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SPEAKING ABOUT ENERGY

Учебное пособие

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Учебное пособие предназначено бакалаврам, изучающим английский язык по направлению подготовки 13.03.02 «Электроэнергетика и электротехника» и профилям подготовки: «Электрооборудование и электрохозяйство организаций, предприятий и учреждений», «Электроснабжение», «Электропривод и автоматика».

В текстах пособия рассматриваются вопросы, касающиеся сферы энергетики – энергия и ее формы, источники энергии, электричество, экологические проблемы в этой области – на основе аутентичных материалов. Разнообразные упражнения предполагают расширение лексического запаса и освоение грамматических структур английского языка, характерных для текстов данной тематики. Предлагаемые задания способствуют снятию лексических и грамматических трудностей при работе с текстами и пониманию некоторых особенностей изучаемого языка. Также представлен ряд дополнительных заданий на повторение пройденного материала для самостоятельной работы, аутентичные статьи из зарубежных источников, словарь.

Учебное пособие может быть рекомендовано лицам, изучающим английский язык и желающим углубить свои знания в профессиональной сфере.

Утверждено экспертным советом по изданию учебной и учебно-методической литературы ВоГУ в качестве учебного пособия

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Предисловие

Учебное пособие предназначено бакалаврам, изучающим английский язык по направлению подготовки 13.03.02 Электроэнергетика и электротехника и профилям подготовки: *Электрооборудование и электрохозяйство организаций, предприятий и учреждений, Электроснабжение, Электропривод и автоматика*. Пособие также может быть использовано лицами, самостоятельно занимающимися английским языком, интересующимися вопросами энергетики и желающими углубить свои знания в профессиональной сфере. Рекомендуется как основной материал бакалаврам, изучающим английский язык по указанному направлению подготовки на занятиях и в ходе самостоятельной работы. Практическая направленность пособия обеспечивается соответствующими заданиями.

Целью данного пособия является развитие и совершенствование навыков устной и письменной речи на английском языке в профессиональной сфере, расширение словарного запаса – на основе аутентичного материала, рассматривающего общие вопросы электроэнергетики: что такое энергия, формы энергии, возобновляемые и невозобновляемые источники энергии, что такое электричество, экологические проблемы в данной области. В ходе работы над уроками пособия учащиеся расширяют общий словарный запас, осваивают терминологическую лексику в рамках направления подготовки, повторяют и закрепляют грамматические структуры, характерные для текстов данной тематики.

Содержание пособия отражает общие вопросы из области электроэнергетики, направлено на овладение учащимися базовыми понятиями данной области на основе оригинальных текстов.

Структура уроков (юнитов) выстроена последовательно, в соответствии с рассматриваемым материалом. Каждый из пяти уроков включает тексты, тематика которых способствует активному освоению терминологической лексики и включает в себя типичные грамматические структуры. Уделяется внимание развитию навыков полного понимания текстов, развитию умения самостоятельно строить монологическое высказывание с опорой на имеющиеся данные. Разработанные дотекстовые упражнения имеют целью снять лексические и грамматические трудности при переводе; послетекстовые задания направлены на отработку и закрепление рассматриваемого в уроке материала, контроль степени его усвоения. Вопросы и задания на самооценку и самоконтроль предусмотрены в конце каждого урока, что позволяет каждому учащемуся зафиксировать свои продвижения в учебе, определить возможные пробелы и закрепить знания.

Дополнительные материалы – обширный тематический словарь, базовые выражения для подготовки аннотаций на английском языке, написания эссе – содержат необходимую для выполнения заданий информацию в помощь учащимся. Раздел повторения включает тексты по заданной тематике для обсуждения в ходе занятий или для самостоятельной работы.

Рекомендуется обсуждение дискуссионных вопросов – до начала работы с текстом, и после выполнения комплекса заданий к нему; в качестве итоговых заданий возможно проведение круглых столов, подготовка презентаций, разработка творческих проектов, в зависимости от уровня знаний учащихся.

Материалы пособия были апробированы в курсе английского языка со студентами первого и второго курсов соответствующего направления подготовки.

СОДЕРЖАНИЕ

Встречающиеся сокращения:

adj – adjective
adv–adverb
cj - conjunction
etc – et cetera = and so on
i.e. – id est = that is
n – noun
ph.v. – phrasal verb
pl - plural
v – verb

UNIT I

What is Energy?

“ ...In Physics today, we have no knowledge of what energy really IS!” (Richard Feynman)

1.Read the epigraph of the unit. The famous American Physicist Richard Feynman talked about it in his famous 1960s Lectures on physics. Do you agree with his statement? Give your reasons.

2.Read and translate the extract below. Do you think the common definition of “energy” is enough for understanding? Why?

We know energy through its manifestations in different forms: heat, magnetism, electricity… etc. We know how to use certain formulas to quantify and use the different forms of energy, that ultimately gave us modern technology, but we still do not know the essence of the energy that can take one form or another. The general scientific definition from the Encyclopedia Britannica: “ENERGY IS THE ABILITY TO PRODUCE ACTION OR EFFECT” defines energy not in what it really is but through one of its attributes. Besides the traditional types of manifestation of Energy in form of heat, motion…etc, many other ‘effects’ can actually be defined as manifestations of energy. We must include vitality, emotions, and thoughts, into the energy repertoire. A whole new picture arises which would need a whole new Physics to grasp it.

About 5,000 years ago, the energy people consumed for their survival averaged about 12,000 kilocalories per person each day. In AD 1400, each person was consuming about twice as much energy (26,000 kilocalories).

After the Industrial Revolution, the demand almost tripled to an average of 77,000 kilocalories per person in 1875. By 1975, it had tripled again to 230,000 kilocalories per person.

3.Before starting to work with the Unit 1, be ready to discuss the following .

- ✓ Could our life be possible without energy?
- ✓ What does the word “energy” mean to you?
- ✓ In what areas can we hear about energy?
- ✓ What types of energy do you think exist?

4.Read the international words and give their translation. Pay attention to their pronunciation:

atom, energy, potential, kinetic, gravitational, molecules, substances, chemical, propane, mechanical, objects, repertoire, reservoir, electrical, electromagnetic, vibration, geothermal, longitudinal, uranium, plutonium.

5.Read the words and their derivatives. Translate them into Russian paying attention to their meaning:

1) energy – energetic – energize – energizing – energetically
2) associate – association – associated – associable
3) design – designer – redesign
4) conduct – conductor – conduction – conducted
5) rotate – rotor – rotation – rotating
6) direct – director – direction – indirect – directive
7) invent – inventor – invention –invented – reinvented
8) recognize – recognition – recognizable – unrecognizable – recognized

6.Fill in the table of derivatives with the appropriate words paying attention to the use of different suffixes you know. Translate the words:

Verb	**Noun**	**Adjective**	**Adverb**
relate	***relationship***	***relative***	***relatively***
	use		
generate			
		convertible	
			efficiently
	energy		
			economically
industrialize			
		partial	
	naturalist		

7.Form verbs using the suffix -ize. ***Translate the words:***

- ✓ final
- ✓ summary
- ✓ energy
- ✓ mobile
- ✓ organ
- ✓ incentive
- ✓ category
- ✓ critic
- ✓ industrial
- ✓ economy
- ✓ symbol
- ✓ real

Make up sentences using the verbs you've made.

E.g. People *were energized* by his ideas.

8.Translate the following words into Russian paying attention to conversion. Consult the dictionary if you need:

1) affect	-	to affect
2) call	-	to call
3) cause	-	to cause
4) challenge	-	to challenge
5) claim	-	to claim
6) end	-	to end
7) form	-	to form
8) hazard	-	to hazard
9) house	-	to house
10) like	-	to like
11) limit	-	to limit
12) measure	-	to measure
13) plan	-	to plan
14) respect	-	to respect
15) sense	-	to sense
16) set	-	to set
17) store	-	to store
18) supply	-	to supply
19) take	-	to take
20) use	-	to use

9.Choose 3-4 pairs of words (a noun and a verb) from the previous exercise above and make up sentences.

E.g. SUPPLY

NOUN The gas supply is of the highest importance to the city. -
Газоснабжение крайне важно для города.
VERB We can supply the goods from our main store. –
Мы можем поставлять товары из нашего центрального магазина.

10.Revise the use of the Passive Voice. Translate the text into Russian paying attention to the difference of using the Active and Passive Voice. If necessary, look the new words up in the dictionary (you may also use the active vocabulary of Unit 1 on the next pages):

Every act that is performed requires energy. In the case of usage, energy is needed to heat and cool our homes, light our offices, operate our factories and manufacture products. It can be said that humanity is truly dependent on using energy in every aspect of our lives, from residential and commercial to transportation and industrial.

The world's energy is derived from five primary resources: petroleum, natural gas, coal, renewable energy and nuclear electric power. Petroleum, natural gas and coal are all categorized under fossil fuels while renewable energy comes from sources that can be regenerated or naturally replenished. The most common energy sources in the world are fossil fuels that have been used extensively since the Industrial Revolution. Renewable energy sources are described as restoring themselves over relatively short periods of time. They are being used more frequently nowadays because they are better for the environment.

11.Transform the sentences changing verbs from the Passive into the Active Voice. Use the appropriate subjects. Translate them.

E.g. 1) Energy **is defined** as the ability or the capacity to do work. –
Physicists **define** energy as the ability or the capacity to do work.
2) Our world **is driven** by energy. – Energy **drives** our world.

1) Once fire **was discovered** it **was applied** by man for cooking and heating.
2) For several thousand years only renewable energy sources (sun, wind, water, wood) **were used**.
3) The first sailing ships and windmills **were developed** harnessing wind energy.
4) Since ancient times, hydropower from many kinds of watermills **has been used** as a renewable energy source for irrigation and other needs.
5) With the advent of the Industrial Revolution, more energy in the form of fossil fuels **was needed**.
6) It has been only less than a century since nuclear power **is being used** as an energy source.

7) In the past century it **was revealed** that much environmental damage **had been caused** by consumption of non-renewable sources of energy.
8) Some sources of energy, such as the sun and wind, **are called** renewable.
9) These sources **are referred to** as alternative to fossil fuel.
10) Chemical, radioactive, and thermal pollution **can be reduced** by the use of non-conventional sources of energy.

12.Translate the sentences from Russian into English. Pay attention to the tenses of the verbs.

1) Энергия окружает нас.
2) Мы используем энергию каждый день.
3) Энергию нельзя создать или уничтожить.
4) Её можно только преобразовывать из одного вида в другой.
5) Полученную энергию можно непосредственно использовать для разных целей.
6) Люди научились преобразовывать одни виды энергии в другие.
7) Самый крупный прорыв в этой области случился в XIX веке.
8) Разработка и использование ископаемых видов топлива (угля, нефти, газа) дали толчок (fuel) индустриализации в мире.
9) Преобразования энергии знакомы человеку тысячи лет.
10) Ученые ведут интенсивные исследования в этой области и в настоящее время.

13.Look through the text and try to give a definition of "energy":

What is Energy? Energy does things for us. It moves cars along the road and boats on the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs and lights our homes at night so that we can read good books. Energy helps our bodies grow and our minds think. Energy is a changing, doing, moving, working thing.

Energy is defined as the ability to produce change or do work, and that work can be divided into several main tasks we easily recognize: Energy produces light. Energy produces heat. Energy produces motion. Energy produces sound. Energy produces growth. Energy powers technology.

Answer the questions about the text:

- ✓ How does energy help us every day?
- ✓ How do you understand the phrase: "Energy is a changing, doing, moving, working thing"? Give reasons.

✓ What does energy produce? Give examples.
✓ What forms of energy do you know?

14.Study the following words and phrases from the texts, memorize them:

1) account for (ph.v)	[ə'kauntfɔː]	объяснять
2) ancient (adj)	['eɪn(t)ʃ(ə)nt]	древний; старинный, старый
3) appliance (n)	[ə'plaɪən(t)s]	аппарат, прибор; приспособление, устройство
domestic electric appliances		*бытовые электроприборы*
4) application (n)	[ˌæplɪ'keɪʃ(ə)n]	применение, использование, приложение; заявление
5) apply (v)	[ə'plaɪ]	применять; использовать, употреблять, обращаться с просьбой, заявлением
6) associate (v)	[ə'səusɪeɪt, -ʃɪeɪt]	связывать; ассоциировать; объединять, соединять
7) cause (v, n)	[kɔːz]	послужить причиной; заставлять; причина, основание
8) compound (n)	['kɔmpaund]	строение, структура, целостное образование; смесь; соединение
9) conservation (n)	[ˌkɔn(t)sə'veɪʃ(ə)n]	охрана, сохранение; защита
10)conversion (n)	[kən'vɜːʃ(ə)n]	преобразование; конверсия; превращение; переход
11)convert (v)	['kɔnvɜːt]	преобразовывать; превращать; трансформировать
12)dependent (adj)	[dɪ'pendənt]	зависящий; зависимый; зависящий от
13)disperse (v)	[dɪ'spɜːs]	рассеиваться; рассеивать; рассредоточивать; рассыпать
14)fission (n)	['fɪʃ(ə)n]	расщепление, распадение
15)fossil fuel	['fɔs(ə)l fjuːəl]	ископаемое топливо
16)freezer (n)	['friːzə]	холодильник; холодильная установка, морозильная камера
17)furthermore (adv)	[ˌfɜːðə'mɔː]	к тому же, кроме того; более

		того
18)fusion (n)	['fjuːʒ(ə)n]	слияние, сплав, объединение
19)gasoline (n)	['gæs(ə)liːn]	бензин; газолин
20)give off (ph.v)	[gɪvɔf]	выделять, испускать
21)harness (v)	['hɑːnɪs, -nəs]	использовать (в определенных целях); приспосабливать,
22)internal (adj)	[ɪn'tɜːn(ə)l]	внутренний; душевный, сокровенный
23)multiple (adj)	['mʌltɪpl]	составной; неоднократный, повторяющийся; разнородный; многочисленный, различный
24)namely (adv)	['neɪmlɪ]	а именно, тоесть
25)nonrenewable (adj)	['nɔnrɪ'njuːəbl]	невосстановимый, невозобновляемый (о природных ресурсах и т. п.)
26)oven (n)	['ʌv(ə)n]	печь; духовка
27)partially (adv)	['pɑːʃ(ə)lɪ]	немного, отчасти, частично, частью
28)perceive (v)	[pə'siːv]	воспринимать; ощущать;понимать, осознавать
29)quantitative (adj)	['kwɔntɪtətɪv]	количественный
30)radiant (adj)	['reɪdɪənt]	лучистый; излучающий; радиационный; светящийся, излучающий свет
31)recognize (v)	['rekəgnaɪz]	признавать; узнавать; распознавать; осознавать
32)renewable (adj)	[rɪ'njuːəbl]	восстановимый, возобновляемый (о природных ресурсах и т. п.)
33)replenish (v)	[rɪ'plenɪʃ]	снова наполнять(ся), пополнять(ся)
34)residential (adj)	[ˌrezɪ'den(t)ʃ(ə)l]	жилой; связанный с местом жительства
35)run out of (ph.v)		истощиться, кончиться (о запасах), иссякать
36)store (v)	[stɔː]	хранить, сохранять,

		запоминать
37)supply (v)	[sə'plaɪ]	снабжать (чем-л.), поставлять; доставлять, восполнять, возмещать
38)take into account		учитывать; приниматьвовнимание
39)take on (ph.v)		приобретать (форму, качествоит. п.); брать
40)transmit (v)	[trænz'mɪt]	передавать; отправлять; пересылать; пропускать
41)transverse (adj)	[trænz'vɜːs]	пересекающийся, поперечный
42)tremendous (adj)	[trɪ'mendəs]	огромный; громадный; потрясающий; гигантский
43)undoubtedly (adv)	[ʌn'dautɪdlɪ]	несомненно, явно, бесспорно
44)visible (adj)	['vɪzəbl]	видимый; видный; заметный; очевидный; зримый; явный
45)wire (n)	['waɪə]	проволока; провод, электрический провод, телеграмма

15.Read the text "What is Energy?" and state the main idea of it. Use the Vocabulary above. If necessary, look the words up in the dictionary. Comprise a terminological vocabulary to the text. Make an annotation to the text.

What is Energy?

We hear about energy everywhere. Like most words, "energy" has multiple meanings. What *is* energy, in the scientific sense? You can't actually *see* the energy itself, or smell it or sense it in any direct way–all you can perceive are its *effects*. So perhaps energy is a fiction, a concept that we invent, because it turns out to be so useful.

Energy can take on many different forms. A pitched baseball has kinetic energy, or energy of motion. When the ball is high above the ground, we say it has gravitational energy. Stretching a rubber band stores elastic energy in it.

Corn flakes and gasoline store chemical energy, while uranium and plutonium store nuclear energy. A hot potato contains more thermal energy than it did when it was cold. Electrical energy is transmitted along wires from power plants to appliances, and radiant energy is given off by light bulbs, lasers, stovetops, and stars.

These multiple forms of energy can be *converted* into each other. As the baseball flies upward, its kinetic energy is converted into gravitational energy; as it falls, the gravitational energy is converted back into kinetic energy. Before the energy entered the ball, it was stored as chemical energy in the batter's breakfast. When the ball hits the ground and rolls to a stop, its kinetic energy is converted into thermal energy, warming the ball and the ground very slightly. A slingshot converts elastic energy into kinetic energy; a burning matchstick converts chemical energy into thermal and radiant energy. Our sun converts nuclear energy into thermal and radiant energy. A hydroelectric dam converts gravitational energy into electrical energy, while an electric motor converts electrical energy into kinetic energy.

Civilization's first significant energy invention was fire. It was only about 5,000 years ago that humans began using other energy sources such as wind. In America, the first natural gas light was created in 1821. The first oil well was dug in 1859. The first gasoline car was built in 1892.

Energy conversions have been familiar to humans for thousands of years. Only over the last few centuries, however, did scientists gradually realize that during every energy conversion, they could account for the energy, unit by unit, in a quantitative way. If you carefully measure the amount of energy before and after some process, taking all forms of energy into account, you find that the *total* amount of energy never changes. Energy can be converted from one form to another, but it *cannot* be created, nor can it be destroyed. This principle is one of the deepest in all of science, and also one of the most useful. In scientific jargon, this principle is known as the **law of conservation of energy**, and also as the **first law of thermodynamics**.

In everyday life, "conservation of energy" has a completely different meaning, namely, using *less* of it. Please don't confuse this use of the word "conservation" with the more technical meaning in the previous paragraph. But if energy cannot be destroyed, what does it mean to "use" energy? The answer lies in the fact that some forms of energy are more useful than others. Our modern industrial society converts energy from more useful forms (mostly chemical energy) into less useful forms (dispersed thermal energy) at a tremendous rate. This is some cause for concern, because supplies of energy in useful forms may be limited, and because energy conversions often have unwanted side effects. "Conserving" energy, in the everyday sense of the word simply means carrying out these conversions to a lesser extent.

Thermal energy is the least useful form of energy. Although it *can* be partially converted into other forms (as in an automobile engine where it is partially converted to kinetic energy), this conversion is never complete. Furthermore, thermal energy ends naturally to disperse over time, and once it is widely dispersed, it is effectively useless. These annoying properties of thermal energy are summarized in the **second law of thermodynamics**, a principle that is just as important as the principle of conservation of energy (the first law).

16.Look through the text "What is Electricity?" once again and answer the questions:

1. How do we use energy?
2. From where does energy come?
3. What are different types of energy?
4. Is it impossible to answer the question "What is energy" in one definition? Why?
5. How do you define energy for yourself?
6. What forms of energy can you name?
7. How do scientists define "energy"?
8. Why is energy conversion so important for us? Give some examples of energy conversions.
9. What is the first law of thermodynamics about? Explain it as simply as you can.
10. What other laws of thermodynamics do you know?

17.Name a process or a device (other than those mentioned in the text above) that converts energy in each of the following ways:

(a) from gravitational to kinetic;
(b) from kinetic to thermal;
(c) from thermal to kinetic;
(d) from electrical to thermal;
(e) from electrical to gravitational;
(f) from chemical to gravitational;
(g) from chemical to electrical;
(h) from electrical to chemical;
(i) from nuclear to electrical;
(j) from kinetic to electrical;
(k) from radiant to electrical.

18.Match vocabulary words and their definitions:

1.	to associate	a)	to fill (something) up again
2.	to apply	b)	to acknowledge that something exists or that it is true
3.	to harness	c)	to bring or put into operation or use
4.	to recognize	d)	change the form, character, or function of something
5.	to replenish	e)	to keep or accumulate (something) for future use
6.	radiant	f)	very great in amount, scale, or intensity
7.	to store	g)	preservation, protection, or restoration of the natural environment and of wildlife
8.	to supply	h)	to control and make use of (natural resources), especially to produce energy
9.	tremendous	i)	to a limited extent
10.	partially	j)	to provide with something needed or wanted
11.	conservation	k)	to connect (someone or something) with something else in one's mind
12.	to convert	l)	transmitted by radiation, rather than conduction or convection

19.Look through the text "Forms of Energy" and state the main idea of it. Then do the tasks after the text:

Forms of Energy

We distinguish two main forms of energy: potential and kinetic. As for the first one it is stored energy and the energy of position (gravitational). And the second form – kinetic – is connected with motion: waves, electrons, atoms, molecules and substances.

There are some forms of potential energy. Chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are the examples. As for stored mechanical energy, it is stored in objects by the application of force; compressed springs and stretched rubber bands being the examples. We know that nuclear energy is stored in the nucleus of an atom being the energy that holds the nucleus together. The example is the nucleus of a uranium atom. The energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called fission. The sun combines the nuclei of hydrogen atoms into helium atoms in a process called fusion. In both fission and fusion, mass is converted into energy. Gravitational energy concerns the energy of place or position, for instance, water in a reservoir behind a hydropower dam. A rock resting at the top of a hill contains gravitational potential energy.

Speaking about kinetic energy, we should first mention electrical energy - the movement of electrons, the examples are lightning and electricity. Radiant energy is electromagnetic energy that travels in transverse waves, solar energy is an example. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Light is one more type of radiant energy. Thermal energy or heat is the internal energy in substances – the vibration or movement of atoms and molecules in substances, geothermal energy being an example. One more kinetic energy kind is motion, the movement of a substance from one place to another: this can be wind and hydropower. Sound is also a kind of kinetic energy: the movement of energy through substances in longitudinal waves.

Give translation to the following word combinations from the text above:

- ✓ the energy stored in the bonds of atoms and molecules,
- ✓ by the application of force,
- ✓ compressed springs and stretched rubber bands,
- ✓ the nuclei are combined or split apart,
- ✓ mass is converted into energy,
- ✓ energy that travels in transverse waves,
- ✓ the internal energy in substances,
- ✓ the movement of energy through substances in longitudinal waves.

20.Match the items in Column I with the definitions/phrases in Column II:

1. work	a. total amount of kinetic and potential energy in a system
2. energy	b. energy may change from one form to another, but it cannot be created or destroyed under ordinary conditions
3. potential energy	c. stored energy
4. kinetic energy	d. transfer of energy through motion
5. law of conservation of energy	e. energy in the form of motion
6. mechanical energy	f. the ability to cause change

21.Summarize your knowledge of different forms of energy and fill in the table on the basis of the previous texts and exercises:

Kind of energy	***Definition***	***Examples***
1. Chemical energy	✓ It is the energy stored in the bonds of atoms and molecules.	• biomass, • petroleum, • natural gas…
2. Light energy	✓	• … …
3. Potential energy	✓	• … …
4. Nuclear energy	✓	• … …
5. Kinetic energy	✓	• … …
6. Renewable energy	✓	• … …
7. Mechanical energy	✓	• … …
8. Electrical energy	✓	• … …
9. Sound energy	✓	• … …
10.Gravitational energy	✓	• … …
11.Thermal energy	✓	• … …

22.Combine the words in two columns below to make phrases:

E.g.: global economy.

