flow through
costly problem	to heat up	water pump
Salvage	air-conditioner	to transfer

3. Read the text and be ready to answer the questions.

HEAT EXCHANGERS

Have you ever watched wisps of smoke drifting from smokestacks and wondered how much energy they are uselessly pumping into the air? Maybe less than you might think! Saving energy is a huge and costly problem for factory bosses and it's one reason they often install devices called heat exchangers to salvage as much heat as possible from waste gases. Heat exchangers have lots of other familiar uses too. Engines in cars, ships, and planes use heat exchangers to work more efficiently, gas boilers use them to heat up hot water, and if you have a refrigerator or an air-conditioner in your home, those are using heat exchangers too. So what exactly are heat exchangers and how do they work? Let's take a closer look!

Suppose you have a gas central heating furnace (boiler) that heats hot-water radiators in various rooms in your home. It works by burning natural gas, making a line or grid of hot gas jets that fire upward over water flowing through a network of pipes. As the water pumps through the pipes, it absorbs the heat energy and heats up. This arrangement is what we mean by a heat exchanger: the gas jets cool down and the water heats up.

A heat exchanger is a device that allows heat from a fluid (a liquid or a gas) to pass to a second fluid (another liquid or gas) without the two fluids having to mix together or come into direct contact. If that is not completely clear, consider this. In theory, we could get the heat from the gas jets just by throwing cold water onto them, but then the flames would go out! The essential principle of a heat exchanger is that it transfers the heat without transferring the fluid that carries the heat.

You can see heat exchangers in all kinds of places, usually working to heat or cool buildings or helping engines and machines to work more efficiently. Refrigerators and air-conditioners, for example, use heat exchangers in the opposite way from central heating systems: they remove heat from a compartment or room where it's not wanted and pump it away in a fluid to some other place where it can be dumped out of the way. The cooling fluid is completely sealed inside a network of

pipes, so it never actually comes into contact with the air: it takes heat energy from the air inside and dumps it in the air outside, but it never mixes directly with that air.

In power plants or engines, exhaust gases often contain heat that's heading uselessly away into the open air. That's a waste of energy and something a heat exchanger can certainly reduce (though not eliminate entirely - some heat is always going to be lost). The way to solve this problem is with heat exchangers positioned inside the exhaust tail pipes or smokestacks. As the hot exhaust gases drift upward, they brush past copper fins with water flowing through them. The water carries the heat away, back into the plant. There, it might be recycled directly, maybe warming the cold gases that feed into the engine or furnace, saving the energy that would otherwise be needed to heat them up. Or it could be put to some other good use, for example, heating an office near the smokestack.

In buses, fluid used to cool down the diesel engine is often passed through a heat exchanger and the heat it reclaims is used to warm cold air from outside that is pumped up from the floor of the passenger compartment. That saves the need for having additional, wasteful electric heaters inside the bus. A car radiator is another kind of heat exchanger. Water that cools the engine flows through the radiator, which has lots of parallel, aluminum fins open to the air. As the car drives along, cold air blowing past the radiator removes some of the heat, cooling the water and heating the air and keeping the engine working efficiently. The radiator's waste heat is used to heat the passenger compartment, just like on a bus.

If you have an energy-efficient shower, it might have a heat exchanger installed in the wastewater outlet. As the water drips past your body and down the plug, it runs through the copper coils of a heat exchanger. Meanwhile, cold water that's feeding into the shower to be heated pumps up past the same coils, not mixing with the dirty water but picking up some of its waste heat and warming slightly - so the shower doesn't need to heat it so much.

All heat exchangers do the same job - passing heat from one fluid to another - but they work in many different ways. The two most common kinds of heat exchanger are the shell-and-tube and plate/fin. In shell and tube heat exchangers, one

fluid flows through a set of metal tubes while the second fluid passes through a sealed shell that surrounds them. That's the design shown in our diagram up above. The two fluids can flow in the same direction (known as parallel flow), in opposite directions (counter flow or counter-current), or at right angles (cross flow). Boilers in steam locomotives work this way. Plate/fin heat exchangers have lots of thin metal plates or fins with a large surface area (because that exchanges more heat more quickly); heat exchangers in gas furnaces (gas boilers) work this way.

<https://www.explainthatstuff.com/how-heat-exchangers-work.html>

4. Answer the following questions.

1. Why are heat exchangers so essential in modern industry?
2. How many types of heat exchangers exist?
3. Describe the main principle of heat exchangers' operation.
4. Define main functions of heat exchangers.

5. Find English equivalent in the text.

1.	водонагрівальні радіатори	6.	система центрального опалення
2.	система трубопроводу	7.	відводити тепло з відсіку чи кімнати
3.	поглинати теплову енергію	8.	охолоджувальна рідина
4.	полум'я	9.	вихлопні гази
5.	основний принцип роботи теплообмінника	10.	підніматися вгору

6. Explain the meaning of the following expressions.

1.	common kinds of heat exchanger	6.	an energy-efficient shower
2.	shell and tube heat exchanger	7.	wastewater outlet
3.	a sealed shell	8.	the copper coils

4.	to flow in the same direction	9.	to cool down the diesel engine
5.	to flow in opposite directions	10.	wasteful electric heater

IMPROVE YOUR VOCABULARY

1. Find synonyms in the text to the following words and match them.

1.	to cool down	a	boiler
)	
2.	to salvage	b	refrigerate
)	
3.	to heat up water	c	get into touch with
)	
4.	a gas central heating furnace	d)	warm
5.	to absorb	e	transport
)	
6.	a fluid	f)	save
7.	to throw smth. onto	g	assimilate
)	
8.	essential	h	main/inherent
)	
9.	to transfer	i)	hurl
10.	to come into contact with	j)	liquid

2. Choose the word or phrases from the text above to fill in the gaps.

- Saving energy is a huge and _____ problem for the factory.
- As the water pumps through the pipes, it _____ the heat energy and heats up.
- A heat exchanger is a device that allows heat from a _____ to pass to a second

4. fluid without the two fluids having to mix together or come into direct contact.
5. You can see heat exchangers in all kinds of places, usually working to heat or _____ buildings or helping engines and machines to work more efficiently.
5. In power plants or engines, _____ gases often contain heat that's heading uselessly away into the open air.
6. In buses, fluid used to cool down the diesel _____ is often passed through a heat exchanger.

3. Choose the most suitable word to fill in the gaps.

ELECTRIC CIRCUIT

An electric **1** _____ is a collection of electrical devices and components connected together for the purpose of processing information or energy in electrical form. An electric circuit may be described mathematically by ordinary differential equations, which may be linear or nonlinear, and which may or may not be time varying.

Electric Charge. In circuit theory, we postulate the existence of an indivisible unit of **2** _____. There are two kinds of charge, called *negative* and **3** _____ charge. The negatively charged particle is called an **4** _____. Positive charges may be atoms that have lost electrons, called **5** _____; in crystalline structures, electron deficiencies, called *holes*, act as positively charged particles.

Voltage. The **6** _____ of charged particles either requires the expenditure of energy or is accompanied by the release of energy. The voltage, at a point in space, is **7** _____ as the work per unit charge (joules/coulomb) required to **8** _____ a charge from a point of zero voltage to the point in question.

Sources of Voltage or Electric Potential Difference. A voltage is caused by the **9** _____ of opposite electric charges and represents the work per unit charge (joules/coulomb) required to move the charges from one point to the other. This separation may be forced by physical motion, or it may be initiated or complemented by thermal, **10** _____, magnetic, or radiation causes.

1.	A. square	B. circuit	C. triangle
2.	A. charge	B. load	C. fill
3.	A. neutral	B. negative	C. positive
4.	A. ion	B. proton	C. electron
5.	A. neutron	B. ions	C. proton
6.	A. act	B. motion	C. move
7.	A. defined	B. named	C. called
8.	A. act	B. move	C. run
9.	A. separation	B. division	C. divorce
10	A. physical	B. biological	C. chemical

TRANSLATION PRACTICE

1. Translate into English.

1. Усі теплообмінники виконують одну і ту ж роботу – передають тепло від однієї рідини до іншої – проте всі вони працюють за різним принципом.
2. Ви можете побачити теплообмінники в різноманітних місцях, які зазвичай працюють для обігріву чи охолодження приміщень або допомагають двигунам та техніці працювати ефективніше.
3. Ці дві речовини можуть текти в одному напрямку (що має назву паралельний потік), або в протилежному (що має назву зустрічний потік або протиструм) чи під прямим кутом (перехресний потік).
4. Вода, яка охолоджує двигун, протікає через радіатор, що має безліч паралельних ребер.
5. На електростанціях або ж у двигунах, відпрацьовані гази часто містять тепло, яке марно виходить у відкрите повітря.
6. Охолоджуюча рідина повністю закрита та знаходиться в системі труб.
7. Наприклад, холодильники та кондиціонери використовують теплообмінники у зворотньому напрямку від системи центрального опалення.

8. Основним принципом роботи теплообмінника є те, що він передає тепло не передаючи рідину, яка несе це тепло.
9. Котел працює, спалюючи природний газ та створюючи лінію чи сітку струменів гарячого газу, що піднімається над водою та тече по всій системі труб.
10. Якщо у вас встановлено енергоефективний душ, він може мати теплообмінник, який встановлено на виході стічних вод.

IDIOMATIC LANGUAGE

1. Match two parts of the idiom and complete the sentences below using these expressions.

1.	it's not rocket science	a)	to stay quiet
2.	to blow a fuse	b)	in agreement or harmony with someone or something
3.	to button your lip	c)	very intelligent
4.	as bright as a button	d)	it's not difficult
5.	in tune with	e)	to lose your temper

- _____ to ask all workers to work to their strengths.
- She was _____ and sharp as anything. If it had been her running the company, it might still be OK.
- He is more _____ his players today, because he has asked them for their opinions.
- For all my experience, I _____ in the quarter-final and could have been sent off.
- He had the grace and good sense _____, even though this clearly caused him personal pain.

GRAMMAR REVISION

1. Put the verbs in brackets into the correct tense using Conditional Sentences.

You can find grammar references in Appendix A.

1. If you had locked the door, the burglars _____ (to break) into the lab.
2. If I were you, I _____ (to ask) for help in this experiment.
3. If I _____ (to take) out the loan in the bank, I will develop my own business.
4. Hurry up, or else we _____ (to be late) for the negotiations.
5. If I see him today, I _____ (to say) to call you back.
6. If he _____ (to finish) his project on time, he would have got a promotion.
7. If they had been more careful during the experiment, they _____ (to stay alive).
8. If they miss the train, they _____ (to have) no possibility to introduce their latest invention.
9. If you _____ (to apply) for this vacancy earlier, you would have been involved in this colossal project.
10. It stocks _____ (to rise) in the market, we will be on the verge of collapse.

2. Match phrases to make grammatically correct sentences.

1.	If the supply cord is damaged,	a)	start on a ramp in order to keep better
2.	If you don't want unpredicted situations,	b)	you would not have burnt yourself by touching the hot surface of the appliance
3.	If you had been more careful,	c)	I would make a breakthrough in electrical engineering
4.	If I were more accurate,	d)	it must be replaced by the manufacturer
5.	If you want to balance on the monowheel,	e)	keep the appliance and its cord out of reach of children aged less than

		8 years
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SPEAKING

You are invited to make a report on advanced heat exchangers at the international conference. Study the issue and create a presentation. You can include the following items in your presentation:

- *how heat exchangers work*
- *types of heat exchangers*
- *the benefits you get from installing heat exchangers*
- *how to improve the efficiency of heat exchangers*

LISTENING

What is a Heat Exchanger

1. Explain the meaning of the following words and phrases before watching the video.

dissipate from	high capacity	pump back
to come into direct contact	high maintenance	a liquid cooling loop
corrugation	the coolant	pump through

2. Watch the video What is a Heat Exchanger?

<https://www.youtube.com/watch?v=WYJ9BsCrifQ>) and say about challenges in meaning.

3. Watch the video again and fill in the missing gaps.

1. A heat exchanger is a device that allows heat from a _____ to pass to another liquid or gas without the two fluids having to mix or come into direct contact.
2. Closed loop liquid cooling is defined as a high _____, high maintenance cooling system that uses liquid as the coolant and a heat exchanger for heat removal from the coolant.
3. In a liquid cooling loop, the _____ is pumped through a cold plate that is in contact with a hot integrated _____.
4. For efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing _____ to fluid flow through the exchanger.
5. Performance of the exchanger can also be affected by the addition of fins or _____ in one or both directions, which increases surface area for enhanced thermal transport.

4. Find the information in the video.

1. What are heat exchangers used for?
2. How is defined closed loop liquid cooling in the video?
3. What are the most commonly used coolants?
4. What happens with coolants in the liquid cooling loop?

WRITING

Local authorities are going to organize an auction where all scholars and researchers will have a possibility to introduce their latest inventions. The main condition for taking part in this event is to write down an argumentative essay to

the organizers of the auction and persuade them that your invention is worth being exhibited. Write a short essay (200-250 words).

PROJECT WORK

PROJECT C. SELF-EFFICIENT COMMUNITY

1. Test Your Energy Efficiency Knowledge.



Electric Power Management System for Self-sufficient Operation

1. Which of these is an effective way to improve energy efficiency for air conditioning?
 - A. Using portable heaters as well as air conditioning
 - B. Dressing for the seasons: heavier in winter and lighter in summer
 - C. Opening doors and windows when heating is on
 - D. Turning the air conditioning higher than needed to help it warm up quicker

2. Which of these is NOT a step in the energy audit process?
 - A. Observation
 - B. Analysing the data
 - C. Assessing health and safety
 - D. Formulating a plan of action

3. Which of these types of bulbs are the most efficient?
- A. LED
 - B. Incandescent
 - C. CFL
 - D. Halogen
4. Why should you analyse the building itself during an energy audit?
- A. To see if extra overhead lighting can be installed
 - B. To check for areas from which draughts are originating
 - C. To make sure it is presentable
 - D. To ensure all windows are closed at all times
5. Why is using an energy management system effective?
- A. It enables you to monitor individual users' energy usage and penalise them for any wastage
 - B. It enables you to schedule energy audits so employees are prepared to reduce their usage during the audits
 - C. It cuts energy consumption in half by automatically setting equipment to energy-saving settings
 - D. It enables you to effectively configure equipment and track energy usage throughout the building

<https://www.highspeedtraining.co.uk/hub/energy-efficiency-quiz/>

2. Study information given in the project instructions. Plan and create your own energy-efficient community. Present your ideas to the class (See Appendix C, Project C).

SUPPLEMENTARY TEXT

THE 10 GREATEST INVENTIONS OF NIKOLA TESLA

Vocabulary:

contribution – вклад, внесок

look for – шукати

to spin – обертатися

feasible – здійснено

a rift – розкол

5. Neon Lamps

While fluorescent and neon lights weren't discovered by Tesla, he did make many contributions to the advancement of both. What's interesting is that no one working with cathode rays, which are the electrons observed in vacuum tubes like neon lights, really came up with a practical application for the technology. Tesla saw an opportunity and experimented with running electrical particles through gases, developing four different types of lighting. For example, he converted black light into visible light using a phosphorescent substance (which he created), and also found a practical use for such a technology when he created lamps and neon signs.

4. The Adams Power Plant Transformer House

The Niagara Falls Commission was looking for a company to build a hydroelectric plant that would harness the mighty power of the falls for years. At first, they considered Thomas Edison's direct current plant, but after witnessing Tesla's alternating current that was offered by Westinghouse Electric, Westinghouse was offered the contract in 1893. Westinghouse used designs from Tesla but a big hurdle remained on the front of getting and keeping funding for such an ambitious task that a lot of people doubted would work. Yet when the switch was flipped on November 16, 1896, the Adams Power Plant Transformer House worked and started powering the city of Buffalo, New York. Ten more generators were built, and

helped power New York City. The plant was considered revolutionary and set the standard for modern hydroelectric power plants.

3. The Induction Motor

An induction motor uses alternating current and essentially has two parts – a stator and a rotor. The stator stays stationary and uses electromagnets to spin the rotor that’s in the middle. Induction motors are noted for being durable, easy to maintain and cheap to run. In the 1880s, there were two people who were working separately on the induction motor: Tesla and Galileo Ferrari. They both presented their findings in 1888, with the Italian inventor Ferrari presenting his engine two months before Tesla presented his. However, Tesla’s patents held up under the weight of the evidence. Both had developed the same technology and came to the same independent conclusion, but Tesla had filed his patents first. The induction motor was incredibly influential and is still used in everyday products like vacuums, blow dryers, and power tools.

2. Teleautomaton

In 1898, at the Electrical Exhibition at Madison Square Garden, Tesla showed off an invention he called “teleautomaton“, which was a boat controlled by radio waves. He didn’t even have a patent because the patent office didn’t want to issue one on something that they didn’t think was feasible, but he proved them wrong at the exhibition. Tesla controlled the battery operated boat, operating the propellor and lights through the radio waves. This invention was a big first in three different areas. The first was remote controls, influencing the development of objects like television remotes and garage door openers. Secondly, the boat was also one of the earliest robots, as it was a mechanical object that could be controlled without a human physically touching it. Finally, the combination of robotics and radio control technology makes Tesla’s boat the great grandfather of drones.

1. Alternating Current

Without question, the most important inventions from Nikola Tesla involve his contributions to alternating current (AC). It's essential to note that he did not invent or even discover AC, but his inventions made AC applicable for widespread use, helping to electrify the world. The story of how Tesla's AC current came to be the dominant power system is impossible to tell without talking about Thomas Edison. In his early career Tesla worked for Edison, whose company had developed direct current (DC). DC is similar to a battery, in that it only sends power out. The problem with DC is that the electricity loses power as it gets farther out. That's when Tesla developed his advancements in AC, which not only sends power out, but also brings power back to the source. This made it much more feasible to send large amounts of energy over a large area. Edison hated AC and thought that Tesla was completely wrong on the topic, leading to a rift between the two. While Tesla was unemployed, he worked odd jobs until he was able to raise money for the Tesla Electric Company. His work caught the attention of engineer and businessman George Westinghouse, who bought most of Edison's patents involving AC.

Adapted from <https://www.linkedin.com/pulse/10-greatest-inventions-nikola-tesla-sultan-zafar>

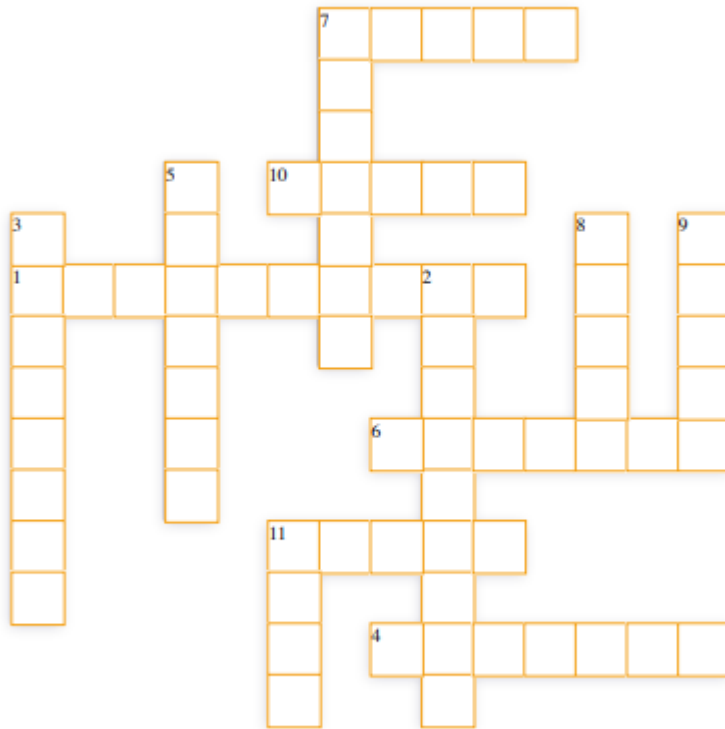
1. Answer the questions to the text.

1. How did Tesla discover neon lamps?
2. What was the Niagara Falls Commission looking for?
3. What was a boat called "Teleautomaton" controlled by?

2. Work in pairs. Make a list of the most essential and vital innovations of the 21th century. Prove your choice and present the results of your discussion to your colleagues. Complete the table to arrange your ideas.

Innovation	Field of Application	Improvements	Notes
1.			
2.			
3.			

CROSSWORD PUZZLE



Across

- 1. The whole mass of air that surrounds the Earth.
- 4. A region with particular weather patterns or conditions.
- 6. To send (used newspapers, bottles, cans, etc.) to a place where they are made into something new.

7. To rot or decompose; also, to decline in quality, energy, etc. 10. Gases and vapor (usually harmful).

11. Produced by or using the sun's light or heat.

Down

2. Restored or replaced by natural processes.

3. A system in which waste materials are buried under the ground.

5. The gradual destruction of something by natural forces (such as water, wind, or ice) : the process by which something is eroded or worn away.

7. The continuous absence of rain, thus causing the land to dry up.

8. Containing poisonous substances.

9. Material that is left over or that is unwanted after something has been made, done, used, etc..

11. Polluted air which is a mixture of smoke and fog.

Here are the words from the crossword:

atmosphere climate decay drought erosion landfill fumes recycler renewables smog solar toxic waste

<https://www.esleschool.com/b2-environment-crossword/>

SMILE

An electrical engineer, mechanical engineer, and software engineer are on their way to a trade show when their car stalls and they are forced to pull over to the side of the road.

The mechanical engineer says, "It's probably a mechanical problem. I'll get my tool box out of the trunk and I can fix it."

The electrical engineer says, "No, I'll bet it's an electrical problem. I have my multimeter with me and I'll go check it out."

Finally, the software engineer says, "I have the solution! Let's all get out of the car and then get back in. I'll bet we'll be back on the road in no time."

SELF-CHECK FOR UNITS 4 – 5

1. Choose an appropriate word to fill in the gap.

1. Zone control systems, often found in larger homes, use automatic **1** _____ to allow the heat pump to keep different rooms at different temperatures.
2. Another advance in heat pump technology is the scroll compressor, which consists of two **2** _____-shaped scrolls.
3. Heat pumps use electricity to **3** _____ heat from a cool space to a warm space, making the cool space cooler and the warm space warmer.
4. Absorption heat pumps use heat as their energy **4** _____ and can be driven with a wide variety of heat sources.
5. During the **5** _____ season, heat pumps move heat from the cool outdoors into your warm house.

- | | | | |
|----|----------------|-------------|------------|
| 1. | A. valve | B. dampers | C. shutter |
| 2. | A. circle | B. oval | C. spiral |
| 3. | A. move | B. place | C. push |
| 4. | A. consumption | B. resource | C. source |
| 5. | A. heating | B. cooling | C. warming |

2. Decide whether the sentences are true (T) or false (F).

1. The biggest advantage of plate heat exchangers compared to other heat exchangers is their heat transfer consumption.
2. Plate heat exchangers basically consist of three inlet ports, ducted heat transfer plates and two outlet ports.
3. Air-to water heat exchangers are a very simple and reliable cooling and/or heating option for smaller spaces with basic climate control needs.
4. Plate heat exchangers are not only efficient but also provide the formation of deposits and dirt that can accumulate over time.

5. Water that cools the engine flows through the radiator, which has lots of parallel, aluminum fins open to the air.

3. Put the verb into correct tense.

1. Let me _____(help) you with your research.

2. If you _____(freeze) water, it _____(turn) into ice.

3. You had better _____(take part) at this conference.

4. Gail _____(get) better results, if she _____(work) harder these days.

5. If they _____(tell) me what to expect during this experiment, I _____(not ask) these questions after.

APPENDICES

Appendix A. Grammar References

Unit 1. Complex Object/ Complex Subject

Complex Object

Subject	Verb	Object (noun/ objective pronoun)	Infinitive
---------	------	--	------------

We use Complex Object after

1. Verbs of perception (we use without TO) to hear to see to watch to feel to observe to notice	4. Verbs of feeling and emotions to like to love to hate
2. Verbs for mental activity to know to think to consider to expect to imagine	5. Verbs of order, permission to order to allow to make to get to have to permit
3. Declarative verbs: to pronounce to declare to report	

Examples:

1. I watched you win.
2. He thinks this question to be of great importance.
3. Mike declared the shop opened.
4. Chief allowed her to leave the work earlier today.