1) hydropower	*a) panels*
2) energy	*b) waves*
3) sufficient	*c) definition*
4) energy	*d) dam*
5) solar	*e) engines*
6) kinetic	*f) conservation*
7) steam	*g) energy*

8)	energy	*h)*	*technology*
9)	transverse	*i)*	*resources*
10)	scientific	*j)*	*energy*
11)	modern	*k)*	*efficiency*
12)	natural	*l)*	*crises*

Make up sentences using the phrases above.

E.g. The role of energy in the global economy is essential.

23.Use the word in capitals at the end of the lines in the text "The World of Energy" to form a word that fits in the space in this line using the necessary suffixes and prefixes:

The World of Energy

We use the word "energy" daily to refer to *different*	DIFFER
things. We are told, for instance, that certain food does not	
provide sufficient energy; we are told about the	
____________________ of energy resources; or we are	EXPLOIT
warned by the ________________ about the energy crises.	POLITICS
When we are tired, we have "no energy."	
We also hear about ________________ sources of	ALTER
energy and the mention, by some religions and	
pseudosciences, of ______________ energy – and so on.	SPIRIT
But what is energy? In general, energy is "the potential to	
produce change," the capacity to act, transform, or set in	
motion. Other accepted _______________ refer to energy	MEAN
as a _______________ resource and as the technology	NATURE
associated with exploiting and using the resource, both	
industrially and ________________.	ECONOMIC
The development of steam engines during the	
Industrial Revolution generated the need for	ENGINE
________________ to develop formulas and concepts to	
describe the thermal and mechanical efficiencies of the	
systems they were developing. Thus, they began speaking	
about "energy." Energy is an abstract physical quantity.	
This means that it cannot be measured in a pure state but	
that only _________________ of energy in material	VARY
systems can be observed. These variations are equivalent	

to the work required to change one system from its initial state to a subsequent one. Energy cannot be created or destroyed; it can only be transformed from one form to another.

Human ingenuity has been able to put the different forms of energy at its service by developing machines of all kinds. The ___________________ that people throughout history have developed to satisfy their instinct to explore are the inventions that made people move faster and travel farther with less and less energy. The progression from animal-driven __________________ to steam engines and internal-combustion engines is a key to understanding modern ___________________.

INVENT
TRANSPORT
CIVILIZE

Translate the word combinations from the text above:

- ✓ certain food does not provide sufficient energy,
- ✓ we are warned,
- ✓ the potential to produce change,
- ✓ the capacity to act, transform, or set in motion,
- ✓ the technology associated with exploiting and using the resource,
- ✓ to develop formulas and concepts,
- ✓ an abstract physical quantity,
- ✓ it cannot be measured in a pure state,
- ✓ to change one system from its initial state to a subsequent one,
- ✓ energy cannot be created or destroyed; it can be transformed,
- ✓ human ingenuity,
- ✓ to satisfy their instinct to explore,
- ✓ animal-driven,
- ✓ internal-combustion engines,
- ✓ a key to understanding.

Answer the questions concerning the text above:

- ➢ What is “energy” – in general?
- ➢ What need did the steam engines during the Industrial Revolution generate?
- ➢ Name some forms of energy that can be transformed more easily than others.
- ➢ What forms of energy did people put at service by developing various machines?

24.Retell the text "What is Energy". Expand your answer speaking about different forms of energy, possible future trends of development in this field. You may use additional sources of information to speak about historical facts and main historical events connected with the progress in the sphere.

FINAL TASK

Make reports/presentations in groups or individually speaking about various forms of energy. You may also use pictures and some other additional material to help make your report informative and interesting. Be sure to emphasize their definitions, sphere of usage, examples, peculiarities, modern trends in today's changing economic conditions.

You may choose one of the following topics:

- Chemical energy
- Light energy
- Nuclear energy
- Mechanical energy
- Electrical energy
- Sound energy
- Gravitational energy
- Thermal energy

UNIT I SELF-ASSESSMENT

Fill in the table below assessing yourself 1/2/3. Use the information below:

I know:	
1. the vocabulary of the Unit	
2. terms and their definitions	
3. English grammar rules of the Unit (Active and Passive Voice)	
4. word-building elements (suffixes) from the Unit	
I can:	
1. use active vocabulary of the Unit	
2. give a definition of energy	
3. identify different energy types that exist	
4. define potential and kinetic energy	
5. understand basic concepts from the Unit (energy, potential energy, kinetic energy, …)	
6. compare different types of energy and differentiate them	
7. make sentences using the English Tenses in the Active and Passive Voice	
8. form new words using different suffixes.	
TOTAL:	

The basis for your assessment:

Я знаю и понимаю 85-100% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу. Я умею использовать времена активного и пассивного залога правильно.	3	☺
Я знаю и понимаю 50-85% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу, но иногда допускаю ошибки. Я умею использовать времена активного и пассивного залога, но иногда допускаю ошибки.	2	😐
Я знаю и понимаю менее 50 % слов и понятий. Я плохо владею произношением и орфографией, частично способен к двуязычному переводу, часто допускаю ошибки. Я не понимаю и не умею использовать правильно времена активного и пассивного залога, часто допускаю ошибки.	1-0	☹

<u>Results</u>: 30-36 points – Excellent, 24-29 – Good, 15-23 – Satisfactory.
If your result is below 15, you should work with the material of the unit again!

UNIT I – REVISION TASKS

1. Translate the sentences into Russian paying attention to the use of the Passive Voice:

1. Electrical energy is transmitted along wires from power plants to appliances.
2. Radiant energy is given off by light bulbs, lasers, stovetops and stars.
3. Multiple forms of energy can be converted into each other.
4. The kinetic energy is converted into gravitational energy.
5. The gravitational energy is converted back into kinetic energy.
6. The energy was stored as chemical energy.
7. Energy can be converted from one form to another, but it cannot be created, nor can it be destroyed.
8. This principle is known as the law of conservation of energy.
9. Once thermal energy is dispersed, it is useless.
10. The properties of energy are summarized in the second law of thermodynamics**.**

2. Choose the right variant:

1) **Which of the following is the best definition for Kinetic Energy?**
   A. The energy of chemical bonds
   B. The energy of objects with heat
   C. The energy that is stored
   D. The energy of movement

2) **When a tennis ball bounces on the floor, which of the following best describes what happens to the height of the rebound bounce of the ball?**
   A. The ball comes back to the height it was dropped from originally
   B. The ball comes back to some fraction of the height it was dropped from originally
   C. The ball comes back to a height higher than it was dropped from originally

3) **Which of the following is the best definition for Potential Energy?**
   A. The energy of chemical bonds
   B. The energy of objects with heat
   C. The energy that is stored
   D. The energy of movement

4) **What percentage of energy can be transformed when an energy transformation from potential to kinetic occurs?**
   A. More than 100 %
   B. 100%
   C. Less than 100%

5) **Which of the following choices are all forms of energy?**
   A. Light, Sound, Heat, and Inertia
   B. Chemical Potential, Friction and Gravitational Pull
   C. Light, Mechanical, Electrical and Friction
   D. Light, Electrical, Mechanical and Heat

6) **Which of the following describes the energy transformations needed to light up the light bulb on the generator?**
   A. Chemical Potential to Mechanical to Electric and then Light
   B. Chemical Potential to Electric to Mechanical and then Light
   C. Chemical Potential to Light to Electric and then Mechanical

3. Fill in the blanks with the words from the box. You can use words more than once. Use the text "Forms of energy" if necessary:

• radiant	• kinetic
• gravitational	• potential
• chemical	• sound
• thermal	• motion
• nuclear	• conservation of energy
• electrical	• energy efficiency
• mechanical	

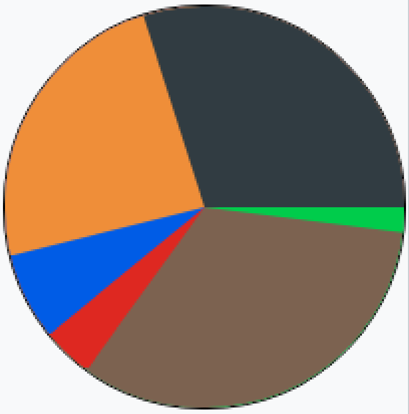
1. Energy that is stored within an object is called _________ energy.
2. Compressed springs and stretched rubber bands store__________ energy.
3. The vibration and movements of the atoms and molecules within substances is called heat or _________ energy.
4. The energy stored in the centre of atoms is called _________ energy.
5. The scientific rule that states that energy cannot be created or destroyed is called the Law of _________.
6. The movement of energy through substances in longitudinal waves is _________
7. The energy of position – such as a rock on a hill is ___________ energy.
8. The movement of objects and substances from place to place is _______ energy.
9. Electromagnetic energy traveling in transverse waves is _________ energy.

10. Energy stored in bonds of atoms and molecules is ________ energy.
11. The movements of atoms, molecules, waves and electrons is ________ energy.
12. The movement of electrons is ________ energy.
13. The amount of useful energy you get from a system is its _______________.
14. The energy in petroleum and coal is stored as ________ energy.
15. X-rays are an example of ________ energy.
16. Fission and fusion are examples of ________ energy.
17. A hydropower reservoir is example _______________ energy.
18. Wind is an example of the energy of ________.

4. Read the text "World energy consumption" and state the main idea of it. Translate it into Russian. Say what you think about possible future trends in the sphere of energy on a global scale.

World Energy Consumption

World energy consumption is the total energy used by the entire human civilization. It involves all energy harnessed from every energy source applied in every industrial and technological sector in every country. Being the power source metric of civilization, World Energy Consumption has deep implications for humanity's socio-economic-political sphere.



World total primary energy consumption by fuel in 2015[2]

Coal (30%)
Natural Gas (24%)
Hydro (7%)
Nuclear (4%)
Oil (33%)
Others (Renewables) (2%)

Institutions such as the International Energy Agency (IEA), the U.S. Energy Information Administration (EIA), and the European Environment Agency (EEA) record and publish energy data periodically. Understanding World Energy Consumption may reveal systemic trends and patterns, which could help frame current energy issues and encourage movement towards collectively useful solutions.

From 2000–2012 coal was the source of energy with the largest growth. The use of oil and natural gas also had considerable growth, followed by hydropower and renewable energy. Renewable energy grew at a rate faster than any other time in history during this period. The demand for nuclear energy decreased, in part due to nuclear disasters.

https://en.wikipedia.org/wiki/World_energy_consumption

UNIT II

What is Electricity?

"I am reminded of the professor, who when asked the question "What is electricity?", replied ***"It all depends what you mean by 'is' "****. (A. Gilchrist)*

1.Here are some answers to this question. Read and translate them. What do you think about all these opinions?

Loring Chien, electrical engineer for 40 years:

– Basically its the flow of charged electrons. All other descriptions take off from there. How they flow, and how they're controlled and how they're created and what wonderful things we have been able to do with them.

Robin Chrystie, Scientist, Inventor, Optimist:

– That's a good fundamental (and big) question! Some definitions in the literature are comprehensive, but not always comprehensible.

Zhenya Savchenko, Designer, Engineer:

– No one really knows. It's virtually everywhere around us. We sort of know how it behaves. Engineers will jump to explain how it works, but have a hard time explaining what it is without introducing a bunch of other unknowns.

Zach Imholte, Electrical Engineer, Interested in Everything:

– Electricity generally refers to electrical energy. Electrical energy comes in many forms that we may use for practical applications. Generally speaking, this is either as a voltage (a potential difference) or as a current (the movement of charge carriers).

2.Before starting to work with the Unit II, be ready to discuss the following .

- ✓ What could our life be without electricity?
- ✓ What do you know about electricity?
- ✓ Name some scientists who contributed greatly to the development of electricity?
- ✓ What are the advantages/ disadvantages of using electricity?
- ✓ What electrical devices do people use in their daily lives?

3.Read the international words and give their translation. Pay attention to their pronunciation:

electricity, adequate, microscope, confuse, engineers, correct, term, conflicting, encyclopedia, electrons, protons, electric, electromagnetic, battery, generator, static, class, phenomenon, bioelectricity, atmospheric, potential, plasma, electrodynamics, electrostatics.

4.Read the words and their derivatives. Translate them into Russian paying attention to their meaning:

1) electric – electron – electrical – electricity
2) confuse – confusion – confused – confusing – confusable– confusedly
3) introduce – introduction – introductory
4) engine – engineer – engineering – engineered
5) generate – generator – generation – generative
6) define – definite – definitely – definition – definable – definiteness
7) apply – applied – application – applicant – applicable – applicability

It has been theorized that an artifact discovered in Iraq, and thought to date from sometime between 224 and 640 CE, might have been a type of battery.

It consisted of small terracotta pot containing a copper tube surrounding an iron rod. If filled with an electrolyte, such as grape juice, it can produce an electric current.

Most scientists, however, think that the pots were used for storing scrolls and that their ability to generate a current is purely coincidental.

5.Form adjectives using the necessary suffixes (**-able, -ible). **Translate the words:

- ✓ practice
- ✓ define
- ✓ attain
- ✓ comprehend
- ✓ access
- ✓ control
- ✓ explain
- ✓ response
- ✓ recharge

Make up sentences using the adjectives you've made.

E.g. As a result, the desire for bar coding technology in healthcare has grown as a realistic and **applicable** solution.

6.Fill in the table of derivatives with the appropriate words paying attention to the use of different suffixes you know. Translate the words:

Verb	Noun	Adjective	Adverb
relate	***relationship***	***relative***	***relatively***
	charge		
invent			
		measurable	
			basically
	safety		
			creatively
sense			
		practical	
	description		
			unfortunately
	manifestation		

7.Study the following information about special questions. Be ready to explain the difference between subject and object questions:

•When we ask questions about the *subject* of a sentence, the word order in the question and the answer is the same:

Edison invented a commercially viable electric light.

Who *invented* a commercially viable electric light?

~~Who did invented a commercially viable electric light?~~

• We use *what, who, which, whose* and *how many, how much* in questions about the subject.

What *was invented* by Edison?

•Questions about the *object* of a sentence need an auxiliary verb (do/does, did, have/has, is/are, etc.) before the subject:

Edison invented a ***Phonograph***.

What did *Thomas Edison* ***invent?***

• *We use* **what, which, who, whose, when, where, how often**, *etc. in questions about the object.*

/ Which device did Edison **invent?**

~~**/ Which device Edison invented?**~~

8. Look through the table below – you can see a summary of question words with examples., read the questions and translate them:

Question word	Example: <u>Subject</u> question	Example: <u>Object</u> question
who	Who knows you?	Who do you know here? (Whom is very formal.)
what	What caused the problem?	What problem did the device cause?
what kind of	What kind of energy exists?	What kind of energy do you know?
which	Which device was sold most?	Which device did you like?
whose	Whose invention won the prize?	Whose invention did they choose?
How many	How many scientists came to the conference?	How many people did you see there?
why		Why didn't this device work?
when		When will you fix it?
how		How do we use this kind of energy?
How far		How far is the laboratory from here?
How long		How long does it take to get there?
How often		How often do you work there?

NOTES:

1. Change the place of a preposition in questions about the object:

He gave the task to John. – Who did he give the task *to?*

Or *To whom did he give the task? (= formal)*

We got the device from the USA. – Where did you get the device *from?*

or *From where did you get the device? (= formal)*

2. What or Which?

We use what when the choice is open. *What color* do you like*? (= open choice)* *What inventions* did he create*? (= open choice)*	*We use which when there is a limited choice:* *Which color* do you prefer, red or blue*?(= limited choice)* *Which inventions* did he create those days*? (= limited choice)*

9.Put the words in the questions below in the right order:

1. where/ Edison /born/ was?
2. did / where / he / grow up?
3. was / he / what / childhood / interested / in / in / his ?
4. like /what / was / Edison / as / a young child?
5. when / invention / make / he / did / first / his?
6. what/ first/his / invention /was?
7. him/ invention / made / famous / did / what?
8. how / public/ when / react / did / the / phonograph / he / demonstrated / his?
9. how / he / first /when / station/ old / power/ launched / was / he / the?
10. what / of / energy / used / kind / sources / were / there?

10.Ask a question about the information underlined in each of the following sentences using **who, what** ***or*** **another question word*****:***

1. One of the greatest pioneers in electricity was Thomas Edison.
2. Thomas Edison lived in the USA.
3. Edison was an inventor, an innovator and a successful businessman.
4. The world's first industrial research laboratory was created by Edison.
5. Edison developed the first commercial incandescent bulb.
6. Edison made thousands of unsuccessful attempts at inventing the light bulb.
7. It took one and a half years to perfect the concept of the incandescent light bulb.
8. In order to develop a successful incandescent light, Edison had to design an entire electrical system.
9. Edison launched the modern electricity in 1882 in New York City.
10. The Pearl Street Station was the first central electric power plant in the United States.

11.Study the following words and phrases from the texts, memorize them:

1. ampere	['æmpeə]	ампер
2. atmospheric	[ˌætməs'ferɪk]	атмосферный, создающий определённую атмосферу

3. attract (v)	[ə'trækt]	привлекать, притягивать
4. backbone (n)	[bakbəʊn]	основа; суть; сущность
5. Basic Electricity		курс основ электротехники
6. be nothing but		не что иное, как
7. breakthrough (n)	['breɪkˌθruː]	прорыв, достижение, открытие, крупное достижение
8. circuit (n)	['sɜː.kɪt]	цепь, схема; контур; электрическая цепь
9. closed loop	['kləʊzd'luːp]	замкнутый цикл; контур; простой цикл
10.common sense	['kɒmən'sens]	здравый смысл
11.comprehensible (adj)	[kɒmprɪ'hɛnsɪbl]	понятный, постижимый, вразумительный
12.comprehensive (adj)	[kɒmprɪ'hɛnsɪv]	всесторонний, обширный, тщательный; подробный
13.confuse (v)	[kən'fjuːz]	смущать, смешивать, сбивать с толку, спутывать
14.contradictory (adj)	[kɒntrə'dɪkt(ə)rɪ]	противоречивый, противоречащий, несовместимый
15.coulomb (n)	['kuːlɒm]	кулон, Кл в системе СИ; единица измерения величины эл.заряда, (названа в честь франц.инженера, физика Чарльза Кулона)
16.define (v)	[dɪ'faɪn]	определять, устанавливать, обозначать, характеризовать
17.discard (v)	[dɪs'kɑːd]	отбрасывать, выбрасывать, отказываться
18.filament (n)	['fɪləmənt]	нить; нить накала, волокно, волосок; крупица, малая толика
19.foresee (v)	[fɔː'siː]	предвидеть, провидеть, знать заранее
20.grasp the concept		понятьсуть

21.harness (v)	['hɑː.nəs]	использовать; обуздывать, покорять, укрощать
22.imbalance (n)	[ɪm'bæləns]	отсутствие равновесия; неустойчивость; дисбаланс
23.incandescent (adj)	[ˌɪnkæn'des(ə)nt]	раскалённый, накалённый добела; яркий, светящийся, сияющий
24.incompatible (adj)	[ɪnkəm'patɪb(ə)l]	несовместимый, несочетающийся
25.involve (v)	[ɪn'vɒlv]	включать, вовлекать, включать в себя, предполагать, подразумевать
26.jump to it	[dʒʌmp]	энергично приступить к делу; предпринять быстрые действия
27.lack (v)	[læk]	испытывать недостаток, нуждаться, не иметь
28.manifestation (n)	[ˌmænɪfes'teɪʃn]	проявление, манифестация, обнародование; обнаружение
29.mean (v)	[miːn]	означать, значить
30.means (n)	[miːnz]	средство, способ
31.motion (n)	['məʊʃ(ə)n]	движение, ход, перемещение
32.phenomenon (n) *pl. phenomena*	[fɪ'nɒmɪnən]	явление, феномен мн.ч. явления
33.pin down (ph.v)	['pinˌdaʊn]	точно определить, установить; заставить (выполнить обещание), поймать на слове
34.possess (v)	[pə'zes]	обладать, владеть, овладевать, захватывать, сохранять, удерживать
35.sensible (adj)	['sɛnsɪb(ə)l]	разумный, здравомыслящий, здравый, благоразумный
36.separate (adj)	['seprət]	отдельный; изолированный; обособленный, особый
37.sort of	[sɔːt əv]	отчасти;какбы, вроде
38.spark (n)	[spɑːk]	искра, вспышка

39.vague (adj)	[veɪg]	смутный; неопределенный; неясный; нечеткий
40.versatility (n)	[ˌvɜːsəˈtɪlɪti]	разносторонность, многосторонность
41.virtually (adv)	[ˈvəːtʃʊəli]	фактически, в действительности; по существу, на деле
42.witness (v)	[ˈwɪtnəs]	быть свидетелем, очевидцем; видеть; свидетельствовать
43.wrongly (adv)	[ˈrɒŋli]	ошибочно, неправильно, по ошибке; по недоразумению

12.Read an extract from the article by William J. Beaty. Try to understand it. If you need, look the words/word combinations up in the dictionary. Comprise a terminological vocabulary to the text. You may use the Vocabulary List and exercises above. Make an annotation to the text.

What is Electricity?

What is electricity? This question is impossible to answer because the word "Electricity" has several contradictory meanings. These different meanings are incompatible, and the contradictions confuse everyone. If you don't understand electricity, you're not alone. Even teachers, engineers, and scientists have a hard time grasping the concept.

Obviously "electricity" cannot be several different things at the same time. Unfortunately we've defined the word *Electricity* in a crazy way. Because the word lacks one distinct meaning, we can never pin down the nature of electricity. […]

Below are the five most common meanings of the word Electricity. Which one do you think is right? Think about this carefully, because if one of these meanings is correct, all the others must be wrong! After all, no "science term" must ever possess several conflicting definitions. Unfortunately our dictionaries and encyclopedias contain all of these contradictions.

1. The scientist's definition: "Electricity" means only one thing: quantities of electricity are measured in Coulombs, so "electricity" is the electrons and protons themselves; the electric charge inside the wires, and not the flow.

Examples: current of electricity, quantity of electricity, coulombs of electricity.

2. The everyday definition: "Electricity" means only one thing: the electromagnetic field energy sent out by batteries and generators.

Examples: price of electricity, kilowatt-hours of electricity.

3. The grade-school definition: "Electricity" means only one thing: it refers to the flow of electrons, the flowing motion of electric charge.

Examples: "current" electricity, amperes of electricity.

4. "Electricity" means only one thing: it refers to the amount of imbalance between quantities of electrons and protons.

Example: "static" electricity, discharge of electricity.

5. "Electricity" is nothing other than the classes of phenomena involving electric charges.

Examples:

bioelectricity,
piezoelectricity,
triboelectricity,
thermoelectricity,
atmospheric electricity
...etc/

6. Other less common definitions:

"Electricity" refers to the flowing motion of electrical energy (electric power, Watts of electricity)

"Electricity" really means the electric potential or e-field (Volts of electricity)

"Electricity" only means the glowing nitrogen/oxygen plasma (sparks of electricity)

"Electricity" is nothing but a field of science (Basic Electricity). […]

For the same reason, we'll never find a simple answer to the question "what is electricity?" because the question itself is wrong. First we must realize that "electricity" does not exist. There is no single thing named "electricity." We must accept the fact that, while several different things do exist inside wires, people wrongly call all of them by a single name.

Although it is possible to trace the history of the harnessing of electrical power and identify the people responsible for various breakthroughs along the way, it is difficult to put a name to the person who first discovered electricity.

Very early in human history, people would have witnessed lightning, an obvious natural manifestation, but would have been unable to explain it.

The known history of electricity goes back to at least 620-550 BC, when, ancient Greeks found that rubbing fur on amber caused an attraction between the two. This discovery is credited to the philosopher Thales of Miletus. There were many centuries before one was able to connect this phenomenon with lightning, and a century more before electrical currents were put to practical use.

So never ask "what is electricity". Instead, discard the word "electricity" and begin using the correct names for all the separate phenomena. Here are a few of them:

What is electric charge?
What is electrical energy?
What are electrons?
What is electric current?
What is an imbalance of charge?
What is an electric field?
What is voltage?
What is electric power?
What is a spark?
What is electromagnetism?
What is electrical science?
What is electrodynamics?
What is electrostatics?
What are electrical phenomena?

The above questions all have sensible answers. But if you ask ‘what is electricity?’ then all of the answers you'll find will just confuse you, and you'll never stop asking that question.

13.Look through the text “What is Electricity?” once again and answer the questions:

1. Why is it impossible to answer the question “What is electricity”?
2. Why must no science term ever possess several conflicting definitions?
3. How do we define electricity in our daily life?
4. How do scientists define “electricity”?
5. What does electricity mean in the grade-school?
6. Does electricity exist? Explain your answer.
7. Using the English-English dictionary (if necessary), give definitions of some electric phenomena, namely:
    - *electric charge*
    - *electrical energy*
    - *electrons*
    - *electric current*
    - *an imbalance of charge*

- *an electric field*
- *voltage*
- *electric power*
- *a spark*
- *electromagnetism*
- *electrical science*
- *electrodynamics*
- *electrostatics*

8. What definition of electricity do ***you*** use?

14.Match vocabulary words and their definitions:

1) to confuse	a) to throw something away or get rid of it because you no longer want or need it
2) direct current	b) a form of electricity that regularly changes direction as it flows, and that is the form of electricity used in homes and buildings
3) to lack	c) based on or acting on good judgment and practical ideas or understanding
4) to define	d) notable to exist or work with another person or thing because of basic differences
5) to discard	e) to be very different from each other
6) virtually	f) electrical current that moves in one direction only
7) alternating current	g) to describe the meaning of something, esp. a word, or to explain something more clearly so that it can be understood
8) imbalance	h) to cause someone to feel uncertain or unclear, or to make something difficult to understand
9) sensible	i) a situation in which two or more things are not equal in size, power, importance, etc. or in which one group has more advantages than the other
10) contradictory	j) to not have or not have enough of something that is needed or wanted
11) incompatible	k) giving light, bright
12) incandescent	l) almost

15.Fill in the sentences with necessary words using the active vocabulary from the box:

✓ direct current	✓ lack
✓ were confused	✓ sensible
✓ incompatible	✓ contradictory
✓ define	✓ meant

1. If equipment or software is _________________ with other equipment or software, it will not work with it.
2. We ______________________ by the fact that the signs pointed in opposite directions.
3. "_____________________ of time" is frequently cited as the reason for poor-quality work.
4. I think the _________________ thing to do is call and ask for directions.
5. It is very difficult to ___________________ the concept of electricity.
6. I keep getting ___________________advice – some people tell me to keep it warm and some tell me to put ice on it.
7. These batteries are _________________to last for a year.
8. All our transmission is done at high voltage _________________.

16.Use the word in capitals at the end of the lines in the text "Electricity" to form a word that fits in the space in this line using the necessary suffixes and prefixes:

Electricity

Electricity is a general term that encompasses a *variety* of phenomena resulting from the presence and flow	VARY
of electric charge. These include many easily _________________ phenomena, such as lightning and	RECOGNIZE
static electricity, but in _________________, less familiar	ADD
concepts, such as the electromagnetic field and electromagnetic induction.	
In general usage, the word "electricity" is adequate to refer to a number of physical effects. In ______________	SCIENCE
usage, however, the term is vague, and these related, but distinct, concepts are better identified by more precise terms (electric charge, electric current, electric field,	

electric potential, electromagnetism).

Electrical phenomena have been studied since antiquity, though advances in the science were not made until the seventeenth and eighteenth centuries. _______________applications for electricity however remained few, and it would not be until the late nineteenth century that engineers were able to put it to _______________ and residential use. The rapid _______________ in electrical technology at this time transformed industry and society. Electricity's extraordinary versatility as a source of energy means it can be put to an almost _______________ set of applications which include transport, heating, lighting, communications, and _______________. The backbone of modern industrial society is, and for the _______________ future can be expected to remain, the use of electrical power.

PRACTICE
INDUSTRY
EXPAND
LIMIT
COMPUTE
FORESEE

Translate the word combinations from the text above:

- ✓ term that encompasses a variety of phenomena,
- ✓ the presence and flow of electric charge,
- ✓ less familiar concepts,
- ✓ in general usage,
- ✓ a number of physical effects,
- ✓ the term is vague,
- ✓ better identified by more precise terms,
- ✓ electrical phenomena have been studied since antiquity,
- ✓ advances in the science were not made until the 17^{th} and 18^{th}centuries,
- ✓ it would not be until the late 19^{th}century that engineers were able to put it to use,
- ✓ electricity's extraordinary versatility,
- ✓ the backbone of modern industrial society.

Answer the questions:

- ➢ Explain what "electricity" is?
- ➢ What phenomena does electricity include?
- ➢ How long have the electrical phenomena been studied?
- ➢ Why can electricity be put to an almost every set of applications including transport, heating, lighting, etc.?

17.Look through the text below opening the brackets and paying attention to the use of the Active Voice and the Passive Voice in it. State the main idea of it:

Most people ______________ (***know***) what electricity is. It ______________ (***come***) out of the wall sockets in our homes and _______________ (***make***) the lights go on. It can hurt you if you touch it. Why is that? Why do you get a shock when you touch a doorknob? Lightning _____________ (***look***) like electricity. Why is that?

Everything in the world __________________ (***make***) up of tiny particles called atoms. They are so small that they cannot ____________________ (***see***) even with a microscope. Atoms __________________ (***make***) of two kinds of electric charge: the positive charges and the negative charges. Most of the time, there are just as many positive charges as negative charges. Each positive charge ________________ (***have***) a negative partner. Sometimes, however, there are too many of one kind of charge. These extra charges ________________ (***go***) looking for a companion. These negative charges ____________________ (***call***) electrons and ____________________ (***hold***) very tightly in the atom so it is easy for them to move around. The moving electrons _________________ (***make***) up what we _________________ (***call***) electricity. There are two kinds of electricity: static and current.

Static electricity is what _________________ (***make***) your hair stand up when you _________________ (***rub***) a balloon against it. It can give you a shock from your doorknob. In static electricity, electrons ___________________ (***move***) around mechanically (by someone rubbing two things together). When you _________________ (***touch***) a doorknob, all the charge wants to leave you and go to the doorknob. You _________________ (***see***) a spark and get a shock as the electrons leave you. Lightning is also the result of static electricity.

In current electricity, electricity has to flow in a closed loop, it ______________ (***call***) a circuit. If the loop ________________ (***break***) anywhere, the electricity can't get through. Electric charges _______________ (***have***) a certain amount of energy. The measure of this energy ________________ (***call***) voltage (Volts).The electrons moving through a circuit _______________ (***call***) a current.

The electrons in a circuit have to _________________ (***push***) by something, like a battery. When we turn on a flashlight the electrons _________________ (***race***) out of the battery through the wires to get to where the positive charges are. On their way, they __________________ (***run***) through the wire inside the light bulb. The thin wire inside the bulb gets very hot and makes light.

https://wonders.physics.wisc.edu/what-is-electricity/

Translate the following phrases from the text above into Russian:

- ✓ the wall sockets in our homes
- ✓ tiny particles called atoms
- ✓ there are too many of one kind of charge
- ✓ electricity has to flow in a closed loop
- ✓ the electricity can’t get through
- ✓ on their way
- ✓ through the wire inside the light bulb

Answer the questions about the text:

- ✓ What two kinds of electric charge are atoms made of?
- ✓ What are the kinds of electricity?
- ✓ How can we get static electricity? Give examples.
- ✓ What is current electricity?
- ✓ What is a circuit?
- ✓ What is a current?

18. Combine the words in two columns to make phrases:

E.g.: static electricity.

1.	electric	*a)*	*energy*
2.	energy-saving	*b)*	*voltage*
3.	power	*c)*	*current*
4.	atomic	*d)*	*consumption*
5.	supply	*e)*	*power*
6.	atmospheric	*f)*	*equipment*
7.	electricity	*g)*	*plant*
8.	alternating	*h)*	*electricity*
9.	electrical	*i)*	*technologies*

Make up sentences using the phrases above.

E.g. Before understanding **static electricity**, we first need to understand the basics of atoms and magnetism.

19.Retell the text “What is Electricity” using your active vocabulary. You may expand your answer speaking about electrical phenomena, great scientists in the sphere. Emphasize the advantages that electricity brought into our lives and the spheres of life that are based on its usage.

FINAL TASK

Prepare a presentation about one of the famous scientists/ inventors who made a great contribution to the development of electricity. You may do it in groups or individually. The list of possible personalities for the presentation includes T.Edison, M.Faraday, G.Volta, W.Gilbert, N.Tesla.

Find pictures, videos, data that will help to make your presentation vivid, impressive and interesting. Be ready to tell the group about:

- some biographical information concerning the inventor
- main inventions
- interesting facts about the inventor/inventions
- how the inventions influence the development of electricity
- famous quotations of the scientists.

UNIT II SELF ASSESSMENT

Fill in the table below assessing yourself 1 / 2 / 3. Use the information below:

I know:		
1. the vocabulary of the Unit		
2. terms and their definitions		
3. English grammar rules of the Unit (special and general questions)		
4. word-building elements (suffixes) from the Unit		
I can:		
1. use active vocabulary of the Unit		
2. identify different electrical phenomena that exist		
3. define electricity		
4. understand basic concepts from the Unit (electricity, charge, current …)		
5. make special and general questions using Active and Passive Voice Tenses		
6. form new words using different suffixes.		
TOTAL:		

The basis for your assessment:

Я знаю и понимаю 85-100% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу. Я умею правильно использовать времена активного и пассивного залога, строить вопросительные предложения.	3	☺
Я знаю и понимаю 50-85% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу, но иногда допускаю ошибки. Я умею правильно использовать времена активного и пассивного залога, строить вопросительные предложения, но иногда допускаю ошибки.	2	😐
Я знаю и понимаю менее 50 % слов и понятий. Я плохо владею правильным произношением и орфографией, частично способен к двуязычному переводу, часто допускаю ошибки. Я не понимаю и не умею использовать правильно времена активного и пассивного залога, строить вопросительные предложения, часто допускаю ошибки.	1-0	☹

<u>Results</u>: 27-30 points – Excellent, 20-26 – Good, 11-19 – Satisfactory.
If your result is below 11, you should work with the material of the unit again!

UNIT II - REVISION TASKS

1.Give each electric term its definition from the next column. If necessary, look the words up in the dictionary, paying attention to the pronunciation of the terms. Learn the words:

1)	voltage ['vəultɪʤ, 'vɔl]	A.	a long thin piece of metal that is used to fasten things or to carry electric current
2)	charge [ʧɑːʤ]	B.	electric polarization in a substance (especially certain crystals) resulting from the application of mechanical stress; it is widely used in microphones, gramophone pickups, and earphones, and also to generate a spark for lighting gas
3)	discharge [dɪs'ʧɑːʤ]	C.	a colorless, odorless reactive gas, the life-supporting component of the air
4)	current ['kʌr(ə)nt]	D.	a measure of electrical energy equivalent to a power consumption of one thousand watts for one hour
5)	coulomb ['kuːlɔm]	E.	the SI unit of electric charge, equal to the quantity of electricity conveyed in one second by a current of one ampere
6)	electron [ɪ'lektrɔn]	F.	an electrical current's force measured in volts
7)	proton ['prəutɔn]	G.	a unit of electric current equal to a flow of one coulomb per second
8)	wire ['waɪə]	H.	a stable subatomic particle with a charge of negative electricity, found in all atoms and acting as the primary carrier of electricity in solids
9)	kilowatt-hour ['kɪləwɔtauə]	I.	the chemical element of atomic number 7, a colorless, odorless unreactive gas that forms about 78 per cent of the earth's atmosphere

10)	ampere ['æmpeə]	J.	storing electrical energy in a battery or a battery-operated device
11)	piezoelectricity [pɪˌetsəʊˌilɪk'trɪsətɪ]	K.	the quantity determining the energy of mass in a gravitational field or of charge in an electric field
12)	triboelectricity [ˌtraɪboʊˌɪlɛk'trɪsɪti]	L.	release or neutralize the electric charge of an electric field, battery, or other object
13)	potential[pə'tenʃ(ə)l]	M.	a stable subatomic particle occurring in all atomic nuclei, with a positive electric charge equal in magnitude to that of an electron
14)	nitrogen['naɪtrəʤən]	N.	a flow of electricity through a wire or circuit
15)	oxygen['ɔksɪʤən]	O.	electric charge generated by friction

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

- ***Make up sentences, using the electric terms above to explain some electric phenomena.***

2.Read the text below and state the main idea of it. Translate it into Russian. Say what you know about generators and their usage today.

At homes, electricity is used for lighting and for operating vacuum cleaners, television sets, and other appliances to make our lives comfortable. It's also often used for cooking and heating. It's used to drive machines and computers in factories and offices. It provides power for telephone and broadcasting systems. It's used to drive electric trains, and when stored in batteries it's used to power certain motor vehicles - it's even possible to have an electrically driven car. The production of electricity supply power for all this thing is carried out by means of generators. Isolated buildings in rural areas, such as farm houses, may have small generators fuelled by petrol to make the electricity they need. Small generators like these are also used to supply electric power to settlements in developing countries. But in most industrialized nations, the making of electricity is done on a huge scale at vast electricity power stations. Here, large generators are used, but these must be driven by some kind of engine or turbine for which energy has to be provided. The turbine may be driven by steam turbine, coal, oil, or natural gas may be passed through the boiler.

3.Make up questions to the text above. Start with the following:

Special questions TO THE OBJECT:

What …____?
Where …____?
How … ____?
How many … ____?
Why … ____?
Who … ____?

Special questions TO THE SUBJECT:

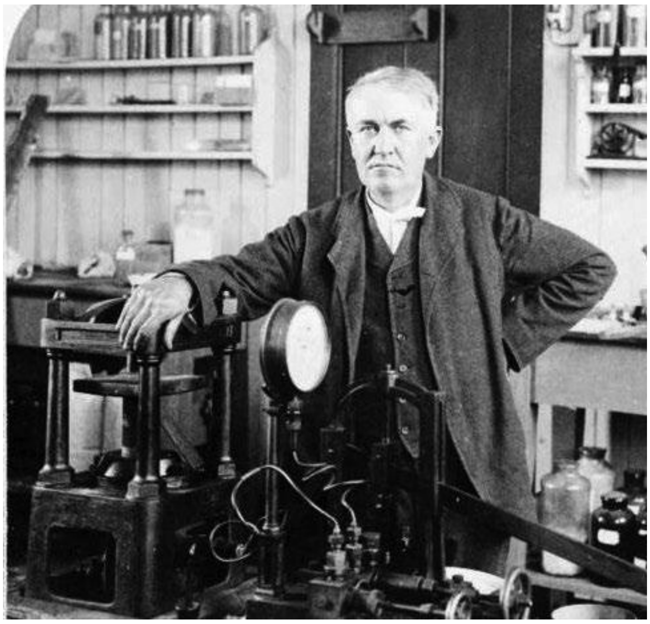
What …____?
Who …____?

General questions:

Do … ____?
Does … ____?
Will … ____?
Have … ____?
Is… ____?
Are …____?
Did …____?
May … ____?

4.Read the text about Mr. Edison and his great invention. Say what you know about him and name his inventions/ important contribution into the development of electricity.

Mr. Edison and His Light



In 1879, Thomas Edison focused on inventing a practical light bulb, one that would last a long time before burning out. The problem was finding a strong material for the filament, the small wire inside the bulb that conducts electricity.

Finally, Edison used ordinary cotton thread that had been soaked in carbon. This filament didn't burn at all - it became incandescent; that is, it glowed.

The next challenge was developing an electrical system that could provide people with a practical source of energy to power these new lights. Edison wanted a way to make electricity both practical and inexpensive. He designed and built the first electric power plant that was able to produce electricity and carry it to people's homes.

Edison's Pearl Street Power Station started up its generator on September 4, 1882, in New York City. About 85 customers in lower Manhattan received enough power to light 5,000 lamps. His customers paid a lot for their electricity, though. In today's dollars, the electricity cost $5.00 per kilowatt-hour!

UNIT III

Sources of Energy

Before starting to work with the Unit III, be ready to discuss the following .

- ✓ What sources of energy do you know?
- ✓ Which of them are widely used in our daily lives?
- ✓ What sources of energy will be in priority in the future, and why?

1.Read the international words and give their translation. Pay attention to their pronunciation:

period, transport, factor, problem result, role, scenario, modern, commercial, traditional, ocean, perspective, type, final, radiation, collector, turbine, balance, tropical

2.Read the words and their derivatives. Translate them into Russian paying attention to their meaning:

9) continue – continuation – continual – continually – continuous – continuously
10) doubt – doubtful – doubtless – doubted – undoubtedly
11) desire – desired – desirable – desirably – desirability
12) certain – certainty – uncertainty – certainly
13) exhaust – exhaustion – exhausting – exhaustible – exhaustingly
14) foresee – foreseeable – unforeseeable – foreseen – foreseeingly
15) category – categorize – categorization

3.Fill in the table of derivatives with the appropriate words paying attention to the use of different suffixes you know. Translate the words:

Verb	**Noun**	**Adjective**	**Adverb**
relate	***relationship***	***relative***	***relatively***
	dependence		
explore			
		valuable	
			definitely
	uncertainty		
classify			
		traditional	
	totalizer		

4.Form verbs adding the suffix – fy (-ify) to the nouns and adjectives. If necessary, consult the dictionary. Translate the words:

✓ class	✓ glory	✓ intensive
✓ identity	✓ sign	✓ simple
✓ dignity	✓ specific	✓ just
✓ purity	✓ dense	✓ electric

5.Form nouns using the suffix –age. If necessary, consult the dictionary. Translate the words into Russian.

✓ break	✓ marry	✓ block
✓ leak	✓ percent	✓ pass
✓ inherit	✓ use	✓ carry
✓ store	✓ patron	✓ short

6.Form adjectives with negative meaning using negative prefixes –un/ –in/ –ir. If necessary, consult the dictionary. Translate the words:

✓ desirable	✓ typical	✓ available
✓ exhaustible	✓ reliable	✓ resistible
✓ foreseeable	✓ traditional	✓ conceivable
✓ rational	✓ valuable	✓ definite

7.Revise the use of the Infinitive and all its functions. Read the text about the choice of energy sources, paying attention to the translation of the sentences:

To use the 'right' energy sources is one of the steps to prevent the environment from pollution and conserve it.	Использовать правильные источники энергии – это один из первых шагов к защите от загрязнения окружающей среды и ее сохранению.
It isn't easy to determine which of the different sources of energy is better to use.	Нелегко определить, какой источник энергии лучше всего использовать.

Our task is to understand all the pros and cons of using different energy sources.	Наша задача состоит в том, чтобы понимать все за и против использования различных источников энергии.
We have nobody to tell us clearly what sources we should use to meet the growing energy needs and achieve our environmental objectives.	Нет никого, кто ясно скажет нам, какие источники мы должны использовать, чтобы удовлетворить растущие потребности в энергии и достичь целей по защите окружающей среды.
No energy source is perfect enough to be environmentally friendly but we should seek to utilize more efficient and less polluting ones.	Ни один источник энергии не является достаточно совершенным, чтобы быть благоприятным по отношению к окружающей среде, но мы должны стремиться использовать более эффективные и менее загрязняющие источники энергии.

8.Read the text concerning Energy Sources and say why the energy classifications are rather ambiguous. Give examples from the text. Give some more examples.

Energy Sources

Energy sources are sometimes classified under headings such as renewable, traditional, modern, commercial and conventional. The terminology is rather ambiguous, since it depends very much on the context. For example, wind energy is clearly renewable, but is it traditional?

Windmills have been used for several centuries, making it traditional, but wind has been used to generate electricity only in this century, so perhaps it is modern. In different areas of a country a source may be classified differently. For example, fuel wood in rural areas is often non-commercial, whereas in towns it generally has to be bought.

Renewable means that a source is not depleted by use – wind is always renewable, while biomass can be renewable if regrowth is matched by consumption. Fossil fuels are nonrenewable, as they will eventually be depleted (i.e. run out) as there is no viable way to produce more of them. Another classification, new and renewable, covers all the renewable forms of energy plus ocean and geothermal. Some energy analysts also include nuclear energy in this category, though clearly not because it is renewable.

Whether an energy resource is traditional or non-traditional depends very much on the user's perspective. Many biomass users would be regarded as using a traditional source (that is, what they have always used) and they would regard using fossil fuels as non-traditional. However, it can be the conversion technology rather than the resource which determines the classification. Wood can be regarded as a traditional energy resource, but if it is used in a gasifier it produces a non-traditional energy source. Similar difficulties arise when categorizing energy sources as conventional and non-conventional.

Commercial energy refers to those energy sources which have to be paid for. This always includes the fossil fuels and some new and renewable sources. Biomass is usually classified as non-commercial – however, this depends again on where you are in the world.

Answer the questions about the text:

- ✓ Why is terminology concerning energy sources rather ambiguous?
- ✓ What does 'renewable' mean?
- ✓ What is the difference between traditional and non-traditional energy resources?
- ✓ What do the classifications of resources depend on?
- ✓ What does commercial energy refer to?