Complex Subject

Subject	Verb in Passive Voice	Infinitive
---------	--------------------------	------------

We use Complex Subject after

1. Verbs to know to think to state to report to say to announce	4. After expressions to hate to be likely to be certain to be unlikely to be sure
2. Verbs of assumption to expect to suppose to believe to consider	5. These verbs are used in active voice to appear to seem to happen to prove to turn out
3. Verbs of perception: to see to hear to notice	

Examples:

1. She was thought to be working here.
2. The writer is expected to be famous
3. They were heard to leave the town.
4. The journey turned out to be uninteresting.

Unit 2. Modal Verbs for Necessity

The modal verbs **must**, **have to**, **need to** and **have got to** show that something is not optional; it is necessary.

Must is the strongest and most serious modal verb of the three and is most common in writing. It is unusual to use “must” in questions.

I must study tonight.

Have got to is most common in informal speech. It is not used in questions.

I have got to study tonight. = I must study tonight.

Have to is the most commonly used modal of obligation. It is useful for forming questions and negatives.

Need to, **have to** are often used in the same context, but many times, need to is used to express something that is less urgent, something in which you have a choice.

I have to work late tonight

I need to work late tonight

If something is forbidden

must not / mustn't + base form of the verb

You must not drink and drive.

You mustn't leave medicines where children can find them.

No obligation

We use **don't have to** to show that there is no obligation.

don't / doesn't / didn't + have to + base form of the verb

You don't have to wear a tie in our office. You can wear a tie if you want to but it's OK if you don't.

needn't + base form of the verb You needn't worry about me. I'll be fine.

Unit 3. Participles, Participle Constructions

Participles are words derived from verbs that can function as adjectives or as parts of verb phrases to create verb tenses. There are two types of participles:

Present participle (ending *-ing doing*)

Past participle (done).

Perfect Participle (having done)

Present participles always end in *-ing* and function as adjectives. They help form progressive verb tenses.

Past participles end in *-ed*, or other past tense irregular verb endings, and function as adjectives. They also combine with the verb *to be* to create passive verb forms.

Perfect participles combine *having* with a past participle.

Participial phrases modify the subjects of sentences.

Use:

1. to shorten relative clauses
2. to make one sentence out of two
3. after verbs of ›perception‹ (e.g. *see, watch, hear, listen to, smell, feel*)
4. after verbs of ›rest‹ and ›movement‹ (e.g. *run, go, come, stay, stand, lie, sit*)
5. after the verb *have*
6. instead of a subordinate clause

Examples

1. The cars which are produced in Japan are nice.

The cars **produced** in Japan are nice.

2. I saw the man. He came to the shop.

I saw the man **coming** to the shop.

3. I saw the car **coming** round the corner.

4. The girl sat **sleeping** on the sofa.

5. I have my clothes **washed**.

6. When you go to England you improve your English.

Going to England improves your English.

Unit 4. The Gerund and The Infinitive

The **to-infinitive** is used:

1. To express purpose;
2. After certain words: *refuse, promise, plan, hope, expect, want, decide, agree, etc.*;
3. After adjective which:
 - describe feelings/emotions: *happy/glad*;
 - express willingness/unwillingness;
 - refer to a person's: *mean, clever*;
 - with the adjectives *fortunate* and *lucky*;
4. After such constructions as:
 - It+be+adjective+of+noun/pronoun;
 - It+to be+adjective/noun.
5. After *too/enough*;
to talk about an unexpected event which can be unpleasant, usually with *only*;
after be + the first/second..../next/last/best;
after verbs and expressions such as: *ask, learn, find out, wander, explain, want, decide, etc.* when they are followed be

The **-ing form** is used:

1. As a noun;
2. After certain verbs: *admit, anticipate, appreciate, avoid, consider, continue, delay, deny, discuss, enjoy, escape, excuse, fancy, finish, forgive, imagine, involve, keep, mention, mind, miss, postpone, practice, prevent, recall, recollect, report, resist, risk, save, stand, suggest, understand, etc.*;
3 after: *like/dislike, hate, enjoy, love, prefer* to express general preference.
BUT: *would like/ would love. would prefer* + to-infinitive;
 - after: *spend/waste/lose* (time or money);
 - after prepositions;
 - after such expressions as *be busy, it's no use, it's good, it's worth, what's the use of, can't help, can't stand, there is no point in, have difficulty in, have trouble, have hard time, etc.*;
 - after the preposition "to" with verbs and expressions such as *look forward to, be*

question words (*who, what, where, how, etc.*). *Why* is followed by a subject + verb, not by an infinitive.

NOTE: If to-infinitive are joined with “and”, “to” of the second infinitive can be omitted.

used to, get round to, object to, in addition to, etc.;

- after the verbs: *hear, listen, notice, see, watch, fell* to describe an incomplete action.

BUT: After the verbs: *hear, listen, notice, see, watch, fell* + bare infinitive to describe an complete action.

The **bare infinitive** is used:

1. After modal verbs;

BUT: *ought* is followed by to- infinitive;

2. After *had better/would rather*;

3. After the verbs *let/make/feel/see/hear* in active sentence.

BUT: in passive *be made/be saw/be heard/be felt/be allowed to* + to-infinitive;

4. *Help* is followed by to-infinitive or the bare infinitive.

Unit 5. Conditionals

Type 0 Conditionals (general truth)

If + Present Simple, Present Simple

We use this conditional mood to express something which is always true. We can use *when* instead of *if*.

Type 1 Conditionals (real present)

If + Present Simple/Present

Continuous/Present Perfect/ Present Perfect Continuous, Future Simple/modals

We use this conditional mood to express real or very probable situations the present or future.

NOTE: instead of *was* we use *were*

Type 2 Conditionals (unreal present)

If + Past Simple or Past Continuous, would/could/might + present bare infinitive

We use this conditional mood to express imaginary situations which are contrary to facts in the present, therefore, are unlikely to happen in the present or future.

Type 3 Conditionals (unreal past)

If + Past Perfect/Past Perfect Continuous, would/could/might + perfect bare infinitive.

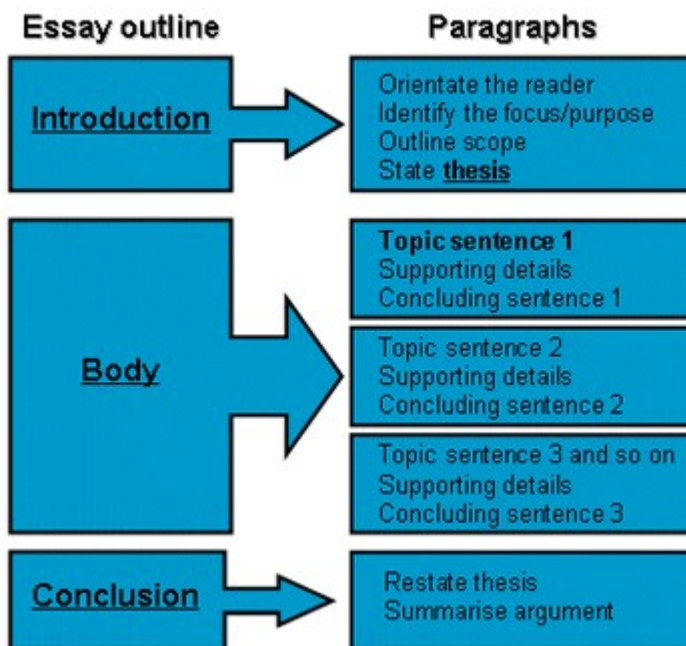
We use this conditional mood to express imaginary situations which are contrary to facts in the past. They are also used to express regrets or criticism.

Appendix B. Essay Writing

Steps for Great Essays

1. Carefully consider the two (or more) texts you're being asked to write about.
2. Make a list of the key similarities and differences in your texts.
3. Isolate the most important points and turn them into your central argument.
4. Write an outline that will form the skeleton of your essay.
5. Fill in textual details to write your essay.
6. Edit!

Essay Structure



ESSAY Writing



Opening:

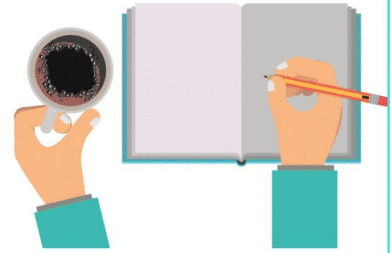
It is often said that.../ Many people claim that...

In this day and age.../ Nowadays.../ These days...

...is a hotly-debated topic that often divides opinion.

It goes without saying that.../ Needless to say,...

The following essay takes a look at both sides of the argument.



Introducing points:

Firstly,.../To start with,.../ First of all,.../ First and foremost,...

Secondly,.../Thirdly.../Lastly,.../Finally,.../Last but not least,...

Furthermore,.../ In addition,.../ What is more,.../On top of that,...

Another point worth noting is.../Another factor to consider is...

Presenting ideas & giving examples:

When it comes to **noun/gerund**,...

In terms of **noun/gerund**,...

Not only...but also...

With respect to **noun/gerund**,...

According to experts,...

Research has found that...

There are those who argue that

For instance.../ For example.../ such as...

Expressing result & reason:

As a result, .../As a result of **noun/gerund**,
noun/gerund has led to/resulted in...

Consequently,.../Therefore,...

On account of **noun/gerund**/due to **noun/gerund**

One reason behind this is...

Contrasting:

Although/Even though subject+verb,...

Despite/In spite of **noun/gerund**,...

Despite the fact that subject + verb,...

On the one hand...On the other hand...

However,.../Nevertheless,.../Even so...

Concluding:

To sum up,.../In conclusion,...

All things considered,...

Taking everything into consideration,...

Weighing up both sides of the argument,...

On the whole,.../By and large,.../In general,...

Opinion:

As far as I am concerned,...

From my point of view,...

In my opinion,...

My own view on the matter is...

Appendix C. Projects for students

PROJECT A. JOB INTERVIEW

Tips how to behave at the job interview

1. To land the job, you'll have to appear professional, confident, and capable. You will be judged not only on your ability to do the job itself but also on how well you will get along with the people with whom you will be working. The hiring manager watches your communication skills and your manners to predict whether you'll work well with others.
2. Mind the tone of your voice. Often, your tone of voice says more than your words do. You can say you know how to perform the job duties, but if it doesn't sound like you do then you won't inspire much confidence in the hiring manager.
3. Body language can communicate almost as much information as what you are actually saying. Your true thoughts and attitude can be reflected in your body language. The more positive you feel about the interview and your abilities, the more likely this will be reflected in your body language.

<https://edu.gcfglobal.org/en/interviewingskills/what-to-do-during-an-interview/1/>

Now, when you know how to behave at the interview you can take your role-cards and role-play the situation.

Role-cards for the interview

Card A

Tell us about what you see as your weaknesses?

What do you find are the most difficult decisions to make?

What salary would you like to be paid?

Can you tell us a little about yourself?

Are you willing to relocate?

What would you do if there was a problem with a customer?

Card B

To describe your PERSONALITY

Some of the adjectives which you could use are:

Hard-working

Trustworthy

Proactive

Persistent

Resourceful

To describe your STRENGTHS and WEAKNESSES

Organization

Being able to solve problems

Being able to work to a deadline or under pressure

Punctuality

Responsibility

Self-criticism

Perfectionism

Being competitive

Being disorganized

Impulsive

To describe your EXPERIENCE

I studied at ...

I have a degree / master / doctorate in ...

I did a course on ...

I graduated from ... in ...

I have worked as ... for ... years

To describe your FUTURE GOALS and why you should get the job

I think I could be perfect for this job because ...

I believe your company is an important player in your industry.

I believe I could be an asset in your company because ...

I'm excited about this opportunity because ...

I'm always looking to develop my skills and I think I could continue doing so in your company.

I would love to work here because ...

I'd be thrilled to work for your company because ...