9.Match the energy sources with their definitions basing your answer on the text above and using the Internet if necessary:

A. Renewable	*1) existing in or as part of a tradition; long-established*
B. Traditional	*2) based on or in accordance with what is generally done or believed*
C. Modern	*3) making or intended to make a profit*
D. Conventional	*4) not depleted when used*
E. Commercial	*5) relating to the present or recent times as opposed to the remote past*

10.Study the following words and phrases from the texts of the Unit, memorize them:

1)	advancement (n)	[əd'vɑːn(t)smənt]	продвижение; прогресс; успех, улучшение
2)	adversely (adv)	['ædvɜːsli]	неблагоприятно
3)	ambiguous (adj)	[æm'bɪgjuəs]	неопределённый, неясный; неоднозначный
4)	available (adj)	[ə'veɪləbl]	доступный; имеющийся; имеющийся в наличии/в распоряжении
5)	barrage (n)	['bærɑːʒ]	заграждение; плотина, дамба, барраж
6)	benefit (n)	['benɪfɪt]	выгода; польза; преимущество
7)	challenge (n)	['ʧælɪnʤ]	сложная задача, проблема
8)	combustion (n)	[kəm'bʌsʧ(ə)n]	сгорание; горение; сжигание
9)	consumption (n)	[kən'sʌm(p)ʃ(ə)n]	потребление; расход
10)	contemporary (adj)	[kən'temp(ə)r(ə)rɪ]	новый, современный
11)	continuously (adv)	[kən'tɪnjuəslɪ]	постоянно, непрерывно, неизменно
12)	cost-effective (adj)	[ˌkɔstɪ'fektɪv]	доходный, прибыльный, рентабельный
13)	costly (adj)	['kɔstlɪ]	дорогой, дорогостоящий
14)	deplete (adj)	[dɪ'pliːt]	истощать, исчерпывать (запасы, финансовые ресурсы)
15)	dioxide (n) *carbon dioxide* *sulphur dioxide*	[daɪ'ɔksaɪd] ['kɑːb(ə)n] ['sʌlfə]	двуокись; диоксид углекислый газ диоксид серы
16)	drive (v)	[draɪv]	управлять, манипулировать; побуждать, стимулировать; заставлять
17)	eventually (adv)	[ɪ'venʧuəlɪ, -tju-]	в конечном счёте, в итоге, в конце концов; со временем
18)	exhaust (v)	[ɪg'zɔːst]	исчерпывать, израсходовать, использовать полностью

19)	explore (v)	[ɪk'splɔː]	исследовать, рассматривать, изучать, анализировать
20)	foreseeable (adj)	[fɔː'siːəbl]	предсказуемый, предвидимый
21)	fossil fuel	['fɔs(ə)l 'fjuəl]	ископаемое топливо
22)	gasifier (n)	[ˈgæsifaɪə]	газификатор; газогенератор; газообразователь
23)	grind (v)	[graɪnd]	шлифовать; перемалывать; растирать; измельчать; дробить
24)	harness (v)	['hɑːnɪs]	использовать (природные ресурсы); приспосабливать
25)	hazard (n)	['hæzəd]	опасность; риск; угроза
26)	inexhaustible (adj)	[ˌɪnɪg'zɔːstəbl]	неистощимый, нескончаемый, неисчерпаемый
27)	inherent (adj)	[ɪn'her(ə)nt]	обязательно присущий, неотъемлемый
28)	intermediate (adj)	[ˌɪntə'miːdɪət]	промежуточный; средний; вспомогательный; посреднический
29)	leakage (n)	['liːkɪʤ]	утечка; течь; протечка
30)	match (v)	[mæʧ]	подходить, соответствовать, приводить в соответствие, согласовывать
31)	pollution (n)	[pə'luːʃ(ə)n]	загрязнение (вредными веществами)
32)	pose (v)	[pəuz]	представлять собой, являться
33)	propel (v)	[prə'pel]	двигать, побуждать, стимулировать, толкать
34)	regard (v)	[rɪ'gɑːd]	рассматривать; считать, относиться; касаться, иметь отношение
35)	regrowth (n)	[riː'grəʊθ]	вторичный рост, отрастание, возобновление
36)	release (v)	[rɪ'liːs]	освобождать; отпускать; выпускать; выделять
37)	run out (ph.v.)		истощиться, кончиться (о запасах), иссякать

38)	scale (n)	[skeɪl]	масштаб, градация, шкала, размер, протяжённость; охват
39)	tidal (adj)	['taɪd(ə)l]	приливной, приливо-отливный; подверженный действию приливов
40)	upset (v)	[ʌp'set]	срывать; расстраивать (планы); нарушать (порядок)
41)	valuable (adj)	['væljuəbl]	ценный; важный; дорогой; дорогостоящий
42)	viable (adj)	['vaɪəbl]	жизнеспособный
43)	waste (v)	[weɪst]	тратить впустую, растрачивать; неэкономно расходовать
44)	waste disposal	[weɪst dɪs'pəuz(ə)l]	уничтожение отходов

11.Read the text "Sources of Energy" and state the main idea of it. Use the Vocabulary above. If necessary, look the words up in the dictionary. Comprise a terminological vocabulary to the text. Make an annotation to the text.

Sources of Energy

One of our most important needs of which consumption increases continuously and will definitely continue to increase in future is undoubtedly the energy. A number of different energy sources exist. Some of these are renewable and some are not. All of us have difficult choices to make when using energy, though it is clear that a mix of sources will need to be used.

There is a limited supply of non-renewable energy resources, which will eventually run out. They include:

- fossil fuels, such as coal, oil and natural gas
- nuclear fuels, such as uranium.

Our renewable energy resources will never run out. Their supply is not limited. There are no fuel costs either. And they typically generate far less pollution than fossil fuels.

Renewable energy resources include:

- wind energy
- water energy, such as wave machines, tidal barrages and hydroelectric power
- geothermal energy
- solar energy
- biomass energy, for example energy released from wood.

The contemporary non-conventional sources of energy like wind, tidal, solar etc. were the conventional sources until James Watt invented the steam engine in the eighteenth century. In fact, the New World was explored by man using wind-powered ships only. The non-conventional sources are available free of cost, are pollution-free and inexhaustible. Man has used these sources for many centuries in propelling ships, driving windmills for grinding corn and pumping water, etc. Because of the poor technologies then existing, the cost of harnessing energy from these sources was quite high. Also because of uncertainty of period of availability and the difficulty of transporting this form of energy, to the place of its use are some of the factors which came in the way of its adoption or development. The use of fossil fuels and nuclear energy replaced totally the non-conventional methods because of inherent advantages of transportation and certainty of availability; however these have polluted the atmosphere to a great extent. In fact, it is feared that nuclear energy may prove to be quite hazardous in case it is not properly controlled.

The Invention Of The Windmill

Windmills were first invented and used in China, where the energy of the wind was used to help grind plants and other materials. These devices used to capture an alternative source of energy were invented in the year two hundred BC, more than two thousand years ago, and these devices are still designed and used in basically the same way today as they were then, except now we use the energy harnessed to produce electricity instead.

Unfortunately, both nuclear and coal energy pose serious environmental problems. The combustion of coal may upset the planet’s heat balance. The production of carbon dioxide and sulphur dioxide may adversely affect the ability of the planet to produce food for its people. Coal is also a valuable petro-chemical and from long term point of view it is undesirable to burn coal for generation of electricity. The major difficulty with nuclear energy is waste disposal and accidental leakage (e.g. leakage at Chernobyl nuclear power plant).

As a result of these problems, it was decided by almost all the countries to develop and harness the non-conventional sources of energy, even though they are relatively costlier as compared to fossil-fuel sources. It is hoped that with advancement in technology and more research in the field of development of non-conventional sources of energy, these sources may prove to be cost-effective as well. The future of wind, solar, tidal and other energy sources is bright and these will play an important role in the world energy scenario.

Although oil, natural gas, and coal will remain the primary energy sources for the foreseeable future, a variety of resources will be needed to meet the world’s growing demand. All energy sources have benefits, as well as challenges to produce, deliver, and use on a wide-scale and efficient basis.

12.Look through the text "Sources of Energy" again and answer the questions:

1. Why is energy one of the most important needs nowadays?
2. Why is the supply of non-renewable energy resources limited?
3. What do they (non-renewable) include?
4. Enumerate renewable energy resources. Characterize each of them.
5. What non-conventional sources have people used for many centuries? What were the purposes?
6. Why was the cost of harnessing energy from these sources quite high?
7. How can using nuclear energy be hazardous (to the people and the nature)?
8. Why does coal energy pose serious ecological problems? How can people change the situation?
9. How did the countries decide to try to solve these problems?
10. Why is it important to make serious research in the field of developing non-conventional sources of energy?
11. What challenges are ahead in this sphere? Think and prove your point of view.

13.Give the English equivalents from the text above to the following Russian ones:

1) одна из самых важных потребностей,
2) потребление непрерывно растет,
3) существует довольно много источников энергии,
4) возобновляемые источники энергии,
5) всем нам нужно сделать трудный выбор при использовании энергии,
6) ограниченный запас невозобновляемых источников энергии,
7) в итоге иссякнут (закончатся),
8) обычно образуют намного меньше загрязнения (окружающей среды), чем…,
9) приливо-отливные плотины,
10) нетрадиционные источники энергии,
11) изобрел паровой двигатель,
12) доступны бесплатно,
13) не загрязняют окружающую среду,
14) люди использовали в течение многих веков,

15) управление движением кораблей,
16) управление ветряными мельницами,
17) перемалывание зерен,
18) стоимость использования энергии была довольно высока,
19) неопределенность периода доступности,
20) причины (факторы), которые вставали на пути принятия или развития,
21) неотъемлемые преимущества перевозки,
22) загрязняли атмосферу в большой степени,
23) оказывается, ядерная энергия может быть довольно опасной,
24) в случае если ею не управляют должным образом,
25) и ядерная энергия, и энергия от сжигания угля представляют серьезные проблемы для окружающей среды,
26) может нарушить тепловое равновесие (баланс) планеты,
27) выработка углекислого газа и двуокиси серы может неблагоприятно воздействовать на способность…,
28) с точки зрения долгосрочной перспективы нежелательно сжигать уголь для получения электричества,
29) уничтожение отходов и случайные утечки
30) развивать и использовать нетрадиционные источники энергии,
31) более дорогостоящие по сравнению с …,
32) возможно, эти источники окажутся также рентабельными,
33) основные источники энергии в обозримом будущем,
34) растущая потребность в мире,
35) широкомасштабная и эффективная основа.

14.Have a look at the list of adverbs from the text and try to recall their meaning. Look the words up in the dictionary if you need. Then read the sentences below and translate them into Russian.

1) continuously
2) definitely
3) undoubtedly
4) eventually
5) typically
6) totally
7) properly
8) unfortunately

9) relatively

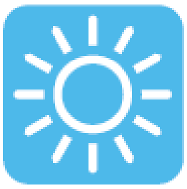
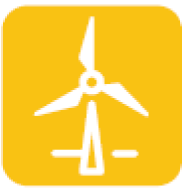
1. Energy consumption increases continuously and will continue to grow in the future.
2. Something should definitely be done about developing and harnessing the non-conventional sources of energy.
3. It is undoubtedly a challenge in the field of energy production to produce, deliver, and use the energy on a wide-scale and efficient basis.
4. The combustion of coal may eventually disrupt the heat balance of the planet.
5. Renewable energy resources typically generate less pollution than fossil fuels.
6. Fossil fuels and nuclear energy could totally replace some energy production methods due to the advantages of transportation and availability.
7. People must control the use of nuclear energy properly to avoid many hazards.
8. There are serious environmental problems connected with nuclear energy's waste disposal and accidental leakage and the combustion of coal, unfortunately.
9. All energy sources are relatively hazardous for people's safety, so people should be aware of their advantages and disadvantages.

15.Match vocabulary words and their definitions:

13. costly	m) to control and make use of (natural resources), especially to produce energy
14. valuable	n) belonging to or occurring in the present
15. contemporary	o) the process of burning something
16. to explore	p) to be aware of beforehand; predict
17. to harness	q) in the end
18. hazard	r) to make or cause to make progress
19. to foresee	s) an advantage or profit gained from something
20. to run out	t) capable of surviving or living successfully, especially under particular conditions
21. benefit	u) very expensive
22. combustion	v) a potential source of danger
23. to advance	w) to travel through (an unfamiliar area) in order

		to learn about it
24. eventually	x)	to have no more of something left
25. viable	y)	existing in something as a permanent, essential, or characteristic attribute
26. inherent	z)	extremely useful or important

16.Match the name and definition with the correct energy source icon:

Energy Source	Definition
1.  Oil/Petroleum	*A. Black rock burned to make electricity*
2.  Geothermal	*B. Portable fossil fuel used in grills*
3.  Solar	*C. Energy from wood, waste, and garbage*
4.  Wind Power	*D. Fossil fuel gas moved by pipeline*

5.

Nuclear

6.

Hydroelectric Power

7.

Hydrogen

8.

Natural Gas

9.

Biomass

10.

Coal

E. Energy from moving air

F. Energy from splitting atoms

G. Energy from flowing water

H. Energy in rays from the sun

I. Fossil fuels for cars, trucks, and jets

J. Energy from heat inside the earth

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

17.Use the word in capitals at the end of the lines in the text "The World of Energy" to form a word that fits in the space in this line using the necessary suffixes and prefixes:

Energy Flows

It was remarked that energy ***conversions*** from the	CONVERSE
original source to the _________________ form often take	USE
place in a number of intermediate stages. The energy flows	
from one form to another at each conversion,	
_________________ or transport step, and these steps can	TRANSFORM
be considered as a chain. Constructing such a chain	
enables an energy analyst to look at the	
_________________ of the different stages in order to	EFFICIENT
reduce costs and avoid _________________ losses.	NECESSARY
When constructing the chain, energy is classified into	
four types: primary, ___________________, final and	SECOND
useful. Primary energy is the energy in the form in which it	
is available in the ___________________ environment.	NATURE
Secondary energy is the energy ready for transport or	
________________. Final energy is the energy which the	TRANSMIT
consumer buys or receives and useful energy is the energy	
_______________ required to perform the work.	ACTUAL
To illustrate the _________________ between final	DIFFER
and useful energy, consider a light bulb: the final energy of	
the process enters the bulb, but most is wasted as heat. The	
useful energy, the light, may represent less than 10% of the	
final energy. This example aside, useful energy is almost	
always in the form of heat or mechanical shaft energy. For	
a few end uses, for example, communications	
___________________, electricity is the useful form.	EQUIP

Translate the word combinations from the text above:

- ✓ it was remarked,
- ✓ take place in a number of intermediate stages,
- ✓ energy flows from one form to another at each conversion,
- ✓ these steps can be considered as a chain,
- ✓ constructing a chain enables an energy analyst to look at …,

- ✓ in order to reduce costs and avoid losses,
- ✓ energy is classified into four types,
- ✓ the energy which the consumer buys or receives,
- ✓ the energy required to perform the work.
- ✓ the final energy of the process enters the bulb, but most is wasted as heat,
- ✓ represent less than 10% of the final energy,
- ✓ this example aside,
- ✓ in the form of heat or mechanical shaft energy,
- ✓ for a few end uses.

Answer the questions concerning the text "Energy Flows":

- ➢ What steps can be considered as a chain in the energy flow?
- ➢ Describe each type in the construction of a chain: primary, secondary, final and useful.
- ➢ What form is useful energy almost always in?

18.Look through the text below opening the brackets and paying attention to the use of the Active Voice and the Passive Voice in it. State the main idea of it:

Primary Energy Sources

Primary energy sources are available in the natural environment. These include:

Biomass energy: any material of plant or animal origin such as woody biomass (stems, branches, twigs) non-woody biomass (stalks, leaves, grass), agricultural residues (rice husk, coconut shell), and animal and human faeces. The energy can ______________ (***convert***) through a variety of processes to produce a solid, liquid or gaseous fuel. The biomass usually _______________ (***need***) some form of processing stage prior to conversion, such as chopping, mixing, drying or densifying.

Solar energy: energy from the sun comes as either direct radiation or diffuse radiation. Direct radiation __________________ (***collect***) when the collector (e.g. a leaf or a solar panel) __________________ (***face***) the sun. Diffuse radiation ___________________ (***come***) from all directions and is even present on a cloudy day. The energy falling on a surface of a specified area is less for diffuse radiation than direct radiation. Solar energy can _______________ (***convert***) through thermal solar devices to heat, or through photovoltaic cells to electricity.

Hydro energy: utilizes the potential energy from water stored behind dams, weirs or natural heads (waterfalls) and the kinetic energy of streams or rivers. Water wheels and hydro turbines _______________ (***use***) to convert this energy source to mechanical or electrical energy.

Wind energy: the kinetic energy from the wind _______________ (***convert***) by wind turbines (also known as wind generators or windmills) into mechanical energy (usually for water pumping) or electrical energy.

Geothermal energy: heat flow from the earth's core to the surface by molten rock or hot water. The heat can ________________ (***use***) for space heating, drying, process heat applications or electricity generation.

Animate energy: energy delivered by humans and animals. This is a major source of energy in agriculture in many developing countries, but never ____________ (***appear***) in national energy balances.

Ocean energy: includes three energy sources: wave and tidal - they both ____________ (***utilize***) the kinetic energy of moving water; and ocean thermal – this ___________ (***utilize***) the heat flow between the warm surface waters and cool deep waters of tropical oceans. All three are still at early stages of development, but the intention is to use them to generate electricity.

Fossil fuels: Coal, crude oil and natural gas. The main commercial fuels around the world.

Nuclear energy: energy released when the nuclei of atoms (usually uranium) break apart. This energy ________________ (***utilize***) by converting it into electrical energy.

Although these sources ______________ (***call***) primary, with the exceptions of solar, nuclear and tidal, they are not ultimate sources of energy. The remainder comes, either directly or indirectly, from solar energy.

Translate the following phrases from the text above into Russian:

- ✓ agricultural residues,
- ✓ processing stage prior to conversion,
- ✓ chopping, mixing, drying, densifying;
- ✓ direct radiation or diffuse radiation,
- ✓ a surface of a specified area,
- ✓ water stored behind dams, weirs or natural heads (waterfalls),
- ✓ water wheels and hydro turbines,
- ✓ wind generators or windmills,
- ✓ molten rock or hot water,
- ✓ process heat applications or electricity generation,

- ✓ energy delivered by humans and animals,
- ✓ national energy balances.,
- ✓ the intention is to use them to generate electricity,
- ✓ energy released when the nuclei of atoms (usually uranium) break apart,
- ✓ they are not ultimate sources of energy,
- ✓ the remainder comes, either directly or indirectly, from solar energy.

Answer the questions about the text:

- ✓ What are primary energy sources are available in the natural environment?
- ✓ What kind of energy comes as either direct radiation or diffuse radiation?
- ✓ Explain the difference between these two kinds of radiation?
- ✓ What kind of energy needs some form of processing stage prior to conversion? What stages does this process include?
- ✓ Where does hydro energy come from?
- ✓ How can wind generators or windmills be used for generating energy?
- ✓ Where is geothermal energy used?
- ✓ What is a major source of energy in agriculture in many developing countries? Why does this source never appear in national energy balances?
- ✓ What three energy sources does ocean energy include?
- ✓ What are the main commercial fuels around the world?
- ✓ How can nuclear energy be received?
- ✓ Why do people try to utilize various primary sources of energy to produce electricity?

19.Continue the sentences on the basis of the information from the text:

1. Primary energy sources are ___________________________.
2. The biomass usually needs some form of ____________________.
3. Energy from the sun comes as either _______________________.
4. Direct radiation is collected _______________________.
5. Diffuse radiation comes from ______________________________.
6. Hydro energy utilizes the potential energy from __________________.
7. The kinetic energy from the wind is converted by ________________.
8. Geothermal energy is _________________.
9. Animate energy is __________________.
10. Ocean energy includes three energy sources, namely ________________.
11. Fossil fuels are _______________________.
12. Nuclear energy is energy released when __________________.

20.Compose a story about energy sources on the basis of the texts of the UNIT 3, using your active vocabulary. Retell it. You may use the plan when preparing for the task and then retelling your story. Expand your answer speaking about some interesting facts concerning the topic and the latest developments in the sphere. Emphasize the advantages of using each energy source and possible disadvantages and hazards for the atmosphere and the life of people.

FINAL TASK

Choose an energy source and make a report/ prepare a presentation about it. Find pictures, videos, data that will help make your presentation vivid, impressive and interesting. While preparing, be ready to answer the following questions:

1. Describe the energy source. (What is it? How does it work?)
2. Is the energy source considered renewable or nonrenewable?
3. What is the history of the energy source?
4. Where is the energy source found?
5. How is the energy source recovered?
6. How is the energy source stored once it is recovered?
7. How is the energy source used today?
8. Is the energy source "efficient?" (production costs compared to energy production)
9. What are the capital costs or setup costs involved in using the energy source?
10. Are there ongoing operating costs involved when using the energy source?
11. What are the advantages of the energy source?
12. What are the disadvantages of the energy source? (finding, extracting, manufacturing, using)
13. What is the economic impact of the energy source?
14. What is the environmental impact of the energy source?
15. Is there a high cost to the consumer in using the energy source?
16. Are there any other interesting facts about the energy source?
17. What is the future of the energy source?
18. What were the sources of your information?

UNIT III SELF ASSESSMENT

Fill in the table below assessing yourself 1 / 2 / 3. Use the information below:

I know:		
1. the vocabulary of the Unit		
2. terms and their definitions		
3. English grammar rules of the Unit (Infinitive and its functions)		
4. word-building elements (suffixes/prefixes) from the Unit		
I can:		
1. use active vocabulary of the Unit		
2. identify different energy sources that exist		
3. define advantages and disadvantages of each energy source		
4. understand basic concepts from the Unit (energy source, alternative energy sources …)		
5. form new words using different suffixes.		
TOTAL:		

The basis for your assessment:

Я знаю и понимаю 85-100% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу. Я умею правильно использовать времена актив. и пассив. залога. Я понимаю функции инфинитива и умею использовать инфинитив в предложении.	3	☺
Я знаю и понимаю 50-85% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу, но иногда допускаю ошибки. Я умею правильно использовать времена активного и пассивного залога, но иногда допускаю ошибки. Я умею правильно использовать инфинитив, но иногда допускаю ошибки.	2	😐
Я знаю и понимаю менее 50 % слов и понятий. Я плохо владею правильным произношением и орфографией, частично способен к двуязычному переводу, часто допускаю ошибки. Я не понимаю и не умею использовать правильно времена активного и пассивного залога в предложении, часто допускаю ошибки. Я не понимаю и не умею использовать правильно инфинитив, часто допускаю ошибки	1-0	☹

<u>Results</u>: 27-30 points – Excellent, 20-26 – Good, 11-19 – Satisfactory.
If your result is below 11, you should work with the material of the unit again!

UNIT III - REVISION TASKS

1.Fill in the table below. It shows the classification of a number of energy resources according to three criteria:

- **familiarity (that is - conventional/traditional and non-conventional);**
- **renewability (renewable or non-renewable);**
- **monetization (commercial and non-commercial).**

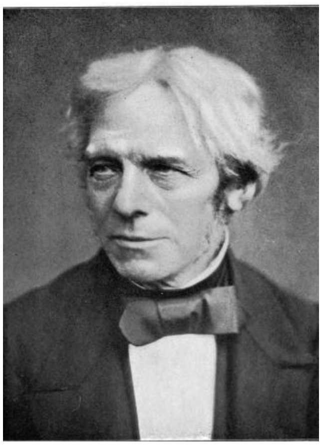
Use the texts of UNIT III or the internet sources if necessary.

	Familiarity			***Renewability***		***Monetization***	
Resource	**Conventional**	**Traditional**	**Non-Conventional**	**Renewable**	**Non-Renewable**	**Commercial**	**Non-commercial**
Large scale hydropower	♦			♦		♦	
Coal							
Oil and gas							
Nuclear							
Fuelwood							
Agricultural residue							
Animal dung							
Animal labour							
Industrial waste		♦	♦		♦	♦	
Solar thermal							
Solar photovoltaic							
Wind							

Small-scale hydropower							
Biogas							

2.Read the text about Michael Faraday and his contribution into the development of electricity. Surf the internet to find more facts about his life and inventions, summarizing the information you know and speaking about his important contribution into the development of electricity.

A Current Began

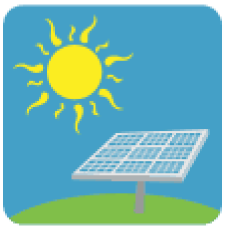


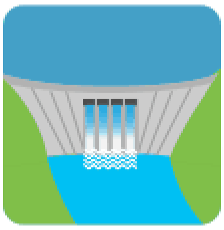
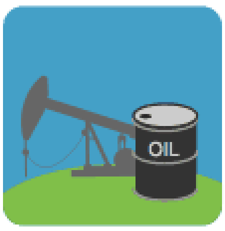
An English scientist, Michael Faraday, was the first one to realize that an electric current could be produced by passing a magnet through a copper wire. It was an amazing discovery. Almost all the electricity we use today is made with magnets and coils of copper wire in giant power plants.

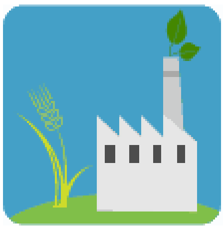
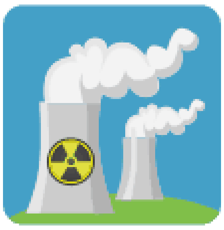
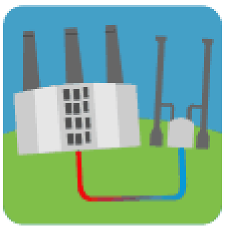
Both the electric generator and electric motor are based on this principle. A **generator** converts motion energy into electricity. A **motor** converts electrical energy into **motion energy**.

3.Learn about Pros and Cons of Energy Sources from the table below. Comprise a vocabulary. Then do the task after the text:

Energy Source Comparison

Energy Source	*Pros*	*Cons*
Solar Energy 	• Non-polluting • Most abundant energy source available • Systems last 15-30 years	• High initial investment • Dependent on sunny weather • Supplemental energy may be needed in low sunlight areas • Requires large physical space for PV cell panels • Limited availability of polysilicon for panels

Energy Source	*Pros*	*Cons*
Wind Energy 	• No emissions • Affordable • Little disruption of ecosystems • Relatively high output	• Output is proportional to wind speed • Not feasible for all geographic locations • High initial investment/ongoing maintenance costs • Extensive land use
Hydropower 	• No emissions • Reliable • Capable of generating large amounts of power • Output can be regulated to meet demand	• Environmental impacts by changing the environment in the dam area • Hydroelectric dams are expensive to build • Dams may be affected by drought
Natural Gas 	• Widely available • Cleanest-burning fossil fuel • Often used in combination with other fuels to decrease pollution in electricity generation • Made safe by adding artificial odor so that people can easily smell the gas in case of a leak	• Transportation costs are high • Lack of infrastructure makes gas resources unavailable from some areas • Burns cleanly, but still has emissions • Pipelines impact ecosystems
Petroleum 	• Efficient transportation fuel for the world • Basis of many products, from prescription drugs to plastics • Economical to produce • Easy to transport	• High CO_2 emissions • Found in limited areas • Supply may be exhausted before natural gas/coal resources • Possible environmental impact from drilling/transporting

Energy Source	*Pros*	*Cons*
Biofuels 	• Abundant supply • Fewer emissions than fossil fuel sources • Can be used in diesel engines • Auto engines easily convert to run on biomass fuel	• Source must be near usage to cut transportation costs • Emits some pollution as gas/liquid waste • Increases emissions of nitrogen oxides, an air pollutant • Uses some fossil fuels in conversion
Coal 	• Abundant supply • Currently inexpensive to extract • Reliable and capable of generating large amounts of power	• Emits major greenhouse gases/acid rain • High environmental impact from mining and burning, although cleaner coal-burning technology is being developed • Mining can be dangerous for miners
Uranium 	• No greenhouse gases or CO2 emissions • Efficient at transforming energy into electricity • Uranium reserves are abundant • Refueled yearly (unlike coal plants that need trainloads of coal every day)	• Higher capital costs due to safety, emergency, containment, radioactive waste, and storage systems • Problem of long-term storage of radioactive waste • Heated waste water from nuclear plants harms aquatic life • Potential nuclear proliferation issue
Geothermal 	• Minimal environmental impact • Efficient • Power plants have low emissions • Low cost after the initial investment	• Geothermal fields found in few areas around the world • Expensive start-up costs • Wells could eventually be depleted

Compare the energy sources given below on the basis of the information from the table. You should speak about pros and cons of each, the sphere of its usage, and make a conclusion:

- ✓ solar and geothermal,
- ✓ wind energy and hydropower,
- ✓ petroleum and uranium,
- ✓ natural gas and biofuels,
- ✓ coal and petroleum,
- ✓ hydropower and geothermal,
- ✓ solar and wind energy.

4.Translate the text into Russian paying attention to using the Infinitive and Passive Voice. If necessary, look the new words up in the dictionary (you may also use the active vocabulary of the previous units):

Smart City - Smart Energy

Urbanization, demographic changes and climate change, mobility, energy and environmental issues *tend to* pose major challenges for growing towns of the future as well as the regions they are located in. The competitiveness of regions will be increasingly determined in towns.

A smart city combines social and technical innovations intelligently in order to create towns as long-term attractive business locations with a high quality of living. In terms of energy, town services have to become more efficient, energy supply has to be prepared for a post-fossil era and our societies for a "zero/low carbon society". The goal is to become more energy-efficient and have more renewable energies in the energy mix. The intelligent interlinking of energy supply, distribution (grids), storage and consumption is an attempt to develop and implement sustainable and smart energy systems. Based on, and in addition to "Sinfonia"*, the cluster members are provided with support to develop and implement new cross-industry solutions for buildings, mobility, infrastructure, the supply, distribution and storage of energy in urban environments as well as the necessary planning tools and business models: expertise from the Renewable Energies, IT, Mechatronics and Life Sciences clusters as well as the key area of Industry 4.0 ("Internet of Things") in the IT and Mechatronics clusters as well as the

Ambient Assisted Living (AAL), Building Information Modelling (BIM) and Smart Energy Solutions initiatives enable holistic concepts and new solutions.

Match the definitions from the text and their explanation:

1) *Sinfonia*	A. is a name for the current trend of automation and data exchange in manufacturing technologies.
2) *Industry 4.0*	B. are concepts, methods, electronic systems, products and services, which transparently assist the daily lives of people in need of support.
3) *Building Information Modeling*	C. are the sciences concerned with the study of living organisms, including biology, botany, zoology, microbiology, physiology, biochemistry, and related subjects.
4) *Life sciences*	D. is a process involving the generation and management of digital representations of physical and functional characteristics of places.
5) *Ambient Assisted Living*	E. **S**mart **IN**itiative of cities **F**ully c**O**mmitted to iNvest **I**n **A**dvanced large-scaled energy solutions.
6) *Mechatronics*	F. are methods of rational energy use
7) *Smart Energy Solutions*	G. is the synergistic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and manufacturing processes.
8) *Smart Energy Solutions*	H. is the intelligent integration of decentralized renewable energy sources and power consumption to form the future energy ecosystem.
9) *Smart Energy*	I. directed towards the interior of buildings can help smooth out energy consumption peaks and create enormous savings in energy production.

1.	2.	3.	4.	5.	6.	7.	8.	9.

Work in pairs or in small groups. Using the Internet, find additional information about one of the following items:

1) "Sinfonia";
2) Industry 4.0;
3) Mechatronics;
4) Life sciences;
5) Ambient Assisted Living;
6) Building Information Modeling;
7) Smart Energy.

Make up a short report on the chosen item. Be ready to present and explain their peculiarities to others.

5.Translate the text into English paying attention to the grammar rules and using the active vocabulary. If necessary, look the words up in the dictionary:

Умные города

Растущая урбанизация делает города главным центром внимания экологической политики. Уже к 2030 жителями городов будут свыше 60% всего мирового населения. Чтобы расти и развиваться, городам нужна энергия. В настоящее время две трети всего потребления энергии относится к городам. Именно города представляют серьезный вызов в области защиты и сохранения окружающей среды. Чтобы справиться с проблемами из-за продолжающегося роста городов, нужно изобретать новые способы для рационального управления ими, для того, чтобы сделать сами города более эффективными.

Главная цель создания умных городов в том, чтобы улучшить качество жизни людей, сделать среду обитания более безопасной и комфортной. В Европе умные города рассматриваются как ответ на вызовы масштабной урбанизации (перенаселение, растущее потребление энергии, распределение ресурсов, защита окружающей среды). Похожая точка зрения существует и в Японии. Умными городами японцы называют те, где инновации ведут к улучшению состояния окружающей среды, общества и экономики.

Развивающаяся область умных городов и эры чистой энергии (Energy 3.0 era) способствует осуществлению двух технологических прорывов, близких к концепции Интернета вещей: созданию миниатюрных датчиков и сетей, чтобы связать все объекты друг с другом. Качество воды, воздуха, движение людей и объектов, изменения погоды, дорожное движение, производство и потребление энергии можно измерить с помощью датчиков и отследить через сети в реальном времени. Это означает такую работу инженерных и электрических, строительных и управляющих компаний, чтобы они были способны связать соответствующе оборудование вместе. Трансформации в области выработки, передачи, распределения энергии, а также снижение ее потребления с помощью современных цифровых и информационных технологий позволяют наиболее эффективно использовать энергоресурсы, что позволяет, в том числе, сохранять устойчивость в создании и развитии умного города.

Surf the Internet to find more information about smart cities. Answer the following questions:

1. What does the term "smart city" mean?
2. What components does a smart city include?
3. Why is the energy management one of the most demanding issues within smart cities?

UNIT IV

Alternative Sources of Energy

Before starting to work with Unit IV, be ready to discuss the following:

- ✓ What sources of energy contribute to environmental pollution?
- ✓ What are main alternative energy sources? How can they help save the environment?
- ✓ Why did people begin to think of using alternative sources of energy?

1.Read the international words and give their translation. Pay attention to their pronunciation:

gas, million, atomic, process, system, alternative, effect, technology, megawatt, kilowatt, ecological, leader, organic, biomass, atmosphere, methane, gasification, boiler, pellet, mile, compressor, conditioner, season, practical, active, passive, collector, aerodynamic, electrochemical, battery, circulate temperature, extract

Wind Power Was Used Thousands Of Years Ago.

In the year thirty two hundred BC, wind energy was used for the first time by the Egyptians. This population invented the sail, to capture the energy from the wind and use it to power their boats. This means that the Egyptians were the first to use an alternative source of energy for sailing, and to create sailboats.

2.Read the words and their derivatives. Translate them into Russian paying attention to their meaning:

1) limit – limited – unlimited – limitation
2) sustain – sustainable – unsustainable – sustainability
3) reside – resident – residential – residence
4) gas – gasify – gasifier – gasification
5) compress – compressive – compressor – compressively
6) collect – collector – collection – collective – collectively
7) mount – mountain – mounted – mountainous

3.Fill in the table of derivatives with the appropriate words paying attention to the use of different suffixes you know. Translate the words:

Verb	Noun	Adjective	Adverb
relate	***relationship***	***relative***	***relatively***
	circulation		
convert			
		alternative	
			correctly
	devotion		
cheer			
		regulative	
			unexpectedly

4.Form verbs adding the suffix –en to the adjectives and nouns. If necessary, consult the dictionary. Translate the words:

- ✓ short
- ✓ wide
- ✓ broad
- ✓ sweet
- ✓ hard
- ✓ threat
- ✓ height
- ✓ weak
- ✓ dark

5.Form nouns and verbs using the prefix –dis. Translate the words:

- ✓ like
- ✓ advantage
- ✓ proportion
- ✓ cover
- ✓ trust
- ✓ connection
- ✓ appear
- ✓ organize
- ✓ comfort
- ✓ agree
- ✓ approve
- ✓ order

6.Form nouns and verbs using the prefix –mis (=неправильно, ошибочно). Translate the words into Russian, use a dictionary if you need.

- ✓ fortune
- ✓ interpret
- ✓ dial
- ✓ count
- ✓ place
- ✓ take
- ✓ chance
- ✓ spell
- ✓ understand
- ✓ lay
- ✓ hear
- ✓ lead
- ✓ behave
- ✓ speak
- ✓ focus

7.Finish the sentences using the appropriate adjective and adverb comparative structures:

E.g.: The nonrenewable energy sources are more pollutant *than any other sources*.

The better we understand benefits of using alternative energy sources, *the better use of energy we have.*

Geothermal energy is as harmless for the environment *as wind energy.*

Ocean energy is one of *the most promising* sources of energy for the future.

1. The more environmentally friendly the energy source is, ______________.
2. Coal is more ______________.
3. Alternative energy sources are less ______________.
4. This energy source is as ______________.
5. The costs of some traditional energy sources are half ______________.
6. Natural gas is the ______________.
7. It is better to use solar energy ______________.
8. The sooner we begin to use less pollutant energy sources ______________.

8.Read the text concerning renewable and alternative sources of energy and tell about the development of energy sources in short.

Over the last 200 years, people have become more and more dependent on energy that they dig out of the ground. In the 1700's, almost all our energy came from wind, water, firewood, or muscle power. The wind powered our windmills and sailing ships. Water powered our waterwheels. Firewood did our cooking and heated our homes. Muscle power (human or animal) did just about everything else. All these energy sources came from the sun, since solar energy drove wind and rain, grew trees, and grew crops to nourish our animals and ourselves. All these energy sources were also renewable, since wind kept blowing, rivers kept flowing, and trees and crops kept growing.

About 1800, we began to get much of our energy from coal dug out of the ground. About 1900 we began to drill for oil and natural gas. By 1950 these "fossil fuels" had mainly displaced the older energy sources except for water power. Fossil fuels come from the decayed remains of prehistoric plants and animals, so their energy also comes, originally, from the sun. In some parts of the world new fossil fuels are being formed even today. But we are using fossil fuels at a far greater rate than they are being created, using up energy stored over hundreds of millions of years in a few hundred years. After 1950, we began to use atomic energy from uranium dug from the ground. Uranium is not a fossil fuel, and its energy does not originate from the sun. But uranium, like fossil fuels, is non-renewable: once it's used up, it's gone forever.

Over the past 25 years, use of older renewable energy sources has increased and we have begun to use new renewable energy sources as well. We have realized that our fossil and atomic fuels will not last forever, and that their use contributes to environmental pollution.

Renewable energy – which basically comes from the sun in one way or another – provides opportunities for an unlimited, sustainable energy supply with low environmental impact. And renewable energy is not just something for the future, but something we can use in our homes today.

Answer the questions about the text:

- ✓ Why have people become more and more dependent on energy over the last 200 years?
- ✓ How did people get energy in the past?
- ✓ What is the main source of energy in the world?
- ✓ Where do fossil fuels come from?
- ✓ Give examples of non-renewable sources form the text.
- ✓ What sources of energy pose a major threat to the environment?

9.Study the following words and phrases from the texts of the Unit, memorize them:

1) absorb (v)	[əb'zɔːb]	впитывать; абсорбировать; поглощать
2) access (v)	['ækses]	иметь доступ, получить доступ (к чему-л.)
3) as though (cj)	[ˌəz'ðəʊ]	как будто бы, словно, как если бы, похоже
4) assure (v)	[ə'ʃuə]	уверять; заверять кого-л.; убеждать; гарантировать, обеспечивать
5) combustion (n)	[kəm'bʌsʧ(ə)n]	горение, возгорание, сжигание
6) comparable (adj)	['kɔmp(ə)rəbl, kəm'pærəbl]	сравнимый; сопоставимый; соизмеримый

7) comprise (v)	[kəm'praɪz]	включать; заключать в себе, содержать
8) contribute (v)	[kən'trɪbjuːt, 'kɔntrɪbjuːt]	вносить; способствовать; содействовать; вносить вклад; сотрудничать
9) convert (v)	[kən'vɜːt]	преобразовывать; превращать; конвертировать; трансформировать
10) crude (adj)	[kruːd]	необработанный, неочищенный; незрелый, непродуманный
11) currently (adv)	['kʌr(ə)ntlɪ]	теперь, в настоящее время
12) cut down (ph.v))	[kʌtdaun]	срубать, вырубать, сокращать
13) dam (v)	[dæm]	перегораживать плотиной; подпирать плотиной; преграждать; сдерживать
14) decay (v)	[dɪ'keɪ]	разрушать, надрывать
15) dig out (ph.v)	[dɪgaut]	откапывать, находить, изыскивать
16) displace (v)	[dɪs'pleɪs]	перемещать; двигать, перекладывать, переставлять, заменять, замещать
17) drill (v)	[drɪl]	сверлить, бурить, добывать; тренировать, натаскивать (вучёбе, спорте)
18) emission (n)	[ɪ'mɪʃ(ə)n]	выброс; распространение; эмиссия; выделение
19) emit (v)	[ɪ'mɪt]	испускать; выделять; выбрасывать
20) free (v)	[friː]	освобождать, высвобождать; отсоединять, отвязывать
21) habitat (n)	['hæbɪtæt]	родина, место распространения, ареал (животного, растения)
22) hub (n)	[hʌb]	ступица (колеса), втулка; центр (событий, внимания)

23)	impact (n)	['ɪmpækt]	воздействие; влияние; эффект
24)	last (v)	[lɑːst]	длиться; продолжаться
25)	limit (n)	['lɪmɪt]	граница, предел; рубеж, ограничение
26)	liquid (n)	['lɪkwɪd]	жидкость
27)	mount (v)	[maunt]	устанавливать; поднимать; монтировать; взбираться; восходить
28)	nourish (v)	['nʌrɪʃ]	оказывать поддержку, снабжать, поддерживать; кормить, питать
29)	opportunity (n)	[ˌɔpə'tjuːnətɪ]	удобный случай, стечение обстоятельств, благоприятная возможность
30)	pellet (n)	['pelɪt]	гранула; шарик; таблетка; пулька; катышек; брикет
31)	primarily (adv)	[praɪ'mer(ə)lɪ]	главным образом; первоначально
32)	rate (n)	[reɪt]	темп; скорость; уровень; показатель; коэффициент
33)	reciprocate (v)	[rɪ'sɪprəkeɪt]	отвечать взаимностью, обмениваться, взаимно делиться; отплачивать (услугойзауслугуит. п.)
34)	refer (v)	[rɪ'fɜː]	ссылаться; упоминать; касаться; иметь отношение
35)	refill (v)	['riːfɪl]	доливать; пополнять
36)	replenish (v)	[rɪ'plenɪʃ]	пополнять, снова наполняться; добавлять; обновлять
37)	residential (adj)	[ˌrezɪ'den(t)ʃ(ə)l]	жилой, связанный с местом жительства
38)	result from (ph.v)	[rɪ'zʌltfrɔm]	вытекать из … (ситуации); исходить из
39)	result in (ph.v)	[rɪ'zʌltɪn]	приводить к
40)	run (v)	[rʌn]	управлять, направлять

41)	shaft (n)	[ʃɑːft]	вал; шахта; ствол; ось
42)	store (v)	[stɔː]	хранить; сохранять; запасать; накапливать
43)	suitable (adj)	['s(j)uːtəbl]	годный, подходящий, соответствующий
44)	sulfur (n)	['sʌlfə]	сера
45)	sulfur dioxide	['sʌlfədaɪ'ɔksaɪd]	двуокись (диоксид) серы
46)	surface (n)	['sɜːfɪs]	поверхность; покрытие; вид, внешность, наружность
47)	sustainable (adj)	[sə'steɪnəbl]	устойчивый; жизнеспособный; устойчивый (не наносящий ущерба окружающей среде)
48)	ultimately (adv)	['ʌltɪmətlɪ]	в конечном счёте, в конце концов
49)	undesirable (adj)	[ˌʌndɪ'zaɪərəbl]	нежелательный,неподходящий, неудобный
50)	vehicle (n)	['viːɪkl]	машина; автомобиль; транспортное средство
51)	well (n)	[wel]	колодец, источник, родник, ключ, водоём

10.Read the text "What are Renewable and Alternative Energy Sources?" and state the main idea of it. Use the Vocabulary above. If necessary, look the words up in the dictionary. Comprise a terminological vocabulary to the text. Make an annotation to the text.

What are Renewable and Alternative Energy Sources?

True renewable energy sources are energy supplies that are refilled by natural processes at least as fast as we use them. All renewable energy comes, ultimately, from the sun. We can use the sun directly (as in solar heating systems) or indirectly (as in hydroelectric power, wind power, and power from biomass fuels). Renewable energy supplies can become exhausted if we use them faster than they become replenished: most of England's forests were cut down for fuel before the English started using coal. If they are used wisely, however, renewable energy supplies can last forever.

Many people use the terms "Alternative Energy", "Renewable Energy" and even "Green Energy" together in the same sentence when talking about energy sources as though they all mean the same thing, but they are not the same. Each term means something different when talking about energy systems. Some say that alternative energy comprises everything that is not based on fossil fuel consumption. While these may be alternative energy sources compared to conventional fossil fuels, alternative energy in its broadest sense, is any type of energy that replaces another, so we can correctly say that coal energy is an alternative energy source compared to crude oil or natural gas but as we now know, coal is a fossil fuel and burning it is bad for the environment. Even nuclear energy was once considered to be an "alternative" to conventional fossil fuels, and was thus called an alternative energy source.

When we speak of alternative energy, we refer to sources of usable energy that can replace conventional energy sources (usually, without undesirable side effects). The term "alternative energy" is typically used to refer to sources of energy other than nuclear energy or fossil fuels.

There are other alternatives to our typical energy sources that are not renewable. Although these are "alternative energy" rather than "renewable energy", they use the energy we have more efficiently than older technologies. In doing this, they help us make our existing energy supplies last longer and give us more time before we run out of stored fossil and atomic fuels. The use of renewable and alternative energy sources can save us money, assure that our grandchildren and great grandchildren will have enough energy, and free us from the uncertainties of depending on energy supplies.

Hydroelectric power in 1920 was a big alternative source of energy.

In the year 1920, the alternative energy cost was very small, and more than one fourth of all the electricity generated and used in the United States of America this year was generated using hydroelectric power. This is an astonishing amount of alternative renewable energy that was used almost one hundred years ago, yet today it is only a fraction of this amount.

11.Look through the text "What are Renewable and Alternative Energy Sources?" and answer the questions:

1. Where does all renewable energy come from?
2. How can we use the sun?
3. Why can renewable energy supplies become exhausted?
4. Can renewable energy supplies last forever? Expand your answer.

5. Why is it incorrect to use the terms “Alternative Energy”, “Renewable Energy” and even “Green Energy” together in the same sentence when talking about energy sources?
6. What is alternative energy in its broadest sense?
7. What sources do we refer to when speaking of alternative energy?
8. How can the use of renewable and alternative energy sources change our future?

12.Give the English equivalents from the text above to the following Russian ones:

1) истинные источники возобновляемой энергии,
2) которые пополняются естественными процессами,
3) использовать солнце непосредственно (прямо),
4) энергия из биомассы,
5) если мы будем использовать их быстрее, чем они будут пополняться,
6) были вырублены на топливо,
7) если они используются мудро,
8) как будто все они означают одно и то же,
9) все, что не основано на потреблении ископаемого топлива,
10) по сравнению с обычными ископаемыми видами топлива,
11) альтернативная энергия в самом широком смысле,
12) любой вид энергии, который заменяет другой,
13) энергия угля является альтернативным источником энергии по сравнению с сырой нефтью или природным газом,
14) ядерная энергия когда-то считалась «альтернативой» традиционным ископаемым видам топлива,
15) мы ссылаемся на источники полезной энергии, которые могут заменить обычные источники энергии,
16) без нежелательных побочных эффектов,
17) источники, отличные от ядерной энергии или ископаемого топлива,
18) эффективнее, чем более старые технологии,
19) продлить наши существующие запасы энергии,
20) прежде чем мы исчерпаем накопленные ископаемые и атомные топлива,
21) может сэкономить нам деньги,
22) освободит нас от неопределенности относительно зависимости от поставок энергии.

13.Continue the sentences on the basis of the information from the text:

1. All renewable energy comes ___________________________.
2. We can use the sun directly ____________________.
3. Renewable energy supplies can become exhausted if ___________________.
4. Being used wisely, renewable energy supplies _______________________.
5. The terms “Alternative Energy”, “Renewable Energy” and “Green Energy” all mean the same thing, but _______________________.
6. Everything that is not based on fossil fuel consumption is _____________________.
7. In its broadest sense, alternative energy is ______________________.
8. Typically, we use the term “alternative energy” to ____________________________.
9. Alternative sources of energy help us ______________________.
10. The use of renewable and alternative energy sources can ____________________________.