PROJECT B. SOLVING ECOLOGICAL PROBLEMS

Instructions:

You are representatives from a local ecological monitoring institution. You have a meeting with a governmental representative and your task is to present them a report on the current ecological state of matters in the local mining industry. You should present some figures, illustrate them with the diagram and discuss the possible solutions to renew an ecological balance in your region. You can speak about employees and their health problems, environmental issues, advanced technologies and so on.

Act the conversation. Use role cards.

Procedure:

Step 1: The teacher introduces the topic to the students and outlines the task.

Step 2: Students are organized in groups and receive role cards.

Step 3: The students discuss the present ecological situation in the region and think over possible ways out.

Step 4: The students role play the situation.

Step 5: The teacher evaluates the students' work

Main activity:

1. Teacher divides students into groups.
2. Gives the roles to the students and explains their tasks. Gives them the role cards and list of useful expressions.
3. Students think over the problem and start the role-playing.

Situation:

Environmental impacts of mining can occur at local, regional, and global scales through direct and indirect mining practices. Impacts can result in erosion, sinkholes,

loss of biodiversity, or the contamination of soil, groundwater, and surface water by the chemicals emitted from mining processes. These processes also have an impact on the atmosphere from the emissions of carbon which have effect on the quality of human health and biodiversity.

Task: discuss in groups

1. Influence on a local biosphere.
2. Discuss the problems of soil erosion and water contamination.
3. Suggest your solutions to these problems.
4. Make a presentation.

Student 1. Ecology body representative.

Set a goal for the meeting.

Decide about the measures the local mining companies should undertake to protect the environment.

Student 2 and Student 3. Representatives of local industrial or mining companies.

Prepare for the meeting with an ecology body representative.

Make a presentation on the ecological impact of your company and be ready to answer the questions of the representative.

Useful phrases:

WELCOME

Good morning/afternoon/evening, ladies and gentlemen/everyone.

On behalf of “Company X”, allow me to extend a warm welcome to you.

Hi, everyone. Welcome to “Name of the event”.

INTRODUCING THE SPEAKER

First, let me introduce myself. My name is “John Miller” and I am the “Position” of “Company X”.

I’m “John” from “Company Y” and today I’d like to talk to you about...

INTRODUCING THE TOPIC

Today I am here to talk to you about...

What I am going to talk about today is...

I would like to take this opportunity to talk to you about...

I am delighted to be here today to tell you about...

I want to make you a short presentation about...

I’d like to give you a brief breakdown of...

Linking

My talk/presentation is divided into “x” parts.

I’ll start with.../First, I will talk about.../I’ll begin with...

...then I will look at...

...next...

and finally...

STARTING POINT

Let me start with some general information on...

Let me begin by explaining why/how...

I’d like to give you some background information about...

Before I start, does anyone know...

As you are all aware...

I think everybody has heard about..., but hardly anyone knows a lot about it.

TRANSITION

I'd now like to move on to the next part...

This leads me to my next point, which is...

Turning our attention now to...

Let's now turn to...

EXAMPLES

For example,...

A good example of this is...

As an illustration,...

To give you an example,...

To illustrate this point...

LINKS

As I said at the beginning,...

This relates to what I was saying earlier...

Let me go back to what I said earlier about...

This ties in with...

GRAPHS AND IMAGES

Let me use a graphic to explain this.

I'd like to illustrate this point by showing you...

Let the pictures speak for themselves.

I think the graph perfectly shows how/that...

If you look at this table/bar chart/flow chart/line chart/graph, you can see that...

EMPHASIS

It should be emphasized that...

I would like to draw your attention to this point...

Another significant point is that...

The significance of this is...

This is important because...

We have to remember that...

PARAPHRASE

In other words,...

To put it more simply,...

What I mean to say is...

So, what I'm saying is....

To put it in another way....

CONCLUSION

We hope that our article will help you in preparing and holding your next presentation. It goes without saying that our list is just a small extract from the huge world of expressions and phrases. As always, the Internet is an inexhaustible source of further information. Here are the links to two websites that we would recommend to you in this context.

Conclusion to the Role-Play

In the end the students should agree on the measures to protect the environment and local biosphere.

Project C. SELF-EFFICIENT ENERGY COMMUNITY

Preparation stage

Read an excerpt about energy efficiency in a community and think over the questions below.

Community energy is all about a group of people coming together, taking action and using local resources to reduce, manage or generate their own energy.

Are there public buildings in your community, like schools or sports clubs, that could have solar PV panels on the roof? Or do you have a natural resource nearby, like a river or a windy hilltop, that could be used to generate electricity with a hydro project or wind turbine?

A community energy project can happen anywhere, from remote villages to city neighbourhoods. And it can involve anything from installing a wind turbine to running an awareness campaign about energy efficiency.

There are many wind and hydro projects in rural areas, with remote communities making the most of their natural resources to become more self-sufficient: providing their own electricity and generating much-needed income.

But more and more, communities in urban areas are developing renewable energy projects – putting solar panels on the rooftops of public buildings, for example – to improve their neighbourhood and play their part in tackling the climate emergency.

<https://energysavingtrust.org.uk/advice/helping-your-community/>

How do you understand the term self-efficient energy community?

What are the features of such community?

What conditions are needed to organize such a community?

Study information about self-efficient energy communities.

You can surf the following sites and search for the information by yourself.

Links to read about energy-efficient communities:

<https://www.archdaily.com/937475/white-arkitekter-plus-regen-villages-create-first-circular-self-sufficient-communities-for-sweden>

<http://cogeneration.net/>

https://www.interregeurope.eu/fileadmin/user_upload/plp_uploads/policy_briefs/2018-08-30_Policy_brief_Renewable_Energy_Communities_PB_TO4_final.pdf

Planning and fulfilling the project

Discuss with your partner information about energy-efficient community.

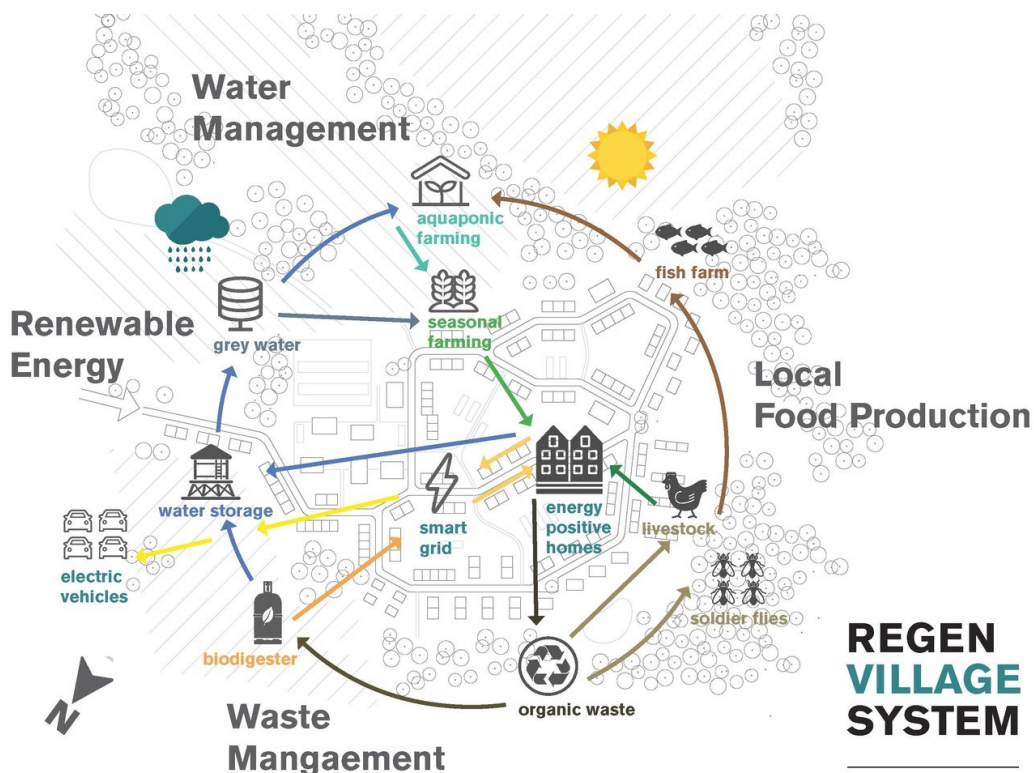
Plan and design your such spot in your city. Think about technologies you would use.

Include in your planning:

1. Street lightning powering
2. Organic wastes usage
3. Advantages to be located near the river or the wood.
4. Means of transportation used.
5. Think about energy sources to be used

After discussion try to draw the

Planning energy self-efficient community



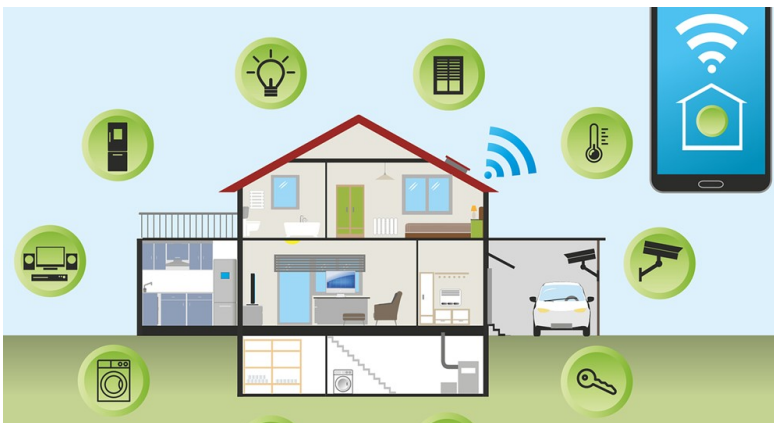
TEXT 1

You are going to read an Introduction to a scientific paper. After reading you can suggest an outline of the article. What topic is covered in the article?

You can check it following the link

https://www.aceee.org/files/proceedings/2002/data/papers/SS02_Panel8_Paper20.pdf

Smart Homes and Energy Efficiency Constructive Technology Assessment of ICT Use in Sustainable Buildings



Introduction

Discussions about 'buildings of tomorrow' mostly follow one of two separate routes. From the perspective of energy-efficient or sustainable buildings, issues such as resource efficiency and use of renewable energies are raised, whereas the perspective of 'building automation' makes extensive use of information and communication technologies (ICT) with a smart response to user requirements. These two pathways are usually followed in isolation without much effort being made to explore synergies between them. From the perspective of sustainable buildings, more emphasis should be put on questions such as: How could the use of ICT further sustainable buildings? Do energy related functions of smart homes meet the demand of potential users and are they effectively used? How could public policy support

usage of ICT in buildings to improve energy efficiency? This article will draw on a recently completed research project in Austria, which was dealing with such questions. A remarkable potential of building automation in residential apartments and buildings to improve environmental performance does indeed exist, as will be pointed out in the next sections, but there are other plausible scenarios which could also result in higher energy consumption by increasing standby losses or triggering further electrification of the household. The contribution of ICT applications to energy efficiency largely depends on the availability of particular functions but perhaps even more on the way such applications are used and accepted by users and on the availability of services building on these technologies. The energy performance of smart homes is not so much a question of developing appropriate technologies or of providing sufficient information to potential users but of evolving contexts of usage and associated learning processes of users and suppliers. How technologies will be used is generally not clear at the time they are first introduced. The path from designing smart home technologies to certain kinds of usage should rather be understood as a process of social learning that has various degrees of freedom at different points of development and spans the whole process from the early design phase to diffusion and (active) appropriation of the technology by users. User requirements and product characteristics can often be discovered only if the product is actually used. Product testing (laboratory testing, field testing) and market research are strategies to organize an effective user-producer communication but often cannot fully capture the context of use and mismatches between technology design and the practice of technology use. Moreover, understanding users' needs deeply and well is a very costly matter for firms, since "need information is very complex and market research techniques only skim the surface." (Von Hippel 2001) Under these conditions of uncertainty firms are likely to develop technological configurations that build on established patterns of user behavior and user expectations. In the case of smart homes this could mean that applications favored by designers and suppliers rather focus on entertainment or computer networks but not on energy efficiency. The main question posed in this paper is how applications could

be promoted that harness the potential of smart homes to improve energy efficiency. After sketching applications of smart-home-technologies that could reduce energy consumption we will discuss preconditions to establish new product uses and strategies to induce social learning processes between users and producers of smart homes. The third part of the paper will present results from an Austrian 'Constructive Technology Assessment' project on smart homes, where user acceptance, existing practices of use and the expectations of designers and suppliers were investigated and brought together in a series of stakeholder workshops and focus group discussions.