14.Match vocabulary words and their definitions:

1.to displace	a) finally; in the end
2. sustainable	b) to produce and discharge (something, especially gas or radiation)
3. impact	c) to provide with the food or other substances necessary for growth, health, and good condition
4. ultimately	d) to respond to (a gesture or action) by making a corresponding one
5. primarily	e) able to be maintained at a certain rate or level
6.to emit	f) to take in or soak up (energy or a liquid or other substance) by chemical or physical action
7. to absorb	g) a marked effect or influence
8. to nourish	h) to remove something undesirable or restrictive from

9. to replenish	i) for the most part; mainly
10. to reciprocate	j) a time or set of circumstances that makes it possible to do something
11. opportunity	k) to move (something) from its proper or usual position
12. to free	l) to fill (something) up again

15.Translate the text into Russian paying attention to the degrees of comparison of adjectives and adverbs. Revise the proper grammar rules if necessary. Make an annotation to the text.

One of the most important elements to meet the essential needs of modern life is the use of energy. At present, more than 80% of the world's energy need is met from fossil fuels like coal, petroleum or natural gas. The fossil fuels are the most common and widely used in houses, commercial and industrial sectors, heat production and production of electric energy.

The cleanest fossil fuel, natural gas, is used in electric production, as a raw material in industry and process electric energy. Natural gas pollutes the environment less than any other resources of this type. It produces nearly a third less carbon dioxide than coal and almost half less than oil when burned.

Coal is the most abundant fossil fuel available on earth. Of all the fossil-fuel sources, coal is the least expensive for its energy content but from an environment point of view it is most dangerous source of energy.

The most important fossil fuel comes from petroleum, which is natural oil found underground.

In different periods a definite energy resource is used more or less but these days petroleum is the most commonly used energy resource in the world. Coal, oil and natural gas are three of the most common types of fossil fuels. But the longer and wider we use them the faster the ecological balance of the world is destroyed. Despite their negative environmental effects they are still popular as they are cheaper than any other alternative sources of energy. Consumptions of fossil fuels in energy production and other applications are much greater than before.

The reason we are still dependent on fossil fuels for energy is about as old as the fossils themselves. A complicated mix of costs, technology and environmental issues means no one source is best. The diverse implementation of energy sources is a positive step toward energy independence and sustainability. It is clear there is not any other option for the entire world to use the reserves in hand in the best way and direct towards to new energy resources.

Say whether the statements are true or false or no information according to the text above:

1. Hydrocarbons are the most available energy sources in the world.
2. Natural gas has more advantages than any other energy sources.
3. Coal is the most popular source of energy.
4. Alternative sources of energy replace fossil fuels more frequently.
5. Consumptions of fossil fuels in energy production and other applications tend to be lower because of their negative environmental effects.
6. The best energy source for the entire world is impossible to determine.

16.Read and translate some facts about energy sources. Think them over and answer the question: <u>What factors can affect the choice of energy sources that a nation or society uses?</u>

1. The choice of energy sources is not so simple as it seems.
2. It isn't easy to determine which of the different sources of energy is best to use.
3. Natural gas is not as harmful as coal.
4. In most areas, natural gas can cost drastically less than electricity to heat your home and the water you use.
5. It can also be half as expensive as coal or oil for the same tasks.
6. Renewable energy, like wind and solar power, is far better for the future of our planet than traditional power sources like coal, gas, and oil.
7. In Britain electricity from wind farms costs twice as much as that from traditional sources.
8. According to the U.S. Energy Information Administration, the average cost of solar power is almost four times as much as traditional coal burning electric generation.
9. Biomass is currently more expensive than using energy sources such as coal, gas or nuclear power.
10. Most renewables are less available and/or have higher costs than fossil fuels.
11. While many alternative energy technologies are becoming more viable and affordable, renewable energy is still often much more expensive than energy efficiency.
12. It is usually much less expensive to save energy than to generate renewable energy.

17.Translate the sentences into English using the active vocabulary of the Unit IV. Try to translate without using the dictionary.

1. С каждым днем растущему человечеству требуется все больше и больше энергии.
2. Самыми главными и распространенными источниками являются ископаемые виды топлива.
3. Ископаемые виды топлива являются наиболее вредными с экологической точки зрения.
4. Чем больше мы используем ископаемые виды топлива, тем сильнее негативный эффект на окружающую среду.
5. Возобновляемые источники энергии являются более безопасными в экологическом отношении.
6. Возобновляемые источники энергии всё шире применяются в энергетике.
7. К наиболее известным возобновляемым источникам энергии относятся гидроэнергия, энергия солнца, энергия ветра, геотермальная энергия, энергия биомассы.
8. Некоторые источники энергии, несмотря на негативные экологические аспекты, будут по-прежнему широко применяться в мире из-за их большей доступности и менее высокой стоимости.

18.Fill in the text "Solar Energy" with correct prepositions from the box:

for	by	to
up	with	for
to	from	by

Solar energy

Solar energy comes directly ________ the power of the sun and is used _______ produce electricity, to produce heat, and for light. Solar's energy contribution _______ heating and lighting is much larger. Solar-electric power can be produced either _______power plants using the sun's heat or _______ photovoltaic (PV) technology, which converts sunlight directly to electricity using solar cells. PV technology is more practical _______residential use. Systems to use the heat of the sun directly can be either active or passive. In active systems, air or liquid circulate through solar collectors and bring heat to where it is used. In passive systems, buildings are built _______windows and heat-absorbing surfaces set _______ to maximize solar heating in winter. Either technology is suitable for residential use. Systems to directly use the light of the sun are most common. The most usual device _______ using sunlight is the window, but skylights and skylight tubes are also used.

Answer the questions about the text "Solar Energy":

- Where can solar energy be used?
- How can it be produced?
- What are devices for using sunlight?

19.Fill in the text "Hydropower" using words and word combinations from the box:

• quality	• convert
• releasing	• results in
• significant	• damming
• represents	• power
• habitat	

Hydropower ___________________ one of the oldest and largest renewable ____________________sources. Hydropower plants __________________ the energy of flowing water into electricity. This is primarily done by ______________________ rivers to create large reservoirs and then ___________________ water through turbines to produce electricity. Hydropower _____________________ no emissions into the atmosphere. But the process of damming a river can create __________________ ecological problems for water _________________ and for fish and wildlife__________________.

Answer the questions about the text "Hydropower":

- How can electricity be produced using hydropower?
- What is the greatest advantage of using hydropower?
- What problems can using hydropower bring?

20.Use the word in capitals at the end of the lines in the text "Biomass Use" to form a word that fits in the space in this line using the necessary suffixes and prefixes:

Biomass Use

Biomass is second to hydropower as a ***<u>leader</u>*** in	LEAD
renewable energy ________________. Biomass has an	PRODUCE
existing capacity of over 7,000 MW. Biomass as a fuel	
consists of organic matter such as ________________	INDUSTRY
waste, agricultural waste, wood, and bark. Biomass can be	
burned ___________________ in specially designed power	DIRECT
plants, or used to replace up to15% of coal as a fuel in	
ordinary power plants.	
Biomass burns cleaner than coal because it has less	
sulfur, which means ______________________ sulfur	LITTLE
dioxide will be emitted into the atmosphere.	
Biomass can also be used indirectly, since it produces	
methane gas as it decays or through a modern process	
called ___________________. Methane can produce power	GASIFY
by burning in a boiler to create steam to drive steam	
turbines or through ___________________ combustion in	INTERN
gas turbines and reciprocating engines.	
The largest use of biomass energy in Virginia, USA,	
is the forest products industry. Furniture plants, sawmills,	
and paper mills __________________ burn their wood	USUAL
waste to produce heat and electricity. Many home	
_____________________ use firewood or pellets for winter	OWN
heat.	

Translate the word combinations from the text above:

- ✓ biomass is second to hydropower,
- ✓ an existing capacity,
- ✓ consists of organic matter,
- ✓ agricultural waste, wood, and bark,
- ✓ specially designed power plants,
- ✓ burns cleaner than coal,
- ✓ will be emitted into the atmosphere,
- ✓ can be used indirectly,

- ✓ it produces methane gas as it decays,
- ✓ steam to drive steam turbines,
- ✓ in gas turbines and reciprocating engines,
- ✓ the forest products industry,
- ✓ furniture plants, sawmills, and paper mills,
- ✓ firewood or pellets for winter heat.

Answer the questions concerning the text "Biomass Use":

- ➢ What does biomass consist of?
- ➢ Why is biomass less harmful for the environment than coal?
- ➢ Where is methane used?

21.Match the beginnings and endings of the sentences in the text "Geothermal Energy". Then read the text, state the main idea of it and answer the questions:

Geothermal energy

Beginning of the sentences:

1. Geothermal power plants use…
2. Steam then powers turbines …
3. Geothermal power plants can draw from underground reservoirs of hot water or …
4. High underground high temperatures are accessed by…
5. In one sense, this geothermal energy is not renewable, …
6. That time is so far off (hundreds of millions of years) that we…
7. Geothermal heat pumps use compressors to pump heat out of the earth (for winter heating) …
8. The energy they pump into and out of the earth is renewable, since it is replaced by …
9. The energy that runs the compressor can either be …

Ending of the sentences:

a) since sometime in the future the core of the earth will cool.
b) high temperatures deep underground to produce steam.
c) or into the earth(when running as air conditioners in summer).
d) can heat water by pumping it into hot, dry rock.
e) renewable or conventional.

f) that produce electricity.
g) drilling wells, sometimes more than a mile deep.
h) think of it as renewable.
i) the cycle of the seasons.

1.	2.	3.	4.	5.	6.	7.	8.	9.

Answer the questions concerning the text above:

- How do geothermal power plants work?
- What is the depth of the wells drilled to get the energy?
- Give examples of where this energy source can be widely used.

22.Look through the text "Fuel Cells" opening the brackets and paying attention to the use of the Active Voice and the Passive Voice in it. State the main idea of it:

Fuel Cells

A fuel cell is an alternative energy device, but it is not necessarily a renewable energy device. It is only renewable if the source of the fuel used is renewable. A fuel cell is an electrochemical device, like a battery in that it ________________ ***(convert)*** the energy from a chemical reaction directly into electricity and heat. But unlike a battery, which _________________ (***limit)*** to the stored chemicals within, a fuel cell ___________________ ***(have)*** the capability of generating energy as long as fuel __________________***(supply)***.

Currently produced fuel cells __________________ ***(combine)*** hydrogen and oxygen without combustion to produce electricity. The oxygen __________________ (***come***) from the air, while the hydrogen can either__________________(***produce***) from water – using electricity, or extracted from fossil fuels.

New fuel cells __________________(***develop***) that can __________________ (***use***) fossil fuels directly. Fuel cell technology has been around for over 150 years and it __________________ (***show)*** great promise in powering vehicles and in providing energy for residential applications.

Translate the following phrases from the text above into Russian:

- ✓ a fuel cell,
- ✓ not necessarily a renewable energy device,
- ✓ but unlike a battery,
- ✓ the capability of generating energy,

- ✓ currently produced fuel cells,
- ✓ hydrogen and oxygen,
- ✓ extracted from fossil fuels,
- ✓ fuel cell technology has been around for over 150 years,
- ✓ shows great promise,
- ✓ powering vehicles,
- ✓ residential applications.

Answer the questions about the text:

- ✓ What is a fuel cell?
- ✓ What is the difference between a fuel cell and a battery?
- ✓ Where do hydrogen and oxygen come from?
- ✓ Where can fuel cells be used in future?

23.Compose a story about alternative energy sources on the basis of the texts of the UNIT IV using your active vocabulary. Retell it. Use a plan when retelling your story. Expand your answer speaking about some interesting facts you know and the latest developments. Emphasize the advantages of using these energy sources and possible hazards for the environment and the life of people.

FINAL TASK

Choose an alternative energy source and make a report/ prepare a presentation about it. Find pictures, videos, data that will help make your presentation vivid, impressive and interesting. While preparing, be ready to answer the following questions:

1. Give a definition of an energy source.
2. When was it used for the first time?
3. How can we get it?
4. Where is this energy source used today?
5. What are the advantages of the energy source?
6. What are the disadvantages of the energy source? (finding, extracting, manufacturing, using)
7. What is the economic impact of the energy source?
8. What is the environmental impact of the energy source?
9. Is there a high cost to the consumer in using the energy source?
10. Are there any other interesting facts about the energy source?
11. What is the future of this energy source?

UNIT IV SELF ASSESSMENT

Fill in the table below assessing yourself 1 / 2 / 3. Use the information below:

I know:		
1. the vocabulary of the Unit		
2. terms and their definitions		
3. English grammar rules of the Unit (degrees of comparison of adjectives)		
4. word-building elements (suffixes/prefixes) from the Unit		
I can:		
1. use active vocabulary of the Unit		
2. identify different alternative energy sources that exist		
3.		
4. understand basic concepts from the Unit		
5. form degrees of comparison of adjectives		
6. form new words using different suffixes/prefixes.		
TOTAL:		

The basis for your assessment:

Я знаю и понимаю 85-100% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу. Я умею правильно использовать - времена активного и пассивного залога, - строить вопросительные предложения, - образовывать степени сравнения прилагательных	3	☺
Я знаю и понимаю 50-85% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу, но иногда допускаю ошибки. Я умею правильно использовать - времена активного и пассивного залога, - строить вопросительные предложения, - образовывать степени сравнения прилагательных но иногда допускаю ошибки.	2	😐
Я знаю и понимаю менее 50 % слов и понятий. Я плохо владею правильным произношением и орфографией, частично способен к двуязычному переводу, часто допускаю ошибки. Я не понимаю и не умею использовать правильно - времена активного и пассивного залога, - строить вопросительные предложения, - образовывать степени сравнения прилагательных, но часто допускаю ошибки.	1-0	☹

<u>Results</u>: 27-30 points – Excellent, 20-26 – Good, 11-19 – Satisfactory.
If your result is below 11, you should work with the material of the unit again!

UNIT IV - REVISION TASKS

1.Read the text "10 Fairly Fun Facts About Renewable Energy" and do the tasks after it:

10 Fairly Fun Facts About Renewable Energy

Most of us are aware of the costly impact our demand for energy has on the environment. Here at Fischer Energy we are passionate about our responsibility to the well-being of our planet. We can all do our bit to lower our use of fossil fuels and with it our carbon footprint. Renewable energy with its non-polluting qualities and infinite capacity can reduce the amount of carbon dioxide that is released into the atmosphere and in-turn help save our increasingly fragile planet.

We owe it to our future generations and it is important that we get to know as much as we can about the four sources of renewable energy; solar, wind, water and the natural heat from the earth. (Bio-fuel and geothermal) Together we can lessen our reliance on traditional forms of energy and move forward to a greener future. So, here are ten fairly fun facts to get you up-to speed.

1. Looking out the window at the pouring rain pummeling against the window, you may find it hard to believe that enough sunlight falls on the earth in a single hour to meet the whole world's energy requirements for an entire year! Harnessed properly, the great fiery ball in the sky is a highly efficient and clean source of energy.
2. As we're on the subject of the weather, it takes a wind speed of just 14mph to convert wind energy into electricity. With one wind turbine producing enough power to supply up-to 1400 homes with electricity, these blustery conditions are ideal for producing renewable energy.
3. About 71% of the planet is made up from water, so it makes sense that this is currently the most commonly used renewable source. Providing the energy needs for over 28 million people.
4. You may think that using renewable energy is a predominantly modern initiative. However, along with indoor plumbing, straight roads and sewage systems the Romans were one of the first to utilize the heat from the earth and harness geothermal energy to heat their homes. In the UK 20% of us live in an area suitable for Geothermal District Heating using heat pumps.
5. Solar panels are an earth-friendly way to generate renewable energy and we have none other than Albert Einstein to thank for this. More-famously

known for his theories on gravity and relativity, Albert was awarded the Nobel Prize in physics in 1921 for his innovative discovery of the photoelectric effect, which allows us to convert sunlight into electricity and to heat our water.

6. It is thought that air travel accounts for up to a huge 9% of the total climate change impact of human activity. With the aviation industry expanding at a significant rate it is difficult to see how this figure can drop. However, all is not lost. Back in 1990 a world record was set when a plane traversed the United States (in stages) powered by solar energy alone!
7. We can use Portugal as a blueprint for what is possible with increasing renewable energy. In just a five-year period the Country's electricity use rose from 15% to 45% in green energy. We're doing pretty well in the UK with renewables accounting for 20% of our electricity with the target of raising this to 30% by 2020.
8. One of the most creative advancements in renewable energy is that we now have the ability to use the sun's rays throughout the night. A power plant in Spain soaks up the sun during the day and then stores them in a special salt enabling over seven hours of power to be distributed to the surrounding areas.
9. Wind turbines have developed rapidly in recent years. 30 years ago a turbine had blades measuring just five meters long. These day's most modern designs feature 75 meter blades producing 25,000 times more power. In Hawaii the biggest turbine in the world boasts blades the length of a football pitch!
10. In Paraguay, 90% of the country's electricity is produced by the Itaipu Dam and in Iceland 100% of their energy is powered by geothermal and hydropower sources. There are even rumors circulating about the practicality of connecting Iceland's efficient source with the UK grid!

Hopefully these fairly fun facts have provided an extra insight into the wonderful world of renewable energy and the endless possibilities that are literally all around us. By harnessing the incredible elements the Earth has given us we have the opportunity to really make a difference and help keep our world happy and healthy for many generations to come.

https://www.fischerenergy.co.uk/BlogPost/Blog/10FairlyFunFactsAboutRenewableEnergy

TASKS:

1. Give translation to the highlighted words and phrases.
2. Find in the text equivalents to the following words and phrases:

1. *Sun* *(3rd paragraph)*	
2. *To understand* *(1st paragraph)*	
3. *Safer and less polluted* *(2nd paragraph)*	
4. *To give somebody a special prize* *(7th paragraph)*	
5. *Using the or original meaning of a word or phrase* *(13th paragraph)*	
6. *A wide, flat part on a tool or machine, used to push back water or air* *(11th paragraph)*	
7. *A clear deep understanding* *(13th paragraph)*	

3. Give a summary to the text.
4. Make 10 questions to the text (special questions beginning with *Where…; Why…; What…; Who…; How…; How much…; How many…; How long…*).
5. Make an annotation to the text.

6. Fill in the table below:

Country/ The Sources Used	***The Energy Sources Utilized***			
	Solar	***Wind***	***Hydro***	***Geothermal***
1. The UK				
2. Hawaii				
3. Portugal				
4. Spain				
5. Iceland				
6. Paraguay				
7. The USA				

2.Use the word in capitals at the end of the lines in the text "Sources of Energy" to form a word that fits in the space in this line using the necessary suffixes and prefixes:

Sources of Energy

People have always used energy to do work for them. Thousands of years ago, humans burned wood to provide light, heat their living spaces, and cook their food. Later, people used the wind to move their boats. A hundred years ago, people began using falling water to make ***electricity***.	ELECTRIC
Today, people use more energy than ever from a ________________ of sources for a multitude of tasks and	VARY
our lives are undoubtedly better for it. Our homes are ________________ and full of useful and entertaining	COMFORT
electrical devices. We communicate very quickly. We live longer, _______________ lives. We travel the world, or at least see it on television and the internet.	HEALTH
The ten major energy sources we use today are classified into two broad groups – nonrenewable and renewable. Nonrenewable energy sources include coal, petroleum, ________________ gas, propane, and uranium.	NATURE

They are used to generate electricity, heat homes, move cars, manufacture products. They cannot be replenished in a short period of time. For example, petroleum was formed millions of years ago from the remains of ancient sea life.

We could run out of _______________ recoverable nonrenewable resources someday. Renewable energy sources include biomass, geothermal, hydropower, solar, and wind. The supplies of these energy sources are replenished in a short time. — ECONOMIC

We use renewable energy sources ______________ to make electricity. Is electricity a renewable or nonrenewable source of energy? The answer is neither. Electricity is _______________ from the other energy sources because it is a _____________ source of energy. That means we have to use another energy source to make it. — MAIN, DIFFER, SECOND

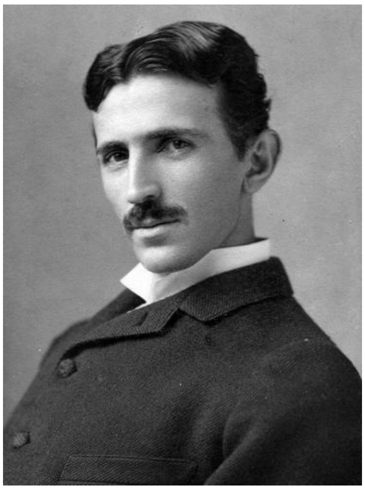
http://cse.ssl.berkeley.edu/energy/Resources/Intro%20to%20Energy%20Reading.pdf

Translate the word combinations from the text above:

- ✓ a multitude of tasks,
- ✓ our lives are undoubtedly better,
- ✓ full of useful and entertaining electrical devices,
- ✓ two broad groups – nonrenewable and renewable,
- ✓ cannot be replenished in a short period of time,
- ✓ from the remains of ancient sea life,
- ✓ recoverable nonrenewable resources,
- ✓ supplies … are replenished in a short time,
- ✓ the answer is neither,
- ✓ we have to use another energy source to make it.

3.Read the text about Nikola Tesla and his contribution into the development of electricity. Surf the internet to find more facts about his life and inventions, summarizing the information you know and speaking about his important contribution into the development of energy field. Say how his advances changed people's lives.

The Question: AC or DC?



The turning point of the electric age came a few years later with the development of **AC (alternating current)** power systems. Croatian scientist, Nikola Tesla came to the United States to work with Thomas Edison. After a falling out, Tesla discovered the rotating magnetic field and created the alternating current electrical system that is used very widely today.

Tesla teamed up with engineer and business man George Westinghouse to patent the AC system and provide the nation with power that could travel long distances – a direct competition with Thomas Edison's DC system.

Tesla later went on to form the Tesla Electric Company, invent the Tesla Coil, which is still used in science labs and in radio technology today, and design the system used to generate electricity at Niagara Falls.

Now using AC, power plants could transport electricity much farther than before. While Edison's DC (direct current) plant could only transport electricity within one square mile of his Pearl Street Power Station, the Niagara Falls plant was able to transport electricity over 200 miles!

Electricity didn't have an easy beginning. While many people were thrilled with all the new inventions, some people were afraid of electricity and wary of bringing it into their homes. They were afraid to let their children near this strange new power source. Many social critics of the day saw electricity as an end to a simpler, less hectic way of life. Poets commented that electric lights were less romantic than gaslights. Perhaps they were right, but the new electric age could not be dimmed.

In 1920, about two percent of U.S. energy was used to make electricity. In 2015, with the increasing use of technologies powered by electricity, it was almost 40 percent.

UNIT V

Ecological Problems in The Energy Sphere

Before starting to work with the Unit V, be ready to discuss the following:

- ✓ What are major ecological problems in the world today?
- ✓ Which of them are connected with producing and utilizing energy?
- ✓ How can using alternative energy sources help decrease hazards and lower environment pollution?
- ✓ What is green energy?
- ✓ Why are the governments of the countries conducting research and development in the sphere of energy production nowadays?

1.Read the international words and give their translation. Pay attention to their pronunciation:

civilization, progression, aspect, local, regional, global, climate, dominant, intensive, factor, element, potential, regulation, social, political, national, international, ecosystem, component, policy, strategy, material, panel, product, innovation, plastics, transformation, standards, trend, temperature, catastrophic, plan, stabilization, million, concentration, option, scenario, ambition, cooperation, investment.

Renewable electricity production is an important part of the future of energy. There are a number of renewable energy electricity technologies available that can help end the dependence on coal and fossil fuels without causing harm to the environment or contributing to carbon emissions and air pollution. Renewable electricity generation can occur from solar power, wind power, wave and tidal power, bioenergy, hydro power, hydrogen and fuel cells, and others.

2.Read the words and their derivatives. Translate them into Russian paying attention to their meaning:

1) advance – advancement – advanced – advancing
2) contribute – contributor – contributory – contribution – contributing
3) imply – implied – implicate – implication – implicit – implicitly
4) afford – affordable -
5) civil – civilian – civilize – civilization
6) foster – fostering – fosterer

7) system – systematic – systematically – systematize – systematization
8) govern – governor – governable - government – governmental – governing
9) courage – encourage – courageous - courageously

3.Fill in the table of derivatives with the appropriate words paying attention to the use of different suffixes you know. Translate the words:

Verb	**Noun**	**Adjective**	**Adverb**
relate	***relationship***	***relative***	***relatively***
	attainment		
contaminate			
		dominant	
			clearly
	innovation		
pervade			
		wide	
			excessively

4.Form adjectives adding the suffix –ful to the nouns. If necessary, consult the dictionary. Translate the words:

- ✓ faith
- ✓ thought
- ✓ hope
- ✓ stress
- ✓ doubt
- ✓ care
- ✓ help
- ✓ meaning
- ✓ use
- ✓ power
- ✓ thank
- ✓ skill
- ✓ wonder
- ✓ harm
- ✓ color

5.Form adjectives using the suffix –less to the nouns. Translate the words:

- ✓ mercy
- ✓ aim
- ✓ care
- ✓ help
- ✓ doubt
- ✓ hope
- ✓ odor
- ✓ use
- ✓ heart
- ✓ sound
- ✓ fear
- ✓ home
- ✓ harm
- ✓ job
- ✓ brain

6.Remember some ways of saying numbers in English:

1. **Oh, zero, nought.**

We say oh	after a decimal point	5.03	five point oh three
	in years	1905	nineteen oh five
We say nought	before the decimal point`	0.02	nought point oh two
We say zero	for the number	0	the number zero
	for temperature	– 5°C	five degrees below zero

2. **The decimal point.**

In English, we use a point (.) and not a comma (,) for decimals. We use commas in figures only when writing thousands.

10,001	ten thousand and one
10.001	ten point oh oh one.

When accounts are prepared on computer, commas are not used!

In English all the numbers after a decimal point are read separately:

10.66	ten point six six
0.325	nought point three two five
0.001	nought point oh oh one / 10^{-3} ten to the power minus three
0.05	zero point oh five / oh point oh five

3. **Per cent (the stress is on the cent)**

4.25%	four point two five per cent
4.025%	four point oh two five per cent
5%	five percent
25%	twenty-five percent
36.25%	thirty-six point two five percent

4. **Squares, cubes, roots.**

10^2	ten squared
10^3	ten cubed
$\sqrt{6}$	the square root of 6

5. Fractions.

$^1/_2$	a half	$^3/_{10}$	three tenths
$^1/_3$	a third	$^3/_4$	three quarters
$^1/_4$	a quarter	$^1/_{12}$	one twelfth
$^1/_5$	a fifth	$3\,^1/_2$	three and a half
$^2/_3$	two thirds	$2\,^3/_4$	two and three quarters

7.Translate the following texts and be ready to read them aloud:

1. In 2015, 33.2% of U.S. electricity came from coal – roughly equal to natural gas (32.7%), but greater than nuclear power (20%) or renewable energy sources (13%).

America has plenty of coal. Its mines produced about 900 million tons in 2015, nearly all of it destined for domestic electricity generation, but also some for export. That is only a tiny fraction of U.S. recoverable coal reserves, which are estimated at about 257 billion tons. In fact, more than $^1/_4$ of the world's total known coal reserves are located in the United States.

Coal consumption in the United States is projected to decrease slightly during the next 25 years, from 801 million tons in 2015 to 557 million tons by 2040 – about 1.4% per year. Future increases in the supply will probably come from western states because of the low sulfur content of the resource in that region, which now provides about 57% of the nation's coal. Wyoming alone typically accounts for about 42% of all domestic coal mined.

2. America relies on its domestic supplies as well as imports of petroleum – about one-quarter of the amount they consume – from a handful of nations. The United States depends heavily on oil, which accounts for 92% of all consumption in the transportation sector and 26% in the industrial sector. U.S. oil production growth in 2014 was the highest in more than 100 years. As of 2015, total world consumption was approximately 94 million barrels per day, about 19 million of which were used by the United States. The U.S. Energy Information Administration (EIA) estimates proved conventional crude oil reserves at more than 1.7 trillion

barrels worldwide. Proved U.S. oil reserves now total 39.9 billion barrels, with more than 3.1 billion barrels discovered since 2012. Extraction of "tight" oil accounted for only 12% of total U.S. oil production in 2008. By 2012, it made up 35% and is predicted to rise to 50% in the near term.

The EIA projects that domestic crude oil production will remain about 9.4 million barrels/day through 2025, and will rise to 11.3 million barrels/day by 2040, an increase of nearly 20%.

3. The United States has abundant deposits of natural gas and imports less than 4% of the total amount consumed annually – chiefly from Canada. In 2015, 29% of the U.S. total energy supply came from natural gas. Natural gas provides 29% of our energy and is used to heat about half the homes in the United States. Natural gas is also used to generate 33% of our electricity. Natural gas is also more energy efficient than coal. On average, a typical coal-burning power plant in 2013 was about 33% efficient in converting heat energy into electrical power. A gas-fired plant was about 42% efficient.

Annual consumption is projected to rise by about 25% during the next 25 years, from 28.3 trillion cubic feet (tcf) in 2015 to 35.4 tcf in 2040.

4. According to Eurostat, the share of renewable energy sources used in the European Union in 2015 was 16.7%. In 2004, this figure was just 8.5%. Since this year, the share of renewable energy in gross final energy consumption has therefore increased considerably across all Member States without exception. Of the 28 EU Member States, 11 Member States had reached their national targets for the year 2020 by 2015. In 2005, the share of renewables in total EU electricity consumption was just under 14%, i.e. more than 86% of electricity consumption was covered by fossil fuels and nuclear energy. The share of the EU's gross electricity consumption covered by renewable energy doubled to almost 29% within the space of 10 years (2005-2015). Back in 2005, the bulk (more than $^2/_3$) of green electricity came from hydropower. By 2015, the share of this technology had fallen to only just over 36%. In contrast, wind, biomass and solar energy have increased considerably, at 33%, 19% and 11% respectively. At the end of 2015, total installed capacity in the EU for the generation of electricity from renewable energy amounted to around 401 gigawatts, or more than twice the level at the end of 2005. Wind energy accounted for approximately 141 gigawatts of this figure, ahead of hydropower (127 gigawatts) and photovoltaics (95 gigawatts).

8.Read the text about energy and environment concerns. Translate it using the active vocabulary of the Unit V:

Energy and Environment Concerns

Energy use and supply is of fundamental importance to society and, with the possible exception of agriculture and forestry, has made the greatest impact on the environment of any human activity - a result of the large scale and pervasive nature of energy related activities. Although energy and environment concerns were originally local in character - for example, problems associated with extraction, transport or noxious emissions - they have now widened to cover regional and global issues such as acid rain and the greenhouse effect. Such problems have now become major political issues and the subject of international debate and regulation. It is very important to cover the social, economic and political dimensions of such issues at local, national and international level. The technological and scientific aspects of energy and environment questions including energy conservation, and the interaction of energy forms and systems with the physical environment and the relationship of such questions with economic and socio-political issues are of great importance nowadays.

Answer the questions:

- ✓ Why are energy and environment questions of great importance today?
- ✓ Explain why energy use and supply became the matter of international debate.

9.Study the following words and phrases from the texts of the Unit, memorize them:

1) abundant (adj)	[ə'bʌnd(ə)nt]	обильный, изобилующий, богатый
2) acid (n)	['æsɪd]	кислота, кислотный, кислый, едкий, язвительный
3) acidification (n)	[əˌsɪdɪfɪ'keɪʃən]	подкисление, окисление
4) advancement (n)	[əd'vɑːnsm(ə)nt]	продвижение, прогресс, успех, распространение
5) affordable (adj)	[ə'fɔːdəbəl]	возможный; допустимый; по средствам, приемлемый

6) along with	[ə'lɒŋ wɪð]	одновременно с; так же, как и
7) attain (v)	[ə'teɪn]	достигать, добиваться, приобретать, добираться
8) byproducts (n)	['baɪprɒdʌkt]	побочный продукт
9) carpool (v)	['kɑːpuːl]	совместно эксплуатировать автомобиль (для поездок на работу, в магазин, в школу…), по очереди подвозить друг друга на автомобиле
10) challenge (n)	['ʧalɪn(d)ʒ]	сложная задача; проблема
11) clearly (adv)	['klɪəli]	очевидно, несомненно, конечно, по-видимому
12) commodity (n)	[kə'mɒdɪti]	товар, продукт, предмет потребления, удобство
13) contaminant (adj)	[kən'tamɪnənt]	загрязняющее вещество; загрязнитель, контаминант
14) contaminate (v)	[kən'tamɪneɪt]	загрязнять, заражать, портить
15) contributor (n)	[kən'trɪbjʊtə]	жертвователь, помощник, содействующий, содействующий
16) controversy (n)	['kɒntrəvəːsi]	спор, дискуссия, полемика, расхождение во мнениях
17) degradation (n)	[ˌdɛgrə'deɪʃ(ə)n]	деградация, ухудшение; уменьшение, понижение
18) determine (v)	[dɪ'təːmɪn]	определять, устанавливать, разрешать, решать, принимать решение
19) disposal (n)	[dɪ'spəʊz(ə)l]	распоряжение, право распоряжаться,-управление, расположение, размещение, устройство
20) due to	[djuː tuː]	из-за, по причине
21) embrace (v)	[ɪm'breɪs]	включать; заключать в себе, охватывать использовать, воспользоваться

22)	excessive (adj)	[ɪk'sɛsɪv]	чрезмерный; излишний; избыточный
23)	exposure (n)	[ɪk'spəʊʒə]	воздействие, демонстрация, расположение, местоположение
24)	face (v)	[feɪs]	встречать смело; смотреть в лицо (чему-л.) без страха, сталкиваться лицом к лицу
25)	fathom (v)	['fað(ə)m]	постигать, понимать, соображать; догадываться
26)	feature (n)	['fi:tʃə]	особенность, характерная черта; признак, свойство
27)	finite (adj)	['fʌɪnʌɪt]	конечный, ограниченный, личный, имеющий предел
28)	flourish (v)	['flʌrɪʃ]	процветать, расцветать, преуспевать, жить
29)	foster (v)	['fɒstə]	благоприятствовать, способствовать; поощрять
30)	greenhouse effect	['gri:nhaʊs ɪ'fɛkt]	парниковый эффект
31)	harmful (adj)	['hɑ:mfʊl]	вредный, пагубный, губительный, тлетворный, разлагающий
32)	hence (adv)	[hɛns]	следовательно, отсюда, с этих пор
33)	implication (n)	[ɪmplɪ'keɪʃ(ə)n]	смысл, вовлечение, соучастие
34)	imply (v)	[ɪm'plʌɪ]	означать, подразумевать, предполагать, значить, заключать в себе
35)	impose (v)	[ɪm'pəʊz]	навязать, навязаться, навязывать, налагать, облагать
36)	inevitable (adj)	[ɪn'ɛvɪtəb(ə)l]	неизбежный, неминуемый, неизменный
37)	meaningful (adj)	['mi:nɪŋfʊl]	многозначительный, значительный, существенный, содержательный
38)	mitigation (n)	[mɪtɪ'geɪʃ(ə)n]	смягчение, уменьшение

39)	noxious (adj)	[ˈnɒkʃəs]	вредный, пагубный, гибельный; нездоровый; ядовитый
40)	occur (v)	[əˈkəː]	происходить, встречаться, иметь место, случаться
41)	overcome (v)	[əʊvəˈkʌm]	преодолевать, побороть, перебороть, побеждать
42)	pervasive (adj)	[pəˈveɪsɪv]	распространяющийся, всеобъемлющий, глубокий, проникающий
43)	portable (adj)	[ˈpɔːtəb(ə)l]	портативный, переносной; ручной; передвижной
44)	predict (v)	[prɪˈdɪkt]	предсказывать; прогнозировать; пророчить
45)	promote (v)	[prəˈməʊt]	способствовать, поощрять, продвигать, стимулировать, поддерживать
46)	push (v)	[pʊʃ]	толкать, проталкивать, помочь пройти какое-л. испытание, подгонять, подталкивать
47)	rapidly (adv)	[ˈrapɪdli]	быстро
48)	reliance (n)	[rɪˈlʌɪəns]	опора, доверие, уверенность
49)	stationary (adj)	[ˈsteɪʃ(ə)n(ə)ri]	стационарный, неподвижный, постоянный, закрепленный, неизменный
50)	stem (v)	[stem]	происходить, возникать, запруживать, перегораживать
51)	tackle (v)	[ˈtak(ə)l]	энергично браться, заниматься, решать; работать (над чем-л.)
52)	taste (n)	[teɪst]	вкус, пристрастие, склонность, стиль
53)	thankfully (adv)	[ˈθaŋkfʊli]	благодарно, с благодарностью, с облегчением
54)	via	[ˈvaɪə]	через; путём, посредством, с помощью
55)	witness (v)	[ˈwɪtnəs]	быть свидетелем, очевидцем, служить доказательством

10.Read the text "Energy and Environment" and state the main idea of it. Use the Vocabulary above. If necessary, look the words up in the dictionary. Comprise a terminological vocabulary to the text. Make an annotation to the text.

Energy and Environment

The development of modern civilization has been dependent on both the availability and the advancement of energy. We have witnessed a progression from animal and steam power, to the internal combustion engine and electricity generation and to the harnessing of alternative sources of energy. Because of our reliance on energy sources, it is also important to understand the effects of energy use on the environment. All aspects of energy – the way it is produced, distributed, and consumed – can affect local, regional, and global environments through land use and degradation, air pollution, the acidification of water and soils, and through global climate change via greenhouse gas emissions.

The majority of our energy stems from fossil fuels such as coal, oil, and natural gas; yet, the burning of these fuels is a large source of carbon dioxide emissions which contributes to the greenhouse effect. Coal is dominant in the production of electricity, while oil is the world's primary transportation fuel. Natural gas use, most commonly for heating, is growing quickly; however, while cleaner and less carbon intensive than coal and oil, natural gas also emits significant amounts of carbon dioxide.

While fossil fuels will remain our largest source of energy for the foreseeable future, they are ultimately finite resources. With concern over domestic supply and reliance on foreign supplies, increasing costs and environmental impacts, there is an increasing push to utilize alternative fuel sources.

Hydrogen is the most abundant element in the universe and could be an important factor in our energy future since it can both carry and store energy. As such, hydrogen can be used in a wide variety of applications,

Amid a global environmental crisis, renewable energy takes centre stage.

We're working hard to promote renewable energy. We know it has the power to tackle problems so many of us are worried about, like climate change on a global scale, air pollution in our towns and cities, and acidity in our oceans.

Thankfully, green energy is increasingly more fashionable and economical around the world. Of course, renewable energy has been around for some time (the Persians fashioned windmills in 200 BC!), but today, we have no choice but to embrace new, renewable technology.

from portable devices and stationary sources to transportation vehicles through the use of fuel cells, with the only byproducts being water and heat. Yet, while it can be manufactured from renewable energy sources, the majority of hydrogen is produced by processing fossil fuels which emit pollutants in the process. A significant challenge in the availability of hydrogen energy is the large amount of energy - fossil, nuclear, hydro – that will be needed to generate the hydrogen.

Nuclear energy provides nearly a fifth of the world's electricity without harmful by-products. Yet, concern over safe storage and disposal of radioactive waste, along with the potential for accidents, radiation contamination and exposure continues. This concern, along with those opposed to nuclear energy, has blocked its advancement as a practical and sustainable energy source.

Between increasing costs and concern over the environmental effects related to fossil fuel use, and controversy over the use of nuclear power, research and development in the area of renewable sources of energy continues to flourish. These sources – wind, solar, geothermal, and water – have been used in one form or another for many centuries, but require additional advancement before they can become cost-competitive with conventional energy sources. They also face the challenge of providing sufficient amounts of electricity to be a meaningful contributor to our growing power needs.

As human consumption of energy continues to increase, further research and development will be necessary to produce alternative and/or renewable sources of energy that are readily available, affordable, and less harmful to the environment than conventional fossil fuels. While our dependence on energy is not likely to decrease, it will be important to foster new innovations in energy technologies with a larger focus on energy efficiency and conservation.

11.Look through the text again and say whether it is TRUE/ FALSE/ NOT STATED, prove your opinion.

1. All energy sources have some impact on our environment.
2. The more people will use alternative and/or renewable sources of energy, the less harmful the impact on the environment will be.
3. Fossil fuels such as coal, oil, and natural gas do substantially more harm than renewable energy sources.
4. Nuclear energy produce many harmful by-products.
5. Fossil fuels are the main sources of energy today.
6. The exact type and intensity of environmental impacts varies depending on the different factors.

7. Renewable sources are the only way to reduce environmental impact.
8. Human consumption of energy from renewable sources is increasing because they are better and cheaper.
9. Renewable sources such as wind, solar, geothermal, biomass, and hydropower also have environmental impacts, some of which are significant.

12.Look through the text "What are Renewable and Alternative Energy Sources?" and answer the questions:

9. What has the development of modern civilization been dependent on?
10. What are harmful effects of producing energy on the environment?
11. Where does the majority of our energy stem from?
12. What are ultimately finite energy resources?
13. Why can hydrogen be considered n important factor in our energy future?
14. What are the only byproducts of utilizing hydrogen?
15. What is the main problem of using nuclear energy?
16. Why is further research and development necessary in the energy field?
17. Explain why new innovation is so crucial in energy technologies. Give reasons.

13.Give the English equivalents from the text above to the following Russian ones:

1) зависело как от доступности, так и от развития энергетики,
2) мы стали свидетелями,
3) к использованию альтернативных источников энергии,
4) из-за зависимости от источников энергии,
5) могут влиять на … среду посредством землепользования,
6) посредством выбросов парниковых газов,
7) связана с ископаемым топливом,
8) значительный источник выбросов углекислого газа,
9) что способствует парниковому эффекту,
10) природный газ также выделяет значительное количество углекислого газа,
11) в конечном счете, являются ограниченными ресурсами,
12) увеличение издержек и воздействие на окружающую среду,
13) растет спрос на альтернативные источники топлива,
14) водород является самым распространенным элементом во вселенной,

15) от переносных устройств и стационарных источников до транспортных средств,
16) причем единственным побочным продуктом являются вода и тепло,
17) путем переработки ископаемых видов топлива,
18) существенная проблема,
19) без вредных побочных продуктов,
20) обеспокоенность по поводу безопасного хранения и утилизации радиоактивных отходов,
21) заблокировала продвижение как практического и устойчивого источника энергии,
22) разногласия в отношении использования ядерной энергии,
23) исследования и разработки в области возобновляемых источников энергии продолжают процветать,
24) требуют дополнительного продвижения,
25) стать конкурентоспособными по стоимости,
26) сталкиваются с проблемой обеспечения,
27) значительный вклад,
28) менее вредный для окружающей среды,
29) наша зависимость от энергии вряд ли уменьшится,
30) способствовать новым инновациям.

14.Continue the sentences on the basis of the information from the text:

1. All aspects of energy can affect ________________________.
2. Fossil fuels are ultimately ___________________.
3. Hydrogen can be used ______________________________.
4. The only byproducts of using hydrogen are ______________________.
5. Nuclear energy provides ______________________.
6. The major problems regarding the use of nuclear energy are connected with ______________________________.
7. Research and development in the area of renewable sources of energy continues ________________________________.
8. Wind, solar, geothermal energy and water have been used in one form or another for many centuries, but now they require _______________________________.
9. As human consumption of energy continues to increase, ______________________________.

15.Match vocabulary words and their definitions:

1) abundant	a) to happen
2) challenge	b) present or noticeable in every part of a thing or place
3) to foster	c) to encourage or support something, or to help something become successful
4) to occur	d) something that needs great mental or physical effort in order to be done successfully and therefore tests a person's ability
5) rapidly	e) to make a strong decision
6) pervasive	f) quickly
7) to predict	g) to force someone to accept something, especially a belief or way of living
8) to promote	h) more than enough; a lot of
9) to determine	i) having a limit or end
10) to contaminate	j) to encourage the development or growth of ideas or feelings
11) to impose	k) to make something less pure or make it poisonous
12) finite	l) to say that an event or action will happen in the future, especially as a result of knowledge or experience

16.Fill in the text below using words and word combinations from the box:

• a key player	• energy markets
• to be important	• into balance
• energy supply	• harmful
• inevitable increase	• for every country

- policies and strategies

The ___________________________ in population and the economic development that must necessarily occur in many countries have serious implications for the environment, because energy generation processes (e.g., generation of electricity, heating, cooling, or motive force for transportation vehicles and other uses) are polluting and ______________________ to the ecosystem.

Energy is considered to be _______________________in the generation of wealth and also a significant component in economic development. This makes energy resources extremely significant ______________________in the world. In bringing energy needs and energy availability ______________________, there are two main elements: energy demand and ________________________.

In this regard, every country aims to attain such a balance and hence develop _____________________________. A number of factors are considered _____________________________ in determining world energy consumption and production, including population growth, economic performance, consumer tastes, technological developments, government policies concerning the energy sector, and developments on world __________________________.

Answer the questions about the text:

- Why have population increase and economic development serious implications for the environment?
- What are two main elements in bringing energy needs and availability into balance?
- What factors in determining world energy consumption and production are considered to be important?

17.Look through the text* "What is Environmentally Friendly Technology?" *opening the brackets and paying attention to the use of the Active Voice and the Passive Voice in it. State the main idea of it:

What is Environmentally Friendly Technology?

Environmentally friendly technology is a rapidly growing field that __________________ (***focus***) on new scientific and technical methods that benefit the earth. Also referred to as "green technology," this area __________________ (***dedicate***) to preserving our natural resources. This __________________ (***involve)*** both the development of new technologies and the improvement of existing ones.

While these inventions, improvements, and scientific developments can have a worldwide impact on our global ecosystem, they also __________________ (***affect)*** people on an individual level. Many green technologies directly __________________ (***affect)*** the everyday lives of those who use them. By improving the way people perform basic tasks such as cooking, cleaning, or heating and cooling their home, green technologies are able to reduce the environmental impact that families __________________ (***have)*** on the earth every day.

Environmentally friendly technology __________________ (***utilize)*** many methods for reducing the impact that various activities have upon the earth. To be considered environmentally friendly, a product or action should be sustainable, __________________ (***produce)*** as little waste and pollution as possible, and __________________ (***utilize)*** the recycling and reuse of materials whenever possible.

Energy is one well-known area of green technology. Sustainable sources of energy __________________ (***include***) wind power, hydroelectric power, biofuels, and solar energy. These environmentally friendly technologies can now be used to power homes, businesses, and even small electronic devices. Solar-powered garden lights, remote controls, and electric shavers are all available for eco-conscious consumers.