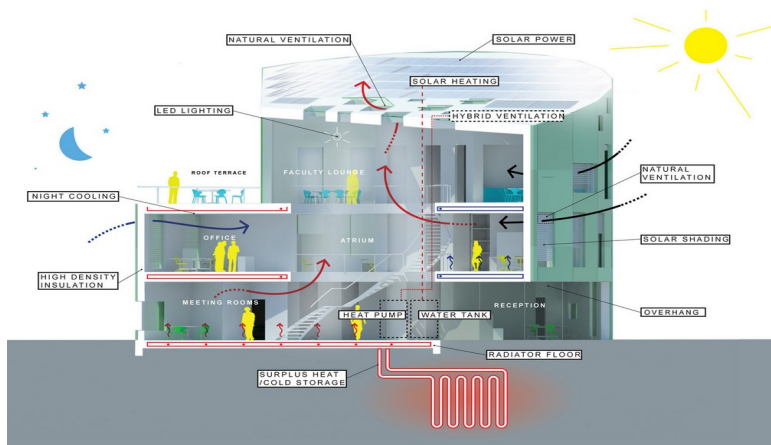
https://www.aceee.org/files/proceedings/2002/data/papers/SS02_Panel8_Paper20.pdf

TEXT 2

You are going to read the text about the recent advanced technologies in energy saving. This text is taken from a newspaper Bloomberg.

Could you notice any stylistic differences in scientific and journalistic styles? What are they?

What Will It Take to Make Buildings Carbon Neutral?



Last month, 19 cities signed a declaration to make all new buildings carbon neutral by 2030. So what happens next?

If cities are going to curb the rise of global temperatures to less than 2 degrees Celsius, they'll have to address the single largest contributor, by sector, to their carbon footprint: buildings. Buildings account for roughly 50 percent of a city's total carbon emissions, and 70 percent in major cities like London, Los Angeles, and Paris. The ultimate goal, as laid out by the World Green Building Council at COP 21 in Paris in 2015, is that by 2050—when 68 percent of the world's population is projected to live in urban areas—all buildings will only use as much energy as they generate. And to get there, a group of large cities is first tackling a closer target. Last month, the mayors of 19 cities—including New York, London, Tokyo, and Johannesburg—declared that they will enact policies and regulations that will make all new buildings carbon neutral by 2030.

The bad news is that the larger challenge is to make existing, not new, buildings more efficient. Buildings that already exist today are estimated to account for 65 percent of all buildings in Organization for Economic Co-operation and Development countries come 2060.

Even so, changing how new buildings are built has major implications for the future. And fortunately, raising standards for new buildings—compared to retrofitting older ones—is the lower-hanging fruit. “New construction is potentially much easier, since you’re starting from scratch,” said Ralph DiNola, CEO of the New Buildings Institute, a nonprofit that advocates for better energy performance in buildings. Not that there won’t be any challenges, DiNola added, but carbon neutrality “is a good and realistic goal as long as we are clear about what that requires for the buildings.” To reach net-zero carbon, DiNola said, the energy usage of buildings will have to be cut anywhere from 50 to 85 percent.

For starters, cities need to have in place a climate action plan; robust building codes that keep up with energy-efficient technology and design; and energy-intensity targets that will guide buildings toward zero carbon emissions, said DiNola. The New Buildings Institute works with New York and other cities to develop “stretch codes”—an extra layer of local, more stringent regulations on top of the base building codes, which focus specifically on energy efficiency. Cities also need to set up a system of rewards and penalties, and give builders and developers enough time to comply.

To reach net-zero carbon, DiNola said, the energy usage of buildings will have to be cut anywhere from 50 to 85 percent—and that means addressing the main energy hogs. “Heating, cooling, hot water, and lighting are the primary loads in most buildings,” according to Maureen Guttman, an architect and green-building expert at the Alliance to Save Energy. On average, those loads account for 75 percent of the energy consumed in the U.S. building sector, and 40 to 50 percent of total energy demand (not just in buildings) in the world.

As I reported last year when New York City announced a mandate to make all its existing buildings greener, features like higher-efficiency heating and lighting

systems help. It isn't a matter of finding new technology, Guttman said—rather, it boils down to designing a good building envelope to avoid heat gain over the warmer seasons and heat loss during the cold. That means good insulation in everything from the walls to the floor to the ceiling and eliminating air leakage (which, by one estimate, can account for at least 25 percent of heating load), as well as an effective ventilation system. It also means windows that reduce heat intake, or “cool” roofs that reflect sunlight instead of absorbing its heat.

Asked whether the 19 cities will reach the 2030 goal, Guttman said there's no question they can. “Zero [carbon] buildings are being built without sophisticated materials or sophisticated equipment,” she added. “We have the technology.”

Solar and wind energy are promising alternatives to fossil fuels, but generating a lot of them requires ample land space that cities don't have. (Solar panels atop tall, skinny buildings can only go so far.) The group of 19 cities that signed the carbon-neutral pledge includes some of world's largest and most populated cities. “That means that they have dense urban infrastructure,” said DiNola. “So they would have to have a way for owners to use renewable energy that is generated off-site, rather than requiring on-site renewable energy generation.”

So where can cities get their renewable energy? Utility-scale solar could remake the world's energy supply by 2050. If that's not fast enough, a 2016 report from Energy Cities, a coalition of local authorities focused on energy transition in the European Union, recommended that officials create partnerships between city centers and their surrounding rural communities. The authors call it a win-win: Urban centers need energy and may be willing to provide financial or technical support to rural communities, and those communities have land for, say, wind farms and solar arrays, but not necessarily the funding and research to develop them.

If cities are serious, “everybody needs to do things differently than the way we do them now,” Guttman said.

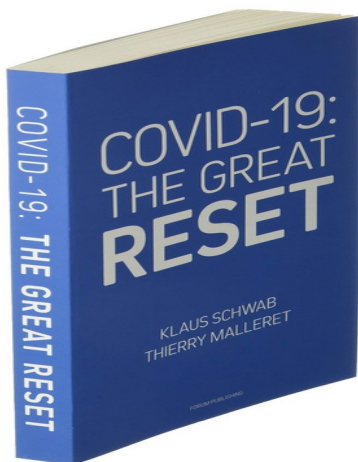
In Washington, D.C., for example, three universities inside the city—Georgetown, George Washington, and American—have collaborated on a project to supply half of their combined energy needs from a solar farm in North Carolina. This

kind of partnership, when scaled up, could address the density challenge that DiNola describes and curb the carbon footprint of not just a few buildings but potentially an entire city.

<https://www.bloomberg.com/news/articles/2018-09-13/how-cities-can-get-serious-about-green-building>

TEXT 3

You are going to read an excerpt from the book by KLAUS SCHWAB and THIERRY MALLERET “COVID-19: THE GREAT RESET” which tells about changes caused by COVID-19.



COVID-19: THE GREAT RESET

Air pollution and pandemic risk

It's been known for years that air pollution, largely caused by emissions that also contribute to global warming, is a silent killer, linked to various health conditions, ranging from diabetes and cancer to cardiovascular and respiratory diseases. According to the WHO, 90% of the world's population breathes air that fails to meet its safety guidelines, causing the premature death of 7 million people each year and prompting the organization to qualify air pollution as a “public-health emergency”. We now know that air pollution worsens the impact of any particular coronavirus (not only the current SARS-CoV-2) on our health. As early as 2003, a study published in the midst of the SARS epidemic suggested that air pollution might explain the variation in the level of lethality, making it clear for the first time that the greater the level of air pollution, the greater the likelihood of death from the disease caused by a coronavirus. Since then, a

growing body of research has shown how a lifetime of breathing dirtier air can make people more susceptible to the coronavirus. In the US, a recent medical paper concluded that those regions with more polluted air will experience higher risks of death from COVID-19, showing that US counties with higher pollution levels will suffer higher numbers of hospitalizations and numbers of deaths. [108] A consensus has formed in the medical and public community that there is a synergistic effect between air pollution exposure and the possible occurrence of COVID-19, and a worse outcome when the virus does strike. The research, still embryonic but expanding fast, hasn't proved yet that a link of causation exists, but it unambiguously exposes a strong correlation between air pollution and the spread of the coronavirus and its severity. It seems that air pollution in general, and the concentration of particulate matter in particular, impair the airways – the lungs' first line of defence – meaning that people (irrespective of their age) who live in highly polluted cities will face a greater risk of catching COVID-19 and dying from it. This may explain why people in Lombardy (one of Europe's most polluted regions) who had contracted the virus were shown to be twice as likely to die from COVID-19 than people almost anywhere else in Italy.

Lockdown and carbon emissions

It is too early to define the amount by which global carbon dioxide emissions will fall in 2020, but the International Energy Agency (IEA) estimates in its Global Energy Review 2020 that they will fall by 8%. Even though this figure would correspond to the largest annual reduction on record, it is still miniscule compared to the size of the problem and it remains inferior to the annual reduction in emissions of 7.6% over the next decade that the UN thinks is necessary to hold the global rise in temperatures below 1.5°C. Considering the severity of the lockdowns, the 8% figure looks rather disappointing. It seems to suggest that small individual actions (consuming much less, not using our cars and not flying) are of little significance when compared to the size of emissions generated by electricity, agriculture and industry, the “big-ticket emitters” that continued to operate during the lockdowns

(with the partial exception of some industries). What it also reveals is that the biggest “offenders” in terms of carbon emissions aren’t always those often perceived as the obvious culprits. A recent sustainability report shows that the total carbon emissions generated by the electricity production required to power our electronic devices and transmit their data are roughly equivalent to that of the global airline industry. The conclusion? Even unprecedented and draconian lockdowns with a third of the world population confined to their homes for more than a month came nowhere near to being a viable decarbonization strategy because, even so, the world economy kept emitting large amounts of carbon dioxide. What then might such a strategy look like? The considerable size and scope of the challenge can only be addressed by a combination of: 1) a radical and major systemic change in how we produce the energy we need to function; and 2) structural changes in our consumption behaviour. If, in the post-pandemic era, we decide to resume our lives just as before (by driving the same cars, by flying to the same destinations, by eating the same things, by heating our house the same way, and so on), the COVID-19 crisis will have gone to waste as far as climate policies are concerned. Conversely, if some of the habits we were forced to adopt during the pandemic translate into structural changes in behaviour, the climate outcome might be different. Commuting less, working remotely a bit more, bicycling and walking instead of driving to keep the air of our cities as clean as it was during the lockdowns, vacationing nearer to home: all these, if aggregated at scale, could lead to a sustained reduction in carbon emissions. This brings us to the all-important question of whether the pandemic will eventually exercise a positive or negative effect on climate change policies.

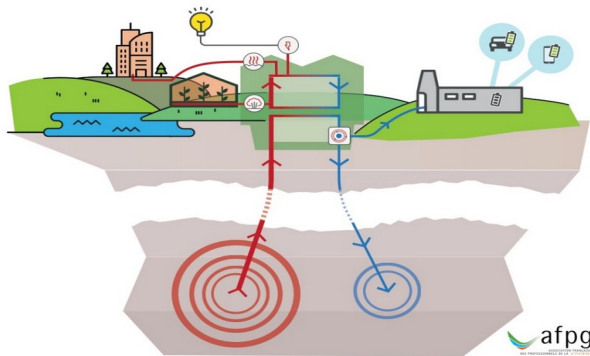
THINK

1. Do you agree with the authors’ vision of our society in future?
2. What changes in other spheres might take place? Consider social sphere, political sphere, employment etc. You can read this book to compare your predictions.

TEXT 4

You are going to read some information about geothermal energy taken from the encyclopedia. Before you read discuss with your partner what you already know about this kind of energy and its application.

Geothermal Energy throughout the Ages



Geothermal energy is one of the oldest types of power used by humans. Archaeological evidence suggests that the earliest direct use of geothermal power occurred at least 10,000 years ago in North America, where indigenous peoples were drawn to hot springs for both spiritual and practical reasons. It is clear that many viewed hot springs as sacred spaces and considered them sites of healing, believing that soaking in warm spring water brought a wide range of medicinal benefits. This drew people to the springs, making them gathering sites for different people and offering opportunities for trade, diplomacy and cultural exchange. Others used hot springs for more mundane reasons, like cooking food or providing an escape from the frigid winter climate.

Similarly, the peoples of ancient Greece and Rome viewed hot springs as places of healing imbued with sacred power. The Greek physician Hippocrates (460–320 BCE) promoted the health benefits of hot bathing, while the Roman author Pliny the Elder (23–79 CE) wrote about the particular benefits of hot mineral baths for people suffering from muscle, joint, or paralytic ailments. The Romans built shrines

at hot springs, many of which yield archaeological evidence that people sought to communicate with the gods. At the shrine to the goddess Minerva at Bath, for example, archaeologists have uncovered 130 lead tablets upon which people had written various pleas to the gods for assistance. Like the indigenous peoples of North America, the Romans also used geothermal energy for more practical applications, such as providing space heating for buildings.

The first effort to harness geothermal energy for industrial use came in 1818 in the Tuscan region of Italy where French engineer François Jacques de Larderel pioneered a new way to extract boric acid from hot springs. While others had developed the means to extract the acid using fire to evaporate the water, de Larderel was the first to harness the region's substantial geothermal energy to drive the process. The town that grew up around the industrial production of boric acid, Larderello, was also home to the first successful effort to produce electricity with geothermal energy. In 1904, Italian scientist Piero Ginori Conti successfully used geothermal energy to power a small generator capable of lighting several light bulbs. This modest beginning was the foundation for much larger experiments, and in 1913, Larderello became the site of the world's first commercial geothermal power plant. After the Second World War, the United States became a major producer of geothermal power. The largest geothermal power plant complex in the world is The Geysers, located in the Mayacamas Mountains north of San Francisco. Opened in 1960, the site now includes twenty-two power plants powered by steam from over 350 wells.

Though feasibility studies have been conducted on multiple sites, there are no geothermal power plants currently operating in Alberta (or, for that matter, anywhere in Canada). The history of geothermal energy in Alberta rests largely in direct use, most particularly in the province's many hot springs.

<http://www.history.alberta.ca/energyheritage/energy/alternative-energy/geothermal-energy/geothermal-energy-throughout-the-ages.aspx>

TEXT 5

You are going to get more information about geothermal energy, its origin, uses and advantages.

Release the power of the Earth

These underground reservoirs of steam and hot water can be tapped to generate electricity or to heat and cool buildings directly.

Geothermal energy has been used for thousands of years in some countries for cooking and heating. It is simply power derived from the Earth's internal heat.

This thermal energy is contained in the rock and fluids beneath Earth's crust. It can be found from shallow ground to several miles below the surface, and even farther down to the extremely hot molten rock called magma.

How Is It Used?

These underground reservoirs of steam and hot water can be tapped to generate electricity or to heat and cool buildings directly.

A geothermal heat pump system can take advantage of the constant temperature of the upper ten feet (three meters) of the Earth's surface to heat a home in the winter, while extracting heat from the building and transferring it back to the relatively cooler ground in the summer.

Geothermal water from deeper in the Earth can be used directly for heating homes and offices, or for growing plants in greenhouses. Some U.S. cities pipe geothermal hot water under roads and sidewalks to melt snow.

Production of Geothermal Energy

To produce geothermal-generated electricity, wells, sometimes a mile (1.6 kilometers) deep or more, are drilled into underground reservoirs to tap steam and very hot water that drive turbines linked to electricity generators. The first geothermally generated electricity was produced in Larderello, Italy, in 1904.

There are three types of geothermal power plants: dry steam, flash, and binary. Dry steam, the oldest geothermal technology, takes steam out of fractures in the ground and uses it to directly drive a turbine. Flash plants pull deep, high-pressure hot water into cooler, low-pressure water. The steam that results from this process is

used to drive the turbine. In binary plants, the hot water is passed by a secondary fluid with a much lower boiling point than water. This causes the secondary fluid to turn to vapor, which then drives a turbine. Most geothermal power plants in the future will be binary plants.

Geothermal energy is generated in over 20 countries. The United States is the world's largest producer, and the largest geothermal development in the world is The Geysers north of San Francisco in California. In Iceland, many of the buildings and even swimming pools are heated with geothermal hot water. Iceland has at least 25 active volcanoes and many hot springs and geysers.

Advantages and Disadvantages

There are many advantages of geothermal energy. It can be extracted without burning a fossil fuel such as coal, gas, or oil. Geothermal fields produce only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces. Binary plants release essentially no emissions. Unlike solar and wind energy, geothermal energy is always available, 365 days a year. It's also relatively inexpensive; savings from direct use can be as much as 80 percent over fossil fuels. But it has some environmental problems. The main concern is the release of hydrogen sulfide, a gas that smells like rotten egg at low concentrations. Another concern is the disposal of some geothermal fluids, which may contain low levels of toxic materials. Although geothermal sites are capable of providing heat for many decades, eventually specific locations may cool down.

<https://www.nationalgeographic.com/environment/article/geothermal-energy>

Unit 1. Nuclear Power Was Supposed to Solve Climate Change...What Happened?

<p>00:08 Since the 1950s the world has had a carbon-free, weather-independent energy source.</p> <p>00:12 It works with our existing grid and infrastructure, and it isn't dependent on batteries or back-up</p> <p>00:16 power from fossil fuels.</p> <p>00:17 If the goal is to slow down climate change, shouldn't we be building more nuclear?</p> <p>00:22 But instead of installing this power generation everywhere we can, it's on the decline around</p> <p>00:26 the world.</p> <p>00:28 What happened?</p> <p>00:28 [OPEN]</p> <p>00:33 Historically, nuclear power has been the world's largest source of carbon-free energy.</p> <p>00:38 Of course, nothing is completely carbon-free.</p> <p>00:41 Fossil fuels were undoubtedly used to build every nuclear plant on Earth.</p> <p>00:44 You need trucks to deliver the fuel rods, construction materials, and that kind of stuff,</p> <p>00:48 but that trade-off applies to all carbon free energy, at least until we get those sweet</p> <p>00:52 Tesla trucks.</p> <p>00:53 Globally, nuclear generates 11% of power, and in the US it provides 20% of our energy.</p> <p>00:58 But since 2013, six nuclear power plants in the US have closed, with dozens more looking</p> <p>01:03 like they may retire in coming years.</p> <p>01:05</p>	<p>02:27 The Diablo Canyon nuclear reactor may have to close because they can't afford to meet</p> <p>02:30 new regulations designed to protect local fish populations.</p> <p>02:33 And in particular, the impacts of nuclear energy have disproportionately fallen on indigenous</p> <p>02:38 peoples around the world.</p> <p>02:39 Since the discovery of Uranium ore in the southwest states, communities have been relocated</p> <p>02:43 and hundreds of barrels of radioactive waste have ended up on Native American reservations.</p> <p>02:47 Should our top priority be reducing carbon emissions or protecting people and biodiversity?</p> <p>02:52 Like most climate change solutions, nuclear energy is full of difficult choices.</p> <p>02:57 But besides nuclear we currently don't have</p>
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<p>After the reactor in Fukushima, Japan melted down in 2011, Germany, China, and Italy all 01:10 shut down or stopped construction on reactors. 01:13 People often cite safety as the big reason for shutting down nuclear power plants. 01:17 But when you actually look at the numbers nuclear is among the safest power technologies 01:20 we have. 01:21 But despite high profile accidents like Chernobyl or 3-mile-island, nuclear power generation 01:25 causes less illness and death than all other fuel-based energy production, by a lot. 01:31 Those deaths are just more spread out, they aren't tied to one event, so we don't 01:34 hear about them. 01:35 Most countries have continued decommissioning. 01:37 Germany plans to completely phase out nuclear by 2022, And when those plants go offline, 01:42 you've gotta make up for that lost power with something, and most of the time we replace 01:46 nuclear with natural gas or coal, not renewables. 01:49 The thing is, a lot of this is economics: even before the Fukushima disaster, nuclear 01:54 power looked like it was on its way out. 01:56 Nuclear is expensive and can't keep up with cheap energy from natural gas. 02:00 But wind and solar started out expensive too, and only became cheaper after decades worth 02:04 of innovation and government policies. 02:06</p>	<p>any carbon-free power generation that operates 03:01 on big scales. 03:03 The closest we can get is hydropower, which supplies 7% of the energy in the US, primarily 03:07 in the West. 03:09 But if you think nuclear is expensive and holds risks for ecosystems, just wait til 03:12 you hear about dams. 03:14 These days it's easier to install smaller, more flexible renewables than big, expensive 03:18 power plants. 03:19 Some companies and researchers are trying to tackle a lot of these issues we've mentioned 03:23 here with cool futuristic technology like smaller reactors that are easier to build, 03:28 eliminate the possibility of a meltdown or reduce fuel waste – but most of these are 03:32 just concepts years away from deployment. 03:35 It's hard to even say if new designs will win over people that are currently afraid 03:38 of or worried about nuclear. 03:40 Or if they'll manage to get through the strict regulations nuclear power has to contend 03:43 with in many countries. 03:45</p>
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<p>So why isn't there as big of a push behind nuclear?</p> <p>02:09 For one thing, big environmental organizations are solidly anti-nuclear.</p> <p>02:13 The Sierra Club for example, says they are "unequivocally opposed to nuclear energy"</p> <p>02:17 - they point to disasters, risks of nuclear proliferation and the dangers of nuclear waste.</p> <p>02:22 Nuclear energy is an area where a climate change solution is at odds with other things</p> <p>02:26 people care about.</p>	<p>And as long as fuels like natural gas are cheaper than nuclear, they'll remain more</p> <p>03:48 popular.</p> <p>03:49 But if our goal is to stop climate change, using fossil fuels is not a solution.</p> <p>03:54 Is it possible to keep global temperatures under control without nuclear?</p> <p>03:57 Probably.</p> <p>03:58 Is it a heck of lot harder?</p> <p>04:01 Definitely.</p> <p>04:02 Funding for this episode is provided by these funders: P. Roy and Diana T. Vagelos, the</p> <p>04:07 Marc Haas Foundation, and Sue and Edgar Wachenheim the third, in support of Peril and Promise,</p> <p>04:12 a public media initiative from WNET in New York, reporting on the stories of climate</p> <p>04:16 change and its solutions. Learn more at pbs.org/perilandpromise</p>
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Unit 2. What If We Burned ALL the Fossil Fuels?

<p>Buried beneath your feet are trillions of tons of dead plants and algae.</p> <p>00:08 Over millions of years, their carbon-rich bodies have been compressed under so much</p> <p>00:12 heat and pressure that they've transformed into energy-rich fossils.</p> <p>00:17 In fact, we call them 'fossil fuels' since we burn them to release their energy.</p> <p>00:22 But burning this coal, oil and gas is releasing carbon-dioxide into the atmosphere, where</p> <p>00:27 it's rapidly building up and heating our planet.</p>	<p>the world.</p> <p>02:36 Rainfall patterns would change too; some parts of the world could get less than a third of</p> <p>02:41 their normal rainfall, and some parts could get twice as much.</p> <p>02:45 Not exactly ideal, if you're a farmer.</p> <p>02:47 And it's worth pointing out that once we've burned our way through 30 Everests-worth of</p> <p>02:52</p>
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00:30

So far, we've burned our way through some 600 billion tons of this carbon.

00:36

That's about the same weight as 4 Mount Everests.

00:39

It's a lot, but we can easily get our hands on way more, because there are 30 Everests

00:44

worth of carbon still buried in the ground - enough for us to keep burning at our current

00:50

rates for another 400 years.

00:52

What would it be like to live on our planet if we burned all the fossil fuels?

01:00

[OPEN]

01:02

Today, out of every million molecules floating around our air, 400 are carbon-dioxides.

01:11

That may sound like a small amount, but it's more carbon dioxide than Earth's atmosphere

01:16

has seen in the last 3 million years.

01:19

And if we burned all the carbon still underground, carbon dioxide levels could reach around 2000

01:25

parts per million.

01:26

That's higher than they've been for the past 50 million years, which is so far back

01:31

that Earth didn't even look like it does today.

01:34

A future world with this much carbon dioxide in the air would be radically different from

01:39

today, but the same physical laws would still govern how that world operated.

01:43

Like, gravity would still make things fall, and carbon dioxide molecules would still trap

01:49

heat.

01:50

So, we can use these physical laws to sketch out what the world might look like with 5

carbon... there'd probably be even more left, because 30 is a conservative estimate

02:56

that doesn't even include fossil fuels that are harder to dig up, like shale gas and methane

03:02

hydrates.

03:03

Once you include those, we may actually have 60 Everests left today.

03:07

If we burned all of those, it would raise carbon-dioxide levels higher than they've

03:11

been for the past half a billion years . Earth is only 4.5 billion years old, so that's

03:17

a tenth of our planet's history.

03:19

It's so long since we've had that much carbon dioxide, that it's hard to say what

03:24

the world might be like.

03:25

But we can be sure that it would be extremely wet, because there's a serious risk we'd

03:30

melt all the world's ice sheets, leading to over 200 feet [60m] of sea level rise.

03:35

That's enough to flood the land where a billion people live today.

03:39

So, if we burn all the fossil fuels, a lot of bad things will probably happen.

03:45

The alternative is to stop using them before they run out, and when that happens is up

03:50

to us.

03:51

The more we burn, the hotter and more extreme our future becomes, so most of the world's

03:56

countries have agreed that we should keep Earth from warming more than 2 degrees Celsius.

04:01

That limits us to burning only 3 more Everests of fossil fuels, which means we'll have to

04:06

01:54
times as much carbon dioxide as today.

01:57
It would be a hot mess.

02:00
A really hot mess.

02:02
Earth's average temperature could soar by 11 to 18 degrees fahrenheit.

02:07
That's enough to make New York hotter than present-day Houston, and Moscow hotter than

02:12
today's Madrid.

02:13
This wouldn't happen just in places that are already hot, like the Middle East.

02:19
The map of hot places on Earth would expand big-time.

02:22
Over half the world's population lives in places likely to overheat.

02:26
Yeash.

02:27
But intolerable heat is just the start of the story.

02:30
Melting ice could raise sea levels by over 100 feet (30m), drowning coastal cities around

02:35

keep the vast majority - around 57 Everests worth - buried in the ground.

04:11
So, how do we keep all that carbon underground?

04:15
The problem is, fossil fuels are cheap and easy to get a hold of, and they've made

04:19
life pretty prosperous today.

04:20
One option, then, would be to make them more expensive.

04:24
If governments choose to increase the price of fossil fuels to include these future damages

04:29
to society, they'd quickly become less appealing.

04:32
Or, we could keep making the alternatives more appealing.

04:36
Renewable power sources like wind and solar don't release carbon dioxide into the air,

04:41
and we could improve them even more by researching new technologies to boost their efficiency,

04:46
making them more dependable, and scaling up production to drive down costs.

04:50
Or, we could make fossil fuels socially unacceptable - just like big health campaigns

04:56
have turned smoking unsexy.

04:58
Or heck, we could do all these things!

05:01
If we want to.

05:03
In fact, these changes are already beginning to happen, each in their own way, and around

05:07
the world we're slowly starting to move away from coal, oil and gas.

05:12
Based on those possible futures we just talked about, that's a good thing too, because

05:17
if we DID end up burning all the world's fossil

	fuels, we would be at serious risk 05:22 of becoming fossil fools.
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Unit 3. What is a zero energy building?

<p>00:05 Most buildings today use a lot of energy - to keep the lights on, cool the air, heat water,</p> <p>00:10 and power personal devices.</p> <p>00:13 Even installing solar systems will not significantly counter the heavy energy load.</p> <p>00:18 There are, however, some buildings that strike a balance; or even tip the scales the other way!</p> <p>00:24 These are called zero energy buildings.</p> <p>00:26 They manage this feat by being extremely energy efficient-- saving 50% - 70% more energy than</p> <p>00:33 typical buildings!</p> <p>00:34 In these ultra-high performance buildings, the amount of energy used can be completely</p> <p>00:39 offset by renewable energy produced on or around the building.</p> <p>00:43 When conditions are not suitable for energy generation, the building will draw energy</p> <p>00:48 from the electrical grid to meet its needs.</p> <p>00:51 When conditions improve, the onsite renewable energy systems will cover the building's energy</p> <p>00:56 need and send excess energy back into the grid to make up the balance.</p> <p>01:00</p>	<p>Over the course of a year, the building gives back as much energy as it takes.</p> <p>01:05 When zero energy concepts are applied to groups of buildings, the benefits are shared and</p> <p>01:10 multiplied within that zero energy community.</p> <p>01:13 These buildings are also: More comfortable</p> <p>01:16 More reliable</p> <p>01:21 Affordable to build and operate</p> <p>01:24 And better for the environment.</p> <p>01:30 While these might seem like "buildings of the future,"</p> <p>01:33 new technologies are constantly emerging that make zero energy easier and easier to achieve today.</p> <p>01:39 In fact, there are already hundreds of zero energy buildings across the U.S. in many</p> <p>01:43 different climates.</p> <p>01:45 By becoming ultra-efficient and giving back as much energy as they consume, zero energy buildings</p> <p>01:50 will play an important part in creating a more competitive, energy-secure future.</p>
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Unit 4. How a VRF (Variable Refrigerant Flow) Heat Pump works

	variety of styles each zone has its own
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over the last 20 or 30 years heat pump
00:08
technology has continued to evolve and
00:10
today homeowners can choose from a
00:12
variety of systems that best fit their
00:14
needs
00:15
the V RF or variable refrigerant flow
00:18
heat pump is a heating and cooling
00:19
system that does not have ductwork as a
00:21
component of the overall system
00:23
they serve as a great application for
00:25
homes and living spaces we're installing
00:27
ductwork is not possible or desired
00:30
commonly known as a mini-split heat pump
00:33
or ductless heat pump the V RF system
00:35
uses a single outdoor condensing unit to
00:38
connect with one or more indoor air
00:39
handlers refrigerant is cycled through
00:43
the lines from the outdoor condensing
00:45
unit to the air handlers where the heat
00:48
or cool air is distributed typically the
00:53
indoor air handlers can be mounted on
00:55
the wall or ceiling and come in a
00:57

01:00
thermostat and when needed multiple air
01:02
handlers can be controlled as separate
01:04
cells providing the right amount of heat
01:06
or conditioned air for that zone
01:09
in addition both heating and cooling can
01:12
occur at the same time so if the
01:15
bedrooms in the back of the house need
01:16
cooling while the front of the house
01:18
requires Heat the system can handle it
01:21
as with other heat pumps there are
01:24
significant energy savings but the vrf
01:26
system provides some added efficiencies
01:29
there is minimal energy loss compared to
01:31
thirty to forty percent energy loss with
01:33
traditional forced air systems that use
01:35
duct work in unconditioned places such
01:38
as attics and in most circumstances vrf
01:42
heat pumps do not require a backup heat
01:44
source whether it's a new sunroom or
01:47
retrofitting an entire house if ductwork
01:50
is not an option a vrf heat pump is the
01:53
perfect option smart energy smart
01:57
choices
01:58

Unit 5. What is a Heat Exchanger?

<p>A heat exchanger is a device that allows heat from a fluid (either a liquid or a gas) to 00:14</p> <p>pass to another liquid or gas without the two fluids having to mix or come into direct contact. 00:20</p> <p>A heat exchanger used for cooling components features a water-to-air, liquid-cooled, 00:24</p> <p>closed loop system. 00:26</p> <p>Closed loop liquid cooling is defined as a high capacity, high maintenance cooling system 00:30</p> <p>that uses liquid as the coolant and a heat exchanger for heat removal from the coolant. 00:36</p> <p>The most commonly used coolants are water, deionized water, inhibited glycol and water solutions, 00:41</p> <p>dielectric fluids, and custom design heat transfer fluids. 00:46</p> <p>In a liquid cooling loop, the coolant is pumped through a cold plate that is in contact with 00:49</p> <p>a hot integrated circuit.</p>	<p>00:52</p> <p>The heat dissipated from the component is transferred in the heat exchanger to the ambient, 00:56</p> <p>resulting in lowering the temperature of the coolant 00:58</p> <p>that gets pumped back to the hot integrated circuit. 01:02</p> <p>For efficiency, heat exchangers are designed to maximize the surface area of the wall between 01:07</p> <p>the two fluids, while minimizing resistance to fluid flow through the exchanger. 01:12</p> <p>Performance of the exchanger can also be affected by the addition of fins or corrugations in 01:16</p> <p>one or both directions, which increases surface area for enhanced thermal transport. 01:21</p> <p>The most common applications include: telecomm, datacomm and other cabinet electronics, 01:26</p> <p>process cooling, power electronics, medical systems, automotive, industrial and HVAC. 01:35</p> <p>For more information on heat exchangers, go to QATS.com.</p>
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Appendix F. Engineering Glossary

1. add-in – вмонтований допоміжний пристрій
2. air-blower – повітрянагнітач, нагнітальний вентилятор, пневмотранспортер
3. air-buster – пневмоперфоратор
4. air-cylinder – пневмоциліндр
5. air-filter – повітряний фільтр
6. alternator-transmitter – (радіо)передавач [(радіо)висилач] з живленням від синхронного (електричного) генератора
7. amplifier-inverter – підсилювач-інвертор
8. antenna-amplifier – антена-підсилювач
9. audio-displacement – зміщення звукового сигналу
10. autoacceleration – самопришвидшування, самопришвидшення
11. backfeed – підживлювання
12. balance-wheel – маховик
13. backlight-lamp – лампа підсвітки
14. base-current – струм керування
15. battery-analyzer – вимірювальний пристрій для перевірки акумуляторів
16. battery-backup – резервне джерело живлення
17. battery-bracket – кронштейн акумуляторної батареї
18. battery-capacity – місткість [ємність] батареї
19. battery-clamp – затискач батареї
20. battery-compartment – блок живлення
21. beamsplitter – світлоділильна пластинка, світлоподілювач, світлоподільник розщеплювач струменя (частинок)
22. blowtorch – паяльна [лютувальна] лампа
23. board-transformer – щит-трансформатор
24. bolt-body – стрижень болта
25. breakthrough – науковий прорив
26. broadside-antenna – поперечноспрямована антена

27. burn-out – вигорання
28. bypass – шунт, узбічник
29. cable-tool – верстат для канатного свердління
30. carry-current – струм носія
31. circuit-connector – рознім
32. circuit-scheme – схема електричного кола
33. circuit-switch – перемикач
34. clipper-amplifier – підсилювач-обмежувач
35. clock-pulse – тактовий імпульс, імпульс синхронізації
36. coil-spring – спіральна пружина
37. collector-current – струм колектора
38. coremaker – стрижневик (спеціальність)
39. corona-tube – лампа коронного розряду
40. cross-band – двобічний зв'язок з рознесеними частотами
41. cutoff-current – знеструмлювання, відтин струму
42. cutout – вимикач; запобіжник, мечик [рубильник, розмикач] (ручний пристрій для вмикання, вимикання та перемикання електричного струму напругою до вольт)
43. dial-light – лампа підсвічування
44. diode-tube – вакуумний діод
45. disconnecter-isolator – розмикач-роз'єднувач
46. draincock – спусковий кран
47. drain-filter – дренажний фільтр
48. engine-compartment – моторний відділ
49. engine-cutoff – припинення роботи двигуна
50. engine-deck – верхня площа блоку циліндрів
51. flowchart – принципова технологічна схема, технологічна карта, схема послідовності операцій, функційна схема, блок-схема
52. fuse-disconnector – запобіжник-роз'єднувач
53. gearwheel – зубчате колесо

54. gooseneck – S-подібна деталь, вигнута труба
55. handwheel – маховик
56. heat-generator – теплогенератор
57. heat-wave – теплова хвиля
58. holddown – затискач
59. insulator-level – електрична міцність ізолятора
60. offtime – час перебування у вимкненому стані
61. outage – (аварійна) перерва електропостачання , перерва (в роботі з будь-яких причин), неробочий стан
62. outlet – виходовий пристрій, пристрій на виході
63. overactivity – надактивність
64. overlap – перетин, перекрив, насув
65. phase-advancer – фазокомпенсатор, фазовий компенсатор
66. phototransistor – фототранзистор, (напівпровідниковий) фототріод
67. pig-tail – короткий дротовий вивід
68. pile-up – накопичування; накопичення, нагромадження; нагромадження
69. piston-actuator – поршневий [толоковий] виконавчий механізм
70. piston-chamber – порожнина циліндра
71. piston-crown – головка поршня [толока]
72. piston-cup – манжета поршня [толока]
73. piston-rod – поршневий [толоковий] шток
74. polyswitch – самовідновний запобіжник
75. rust-resistance – іржотривкість, неіржавність
76. scanner-antenna – антена сканера
77. shave-machine – обробний різець, тангенційний різець, шевер (різальний інструмент – зубчасте колесо або рейка з зубцями)
78. sheath-current – струм в оболонці
79. shortcircuit – коротке замикання
80. space-cable – несний жильник
81. split-phase – розщеплена фаза

- 82.square-wave – меандер, прямокутна [меандрова] хвиля, меандрові коливання
- 83.steam-jacket – парова оболонка [сорочка]
- 84.steam-roller – паровий коток
- 85.steam-room – паровий простір (у резервуарі), робочий простір (циліндра)
- 86.straight-joint – з'єднувальна муфта
- 87.stray-current – мандрівний струм, паразитний струм
- 88.stuck-open – транзистор зі стійким обривом
- 89.suction-filter – вакуум-фільтр, усмоктувальний фільтр
- 90.supply-current – живильний струм, струм живлення, струм джерела струму
- 91.switchboard – комутатор, розподільча [комутаційна, комутаторна] панель, розподільчий щит
- 92.switchgear – розподільчий пристрій
- 93.tap-bolt – самонарізальний болт
- 94.tap-changer – перемикач виходових навиток
- 95.tap-chaser – гребінка для гайконарізної пришиви
- 96.tooth-gear – зубчастий передавач, зубчасте колесо
- 97.toothvoltage – пилчаста напруга
- 98.valve-in-head – клапанний двигун
- 99.valve-plug – вентиль-корок, вентиль-затичка
100. valve-retainer – тарілка клапана

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Image 3. https://www.google.com/search?q=water+source+heat+pumps&tbm=isch&ved=2ahUKEwjh9tCW-gruAhUKsCoKHQAYCIMQ2-cCegQIABAA&oq=water+source+heat+pumps&gs_lcp=CgNpbWcQAzIECAAQE1DuJljuJmDVKWgAcAB4AIABW4gBW5IBATGYAQCgAQGqAQQnd3Mtd2l6LWltZ8ABAQ&scient=img&ei=b10IYN3rIsyPqwGH0JCABw&bih=712&biw=898&rlz=1C1SQJL_ruUA905UA905#imgrc=2cQtglKjEnqInM

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Image 4. [https://www.google.com/search?](https://www.google.com/search?q=air+source+heat+pumps+&tbm=isch&ved=2ahUKEwjguOKT96ruAhVXuCoKHVNwBzUQ2-)

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Image 5. [https://www.google.com/search?](https://www.google.com/search?q=hybrid+heat+pump&tbm=isch&ved=2ahUKEwjz0qjJ96ruAhWGuyoKHfC_CmoQ2-)

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Image 6. [https://www.google.com/search?](https://www.google.com/search?q=heat+pump&tbm=isch&ved=2ahUKEwjVxcqD99TuAhUHvSoKHUSHAEAQ2-cCegQIABAA&oq=heat+pump&gs_lcp=CgNpbWcQAzICCAAYAggAMgIIAFDSC1jSC2CMF2gAcAB4AIABfYgBfZIBAzAuMZgBAKABAAoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=OF8eYNXJGYf6qgHEjoKABA&bih=722&biw=1536&rlz=1C1SQJL_ruUA905UA905#imgrc=56M-W4W8jirTbM)

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Image 7. <https://vanderhyde.com/geothermal-systems/>

<https://forum.english.best/uploads/default/original/2X/5/593fb10f65faf0f12b7f5e8b914caee10f0b41df.png>

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Image 5.

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Image 6. https://www.google.com/search?q=%09Microchannel+heat+exchangers&tbm=isch&ved=2ahUKEwib66PKz6zuAhUQzCoKHV2QDScQ2-cCegQIABAA&oq=%09Microchannel+heat+exchangers&gs_lcp=CgNpbWcQAzIECAAQE1CngAVYp4AFYOKGBWgAcAB4AIAIBXYgBXZIBATGYAQCgAQGqAQotnd3Mtd2l6LWltZ8ABAQ&sclient=img&ei=JT0JYNvELJCYqwHdoLa4Ag&bih=640&biw=900&rlz=1C1SQJL_ruUA905UA905#imgrc=wThwWzTb8aF1GM

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Image 7. https://www.google.com/search?q=Plate+and+shell+heat+exchanger&tbm=isch&ved=2ahUKEwjytanyz6zuAhVVvyoKHZwcBxQQ2-cCegQIABAA&oq=Plate+and+shell+heat+exchanger&gs_lcp=CgNpbWcQAzIECAAQEzIECAAQE1D1pgRY9aYEYL-rBGgAcAB4AIAIBX4gBX5IBATGYAQCgAQGqAQotnd3Mtd2l6LWltZ8ABAQ&sclient=img&ei=eT0JYLKVK9X-qgGcuZygAQ&bih=640&biw=900&rlz=1C1SQJL_ruUA905UA905#imgrc=2HApdz0pWkiXZM

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Image 8. https://www.google.com/search?q=%09Dynamic+scraped+surface+heat+exchanger&tbm=isch&ved=2ahUKEwigxueU0KzuAhVul4sKHYKeArsQ2-cCegQIABAA&oq=%09Dynamic+scraped+surface+heat+exchanger&gs_lcp=CgNpbWcQAzIECAAQE

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Image 9 . https://www.google.com/search?q=%09Adiabatic+wheel+heat+exchanger&tbm=isch&ved=2ahUKEwja4cDE0KzuAhWGuyoKHTduCj4Q2-cCegQIABAA&oq=%09Adiabatic+wheel+heat+exchanger&gs_lcp=CgNpbWcQAzIECAAQE1DVzANYIcwDYPnUA2gAcAB4AIABa4gBa5IBAzAuMZgBAKABAaoBC2d3cy13aXotaWIInwAEB&sclient=img&ei=Jj4JYNq2A4b3qgG33KnwAw&bih=640&biw=900&rlz=1CISQJL_ruUA905UA905#imgrc=-EmXyPsrFxSCvM

Image 10. [https://www.google.com/search?q=A+waste+heat+recovery+unit+\(WHRU\)+&tbm=isch&ved=2ahUKEwiZ_p-a0azuAhVCvSoKHQMFD28Q2-cCegQIABAA&oq=A+waste+heat+recovery+unit+\(WHRU\)+&gs_lcp=CgNpbWcQAIDazwRY2s8EYIvVBGgAcAB4AIABWIGBWJIBATGYAQCgAQGqAQtnD3Mtd2l6LWltZ8ABAQ&sclient=img&ei=2T4JYNmtNcL6qgGDirz4Bg&bih=640&biw=900&rlz=1CISQJL_ruUA905UA905#imgrc=-0IBreuLbC58SM&imgdii=n_rgw1xV-wHZbM](https://www.google.com/search?q=A+waste+heat+recovery+unit+(WHRU)+&tbm=isch&ved=2ahUKEwiZ_p-a0azuAhVCvSoKHQMFD28Q2-cCegQIABAA&oq=A+waste+heat+recovery+unit+(WHRU)+&gs_lcp=CgNpbWcQAIDazwRY2s8EYIvVBGgAcAB4AIABWIGBWJIBATGYAQCgAQGqAQtnD3Mtd2l6LWltZ8ABAQ&sclient=img&ei=2T4JYNmtNcL6qgGDirz4Bg&bih=640&biw=900&rlz=1CISQJL_ruUA905UA905#imgrc=-0IBreuLbC58SM&imgdii=n_rgw1xV-wHZbM)

Image 11. https://www.google.com/search?q=Direct+contact+heat+exchangers&tbm=isch&ved=2ahUKEwj8i6O_0azuAhUQCXcKHUEECJ0Q2-cCegQIABAA&oq=Direct+contact+heat+exchangers&gs_lcp=CgNpbWcQAzIECAAQE1D--QRY_vkEYMz-BGgAcAB4AIABXIgBXJIBATGYAQCgAQGqAQtnD3Mtd2l6LWltZ8ABAQ&sclient=img&ei=Jz8JYLzcH5CS3APBiKDoCQ&bih=640&biw=900&rlz=1CISQJL_ruUA905UA905#imgrc=Sp_rLqizKwwjDM

Image 12. https://www.google.com/search?q=Plate+fin+heat+exchanger&tbm=isch&ved=2ahUKEwj-3O3m0azuAhXYZSoKHOhD9wQ2-cCegQIABAA&oq=Plate+fin+heat+exchanger&gs_lcp=CgNpbWcQAzIECAAQEzIECAAQEzIECAAQEzIICAAQBRAeEBMyCAgAEAUQHhATMggIABAFE

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Image 13. https://www.google.com/search?q=%09Fluid+heat+exchangers&tbm=isch&ved=2ahUKEwj68L340azuAhXTsioKHVeODC4Q2-cCegQIABAA&oq=%09Fluid+heat+exchangers&gs_lcp=CgNpbWcQAzIECAAQE1CPzQJYj80CYLnRAMgAcAB4AIABqwKIAasCkgEDMi0xmAEAoAEBqgELZ3dzLXdpei1pbWfAAQE&sclient=img&ei=nz8JYLqlHtPlqgHXnLLwAg&bih=640&biw=900&rlz=1C1SQJL_ruUA905UA905

Image 14. <https://www.mitsubishielectric.com/news/2013/0214-a.html>

<https://www.esleschool.com/b2-environment-crossword/>

Links to the video

[https://www.youtube.com/watch?](https://www.youtube.com/watch?v=WYJ9BsCrifQ&ab_channel=AdvancedThermalSolutions%2CInc)

[v=WYJ9BsCrifQ&ab_channel=AdvancedThermalSolutions%2CInc](https://www.youtube.com/watch?v=WYJ9BsCrifQ&ab_channel=AdvancedThermalSolutions%2CInc)

Links to Appendices

<https://www.nationalgeographic.com/environment/article/geothermal-energy>

<http://www.history.alberta.ca/energyheritage/energy/alternative-energy/geothermal-energy/geothermal-energy-throughout-the-ages.aspx>

<https://www.bloomberg.com/news/articles/2018-09-13/how-cities-can-get-serious-about-green-building>

https://www.aceee.org/files/proceedings/2002/data/papers/SS02_Panel8_Paper20.pdf

Image to the text 1. <https://www.google.com/url?sa=i&url=https%3A%2F>

[%2Fwww.iotevolutionworld.com%2Fsmart-home%2Farticles%2F438532-how-secure-smart-home-devices-](https://www.iotevolutionworld.com%2Fsmart-home%2Farticles%2F438532-how-secure-smart-home-devices-5steps.htm&psig=AOvVaw33DZPZkyj2HlguGalFuyhY&ust=1642693694808000&source=images&cd=yfe&ved=0CAsQjRxqFwoTCMCyo4aVvvUCFQAAAAAdAAAAABAD)

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Image to the text 5. <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.eia.gov%2Fenergyexplained%2Fgeothermal%2F&psig=AOvVaw3113OiiWu1HVAlqllxccPz&ust=1642694976607000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCLC8g-qZvvUCFQAAAAAdAAAAABAJ>