Some environmentally friendly technologies __________________ (***focus)*** on everyday consumer products such as cleaning supplies, paint and plastics. An increasing number of companies such as method® and Seventh Generation® __________________ (***emerge***) to provide consumers with cleaning products that are safe for the earth. Even leading global companies such as Procter & Gamble®, which __________________ (***produce***) Dawn®, Tide®, Gain®, Bounty®, Puffs®, Charmin®, and other well-known brands, have gotten on board, setting goals for sustainability.

On a larger scale, green building __________________ (***emerge***) as an important area of environmentally friendly technology. Green buildings __________________ (***use)*** sustainable or recycled materials as much as they can and strive to impact the surrounding environment as little as possible. These structures often __________________ (***include***) innovative features such as solar panels for clean energy and energy efficient appliances that __________________ (***use***) less power and water.

As awareness of our impact on the environment __________________ (***increase***), environmentally friendly technology will likely expand as well. The future of this field may see innovations we can't yet begin to fathom as society

__________________ (***strive***) to live lightly upon the earth and reduce and repair the damaging impacts of our ever-increasing population.

http://www.wisegeek.com/what-is-environmentally-friendly-technology.htm#didyouknowout

Translate the following phrases from the text above into Russian:

- ✓ environmentally friendly technology,
- ✓ methods that benefit the earth,
- ✓ referred to as "green technology,"
- ✓ have a worldwide impact on our global ecosystem,
- ✓ perform basic tasks,
- ✓ green technologies are able to reduce the environmental impact,
- ✓ to be considered environmentally friendly,
- ✓ a product or action should be sustainable,
- ✓ as little waste and pollution as possible,
- ✓ the recycling and reuse of materials whenever possible,
- ✓ sustainable sources of energy,
- ✓ solar-powered garden lights, remote controls,
- ✓ eco-conscious consumers,
- ✓ safe for the earth,
- ✓ brands have gotten on board,
- ✓ setting goals for sustainability,
- ✓ strive to impact the surrounding environment as little as possible,
- ✓ innovative features,
- ✓ energy efficient appliances,
- ✓ begin to fathom,
- ✓ reduce and repair the damaging impacts of our ever-increasing population.

Answer the questions about the text:

- ✓ What is an environmentally friendly technology?
- ✓ How do green technologies affect our everyday lives?
- ✓ What should a product or an action be like to be considered environmentally friendly?
- ✓ Why do people construct green buildings?
- ✓ How can you make your energy use more environmentally friendly?

18.Fill in the text "The Energy Transformation Challenge" with correct prepositions from the box:

to	to	of
by	to	in
with	of	by
for	of	

The Energy Transformation Challenge

The transformation ________ the energy system needs to be a core element of the sustainable development agenda, in order ________ improve the living standards of people with equity and environmental sustainability.

Energy goals have been suggested ________ improve access to reliable, adequate and high-quality electricity; to use the best practices ________ the provision of energy services; to ensure that unreliable or low-quality energy sources do not compromise the opportunities of the working poor who are self-employed or run household enterprises.

The latest estimates confirm that emissions trends will likely lead to temperature increases ________ potentially catastrophic consequences. Even if all currently planned mitigation policies are fully implemented, a stabilization of greenhouse gas emissions at 450 parts per million (ppm) will not have been achieved ________ 2050.

Even after taking into account all factors, the likely outlook is that the desired emissions reduction targets will not be met. According ________ some projections, emissions concentrations might reach 700 ppm of carbon dioxide equivalent (CO_2) ________ 2050. These increases would be associated with increases in global average temperature of 2°C -3°C by 2050.

Multiple pathways towards sustainable energy have been identified. There are many existing energy technology options ________ mitigating emissions and increasing welfare. Hundreds ________ scenarios have shown that the world can follow a large number of energy paths towards sustainable development which require, however, ambitious policies, improved international cooperation, including means of implementation, behavioral changes and unprecedented levels ________ investment.

(World Economic and Social Survey 2013, https://sustainabledevelopment.un.org/content/documents/2843WESS2013.pdf)

Translate the following phrases from the text above into Russian:

- ✓ to be a core element,
- ✓ the sustainable development agenda,
- ✓ equity and environmental sustainability,
- ✓ improve access to reliable, adequate and high-quality electricity;
- ✓ unreliable or low-quality energy sources,
- ✓ compromise the opportunities,
- ✓ self-employed or run household enterprises,
- ✓ the latest estimates confirm,
- ✓ potentially catastrophic consequences,
- ✓ currently planned mitigation policies are implemented,
- ✓ after taking into account all factors,
- ✓ the likely outlook,
- ✓ the desired emissions reduction targets will not be met,
- ✓ global average temperature,
- ✓ multiple pathways towards sustainable energy,
- ✓ follow a large number of energy paths towards sustainable development.

Answer the questions about the text "The Energy Transformation Challenge":

- ➢ Why does the transformation of the energy system need to be a core element of the sustainable development agenda?
- ➢ What will emissions trends likely lead to?
- ➢ Is the stabilization of greenhouse gas emissions possible by 2050? Explain why.
- ➢ How can the world provide itself sustainable development?

19.Use the word in capitals at the end of the lines in the text "Biomass Use" to form a word that fits in the space in this line using the necessary suffixes and prefixes:

Energy and Society

A society seeking ____________________ development ideally must utilize only energy resources that cause no environmental impact (e.g., that release no emissions to the environment). However, since all energy	SUSTAIN
resources lead to some ____________________impact, it	ENVIRONMENT
is ______________________ to suggest that some (not all)	REASON

of the concerns regarding the ____________________	LIMIT
imposed on sustainable development by environmental emissions and their negative impacts can be in part overcome through increased energy efficiency.	
Clearly, a strong ____________________exists	RELATE
between energy efficiency and environmental impact since, for the same services or products, less resource	
____________________ and pollution is normally	UTILIZE
associated with increased energy efficiency.	
Energy ____________________, that is, the use of	CONSERVE
energy resources in a rational manner, represents another factor that together with energy efficiency can lead to the	
____________________ of the rate of	STABILIZE
____________________ of energy demand, which is	GROW
predicted to increase rapidly in the near future due to	
population growth and ____________________ use of	EXCESS
various commodities (e.g., cars, computers, air conditioners, household electronic equipment, etc.). Any	
____________________in the energy demand of a society	REDUCE
leads to the ____________________ of its available	EXTEND
energy resources.	

Translate the word combinations from the text above:

- ✓ ideally must utilize,
- ✓ cause no environmental impact,
- ✓ release no emissions to the environment,
- ✓ since all energy resources lead to some impact,
- ✓ the concerns imposed on sustainable development,
- ✓ environmental emissions and their negative impacts,
- ✓ can be overcome through increased energy efficiency,
- ✓ is normally associated with increased energy efficiency,
- ✓ the use in a rational manner,
- ✓ which is predicted to increase rapidly in the near future,
- ✓ due to population growth,
- ✓ various commodities,
- ✓ leads to the extension of available energy resources.

Answer the questions concerning the text "Energy and Society":

- Why must our society ideally utilize only energy resources that cause no environmental impact?
- How can negative impacts be overcome?
- What can stabilize the rate of energy demand growth?

20.Read the text about going green opening the brackets and choosing the right variant below. Explain the meaning of the word "green" in the text:

Basics of Green Social Responsibility

We all have a responsibility, whether we like it or not, to do our part in making our world a greener place. If we go green and (1) _______________ money we are fulfilling our green social responsibility and taking part in (2) _______________ the world we live in.

Whether you are in the business or private sector we all have a (3) _______________ responsibility. Green corporate responsibility is as important as what we do in the home to improve our environment.

At home, there are several things we can (4) _______________ in order to fulfill our green social responsibility. Simple things like unplugging your kitchen appliances when not in use can help you go green and save money. Other changes that can be made at home are (5) _______________ with friends or co-workers, recycling paper and plastics, and using natural and (6) _______________ materials such as copy paper for your printer, toilet paper and paper towels.

In the working world, green corporate responsibility is just as important as what we do at home. Businesses and large corporations are going green and saving themselves lots of money by finding (7) _______________ heating and cooling energy sources, implementing recycling programs and making wiser and greener purchases.

Everyone has a green social responsibility to improve the environment in which we live. Our commitment level must (8) _______________ in order to reap the (9) _______________ of going green. We can save time, money and resources if we are willing to inform ourselves and take personal responsibility for what we do.

http://www.bionomicfuel.com/basics-of-green-social-responsibility/

1.	*get*	*save*	*waste*	*spend*
2.	*utilizing*	*fulfilling*	*affecting*	*improving*
3.	*shared*	*decided*	*agreed*	*defined*
4.	*use*	*bring*	*foster*	*modify*
5.	*carpooling*	*surfing*	*walking*	*traveling*

6.	*misused*	*recycled*	*enlarged*	*decreased*
7.	*recycling*	*conventional*	*new*	*alternative*
8	*lower*	*affect*	*increase*	*decrease*
9	*benefits*	*cons*	*shortages*	*luxury*

Translate the phrases having the word "green" from the text. Explain the meaning of each phrase in English:

1) green social responsibility,
2) to fulfill our green social responsibility,
3) to make our world a greener place,
4) if we go green,
5) green corporate responsibility,
6) to make wiser and greener purchases,
7) to have a green social responsibility,
8) to reap the benefits of going green.

Make an annotation to the text Basics of Green Social Responsibility.

21.Compose a story about energy sources and their impact on ecological environment on the basis of the texts of the UNIT V using your active vocabulary.

Prepare a plan and use it for retelling the story. Expand your answer speaking about some interesting facts you know and the latest developments in this field. Emphasize the advantages and disadvantages of using all energy sources and their impact on the environment and our lives. Say what measures the world powers should take to use greener technologies and provide a sustainable development.

FINAL TASK

Choose any energy source and make a report/ prepare a presentation about its impact on the environment. Find pictures, videos, data that will help make your presentation vivid, impressive and interesting. While preparing, be ready to answer the following questions:

1. Give a definition of an energy source.
2. Where is this energy source used today?
3. Do you use it? How?
4. What are the advantages of the energy source?
5. What are possible hazards of its usage?
6. What is the impact of the energy source on the environment?
7. What are possible uses of this energy source in the future?

UNIT V SELF ASSESSMENT

Fill in the table below assessing yourself 1 / 2 / 3. Use the information below:

I know:		
1. the vocabulary of the Unit		
2. terms and their definitions		
3. English grammar rules of the Unit (numbers)		
4. word-building elements (suffixes/prefixes) from the Unit		
I can:		
1. use active vocabulary of the Unit		
2. identify ecological problems connected with energy production and use		
3. understand basic concepts from the Unit		
4. make special and general questions using Active and Passive Voice Tenses		
5. form new words using different suffixes/prefixes.		
6. read and pronounce numbers in English		
TOTAL:		

The basis for your assessment:

Я знаю и понимаю 85-100% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу. Я умею правильно использовать - времена активного и пассивного залога, - строить вопросительные предложения, - читать и произносить числа на английском.	3	☺
Я знаю и понимаю 50-85% слов и понятий. Я владею правильным произношением и орфографией, способен к двуязычному переводу, но иногда допускаю ошибки. Я умею правильно использовать - времена активного и пассивного залога, - строить вопросительные предложения, - читать и произносить числа на английском но иногда допускаю ошибки.	2	😐
Я знаю и понимаю менее 50 % слов и понятий. Я плохо владею правильным произношением и орфографией, частично способен к двуязычному переводу, часто допускаю ошибки. Я не понимаю и не умею использовать правильно - времена активного и пассивного залога, - строить вопросительные предложения, - читать и произносить числа на английском но часто допускаю ошибки.	1-0	☹

<u>Results</u>: 27-30 points – Excellent, 20-26 – Good, 11-19 – Satisfactory.
If your result is below 11, you should work with the material of the unit again!

UNIT V - REVISION TASKS

1.Read the text "Energy: Choices for Environment and Development" and do the tasks after it:

Energy: Choices for Environment and Development

A safe and sustainable energy pathway is crucial to sustainable development; we have not yet found it. Rates of increase in energy use have been declining. However, the industrialization, agricultural development, and rapidly growing populations of developing nations will need much more energy.

To bring developing countries' energy use up to industrialized country levels by the year 2025 would require increasing present global energy use by a factor of five. The planetary ecosystem could not stand this, especially if the increases were based on non-renewable fossil fuels. Threats of global warming and acidification of the environment most probably rule out even a doubling of energy use bared on present mixes of primary sources.

Any new era of economic growth must therefore be less energy intensive than growth in the past. Energy efficiency policies must be the cutting edge of national energy strategies for sustainable development, and there is much scope for improvement in this direction. Modern appliances can be redesigned to deliver the same amounts of energy-services with only two-thirds or even one-half of the primary energy inputs needed to run traditional equipment. And energy efficiency solutions are often cost-effective.

After almost four decades of immense technological effort, nuclear energy has become widely used. During this period, however, the nature of its costs, risks, and benefits have become more evident and the subject of sharp controversy. Different countries world-wide take up different positions on the use of nuclear energy. Their discussion reflected these different views and positions. Yet all agreed that the generation of nuclear power is only justifiable if there are solid solutions to the unsolved problems to which it gives rise. The highest priority should be accorded to research and development on environmentally sound and ecologically viable alternatives, as well as on means of increasing the safety of nuclear energy.

Energy efficiency can only buy time for the world to develop "low-energy paths" based on renewable sources, which should form the foundation of the global energy structure during the 21st Century. Most of these sources are currently problematic, but given innovative development, they could supply the same amount of primary energy the planet now consumes. However, achieving these use levels will require a program of coordinated research, development, and demonstration projects commanding funding necessary to ensure the rapid development of renewable energy. Developing countries will require assistance to change their energy use patterns in this direction.

Millions of people in the developing world are short of fuel wood, the main domestic energy of half of humanity, and their numbers are growing. The wood-poor nations must organize their agricultural sectors to produce large amounts of wood and other plant fuels.

The substantial changes required in the present global energy mix will not be achieved by market pressures alone, given the dominant role of governments as producers of energy and their importance as consumers. If the recent momentum behind annual gains in energy efficiency is to be maintained and extended, governments need to make it an explicit goal of their policies for energy pricing to consumers, prices needed to encourage the adoption of energy-saving measures may be achieved through several means. "Conservation pricing" requires that governments take a long-term view in weighing the costs and benefits of the various measures. Given the importance of oil prices on international energy policy, new mechanisms for encouraging dialogue between consumers and producers should be explored.

A safe, environmentally sound, and economically viable energy pathway that will sustain human progress into the distant future is clearly imperative. It is also possible. But it will require new dimensions of political will and institutional cooperation to achieve it.

http://www.un-documents.net/ocf-07.htm

TASKS:

1. Give translation to the highlighted words and phrases.
2. Give a summary to the text.
3. Make 10 questions to the text (special questions beginning with *Where…; Why…; What…; Who…; How…; How much…; How many…;How long…*).
4. Make an annotation to the text.
5. Find in the text equivalents to the following words and phrases:

1. Having an important meaning (1st paragraph)	

2. *Danger* *(1st paragraph)*	
3. *Most advanced* *(2nd paragraph)*	
4. *A disagreement* *(3rd paragraph)*	
5. *Self-sustainable* *(4th paragraph)*	
6. *Originate* *(4th paragraph)*	
7. *Impulse* *(7th paragraph)*	
8. *Yearly* *(7th paragraph)*	
9. *To foster* *(7th paragraph)*	

2.Read the text "Environmental Impacts of Renewable Energy Technologies". Make an annotation to the text. Fill in the table below surfing the Internet for information if necessary:

Environmental Impacts of Renewable Energy Technologies

All energy sources have some impact on our environment. Fossil fuels -coal, oil, and natural gas – do substantially more harm than renewable energy sources by most measures, including air and water pollution, damage to public health, wildlife and habitat loss, water use, land use, and global warming emissions.

However, renewable sources such as wind, solar, geothermal, biomass, and hydropower also have environmental impacts, some of which are significant.

The exact type and intensity of environmental impacts varies depending on the specific technology used, the geographic location, and a number of other factors. By understanding the current and potential environmental issues associated with each renewable energy source, we can takes steps to effectively avoid or minimize these impacts as they become a larger portion of our electric supply.

Harnessing power from the **wind** is one of the cleanest and most sustainable ways to generate electricity as it produces no toxic pollution or global warming emissions. Wind is also abundant, inexhaustible, and affordable, which makes it a viable and large-scale alternative to fossil fuels.

Despite its vast potential, there are a variety of environmental impacts associated with wind power generation that should be recognized and mitigated.

Like wind power, the **sun** provides a tremendous resource for generating clean and sustainable electricity.

The environmental impacts associated with solar power can include land use and habitat loss, water use, and the use of hazardous materials in manufacturing, though the types of impacts vary greatly depending on the scale of the system and the technology used - photovoltaic (PV) solar cells or concentrating solar thermal plants (CSP).

The most widely developed type of **geothermal** power plant (known as hydrothermal plants) are located near geologic “hot spots” where hot molten rock is close to the earth’s crust and produces hot water.

In other regions enhanced geothermal systems (or hot dry rock geothermal), which involve drilling into the earth’s surface to reach deeper geothermal resources, can allow broader access to geothermal energy.

Geothermal plants also differ in terms of the technology they use to convert the resource to electricity (direct steam, flash, or binary) and the type of cooling technology they use (water-cooled and air-cooled). Environmental impacts differ depending on the conversion and cooling technology used.

Biomass power plants share some similarities with fossil fuel power plants: both involve the combustion of a feedstock to generate electricity. Thus, biomass plants raise similar, but not identical, concerns about air emissions and water use as fossil fuel plants. However, the feedstock of biomass plants can be sustainable produced, while fossil fuels are non-renewable.

Sources of biomass resources for producing electricity are diverse; including energy crops (like switchgrass), agricultural waste, manure, forest products and waste, and urban waste. Both the type of feedstock and the manner in which it is developed and harvested significantly affect land use and life-cycle global warming emissions impacts of producing power from biomass.

Hydroelectric power includes both massive hydroelectric dams and small run-of-the-river plants. Large-scale hydroelectric dams continue to be built in many parts of the world (including China and Brazil), but it is unlikely that new facilities will be added to the existing US fleet in the future.

Instead, the future of hydroelectric power in the United States will likely involve increased capacity at current dams and new run-of-the-river projects. There are environmental impacts at both types of plants.

Hydrokinetic energy, which includes wave and tidal power, encompasses an array of energy technologies, many of which still in the experimental stages or in the early stages of deployment. While actual impacts of large-scale operations have not been observed, a range of potential impacts can be projected.

https://www.ucsusa.org/clean-energy/renewable-energy/environmental-impacts#.Wx6fTpDIrZE

Energy Source	***Environmental Impact***	***Advantages***	***Potential Hazards***
Wind			
Sun			
Geothermal			
Biomass			
Hydroelectric			
Hydrokinetic			

3.Read the text "Eco Friendly Technology" and state the main idea of it. Make an annotation to the text:

Eco Friendly Technology

The goal of any technology is to make our lives better. Whether it makes us more productive in the workplace or allows us to relax while watching the Super Bowl in high definition with surround sound, we have all come to appreciate what technology can do for us. What we are starting to see however, is what technology is doing to us. Just as the Industrial Revolution sparked an increase in pollution, the technical revolution is responsible for its fair share of environmental hazards and waste.

As companies and consumers have developed a sense of eco responsibility over the years, the commitment to sustainable, or green, living has made its way past the living room and into the corporate board room. To comply with both federal and social standards, companies and consumers alike are looking toward eco tech as a way to achieve sustainability.

Eco friendly technology looks to improve in two major areas: energy efficiency and reduction of harmful waste. Through efforts by the large computer and electronic manufacturers, many high tech products carry the ENERGY STAR approval, meaning they are more energy efficient than other products of a similar function and quality. Through corporate recycling programs like those offered by Apple and HP, outdated computers and components can be recycled for future discounts rather than thrown into landfills where toxic residue can pollute groundwater sources.

Of course, eco tech movements need to be supported by the consumer. Make sure that when you get ready to buy that new computer, or that 42 inch flat-screen television, you are buying from a company that supports eco friendly technology through their products and corporate philosophy.

http://greenlivingideas.com/2007/10/22/eco-friendly-technology/

SUPPLEMENTARY READING

How wind turbines annoy residents and how to reduce it

January 24, 2018

Summary: When falling asleep, relaxing or undertaking recreational activities, nearly a third of residents living near a wind farm are not at all annoyed or only slightly annoyed by the noise of wind turbines. One in ten people experience symptoms of stress. However, noise is not the only problem. In particular, a critical attitude towards a wind farm stimulates the experience of stress. A better information policy during the planning phase could help alleviate problems for residents.

When falling asleep, relaxing or undertaking recreational activities, nearly a third of residents living near a wind farm are not at all annoyed or only slightly annoyed by the noise of wind turbines. One in ten people experience symptoms of stress, such as irritability or difficulty falling asleep. However, noise is not the only problem for those affected, according to psychologists at Martin Luther University Halle-Wittenberg (MLU) in the current issue of the journal *Energy Policy*. In particular, a critical attitude towards a wind farm stimulates the experience of stress. According to the study, a better information policy during the planning phase could help alleviate problems for residents.

In their study, the environmental psychologists working with Prof Gundula Hübner and Dr Johannes Pohl from MLU investigated a wind farm in northern Germany from 2012 to 2014. They conducted surveys of residents, and their project partner UL DEWI (UL International GmbH) analysed sound recordings of wind turbines. The psychologists even took weather into account. This allowed researchers to discover, for example, that the noise from wind turbines is perceived more when humidity is high and when there is frost.

Another result: Symptoms of stress were experienced at least once a month by the nearly 10 per cent of participants surveyed who said they felt annoyed by the wind turbines. "Symptoms include problems falling asleep, disturbed sleep in general, a negative mood, and strong irritability," explains Pohl. By comparison, 16 per cent of the participants surveyed said that they suffer from such symptoms at least once a month as a result of traffic noise.

When the psychologists re-surveyed the residents two years later, the proportion of people suffering from at least one concrete symptom had fallen to 6.8 per cent. "Many residents get used to the noise from the wind farm or they have resigned themselves to it. A good one fourth of those affected close their windows at night so that they are no longer disturbed by the noise," says Pohl. It is notable that the people who continued to have the biggest problem with wind turbines were those who were already very critical of the wind farm. This group showed little interest in learning ways to cope with the stress, says the researcher. This shows how difficult it is to change established attitudes. The environmental psychologists at the University of Halle therefore recommend proactively addressing the residents' problems and concerns during the planning phase. "The way the residents experience the planning and construction phase is a decisive indicator of how strongly or weakly they will be impaired in the long run by the wind farm." Pohl concludes. Therefore, it is important to create the most positive experience possible. This could happen, for example, through early information campaigns and community meetings. Furthermore, residents should be included in the planning wherever possible.

Several residents had also prepared recordings of annoying noise at night. These were analysed by the researchers at DEWI. "The wind and the movement of the rotor blades can cause amplitude modulation, in other words an irregular pulsating of the volume. These irregularities are what annoy some of the residents, something which they perceive to be irregular humming or swooshing," says Dr Johannes Pohl from the Institute of Psychology at MLU. A quiet, steady background noise is easier to ignore, says the researcher. Most of the complaints occurred in the night or in the early morning hours when there are fewer other noises. According to the study, however, the proximity of the resident's home to the wind farm had little significant influence on their annoyance.

The psychologists from Halle will incorporate their study's findings into the project "TremAc," which is being funded by the Federal Ministry for Economic Affairs and Energy. As part of the project, ten university and commercial research institutes are working on a new concept for predicting noise and vibrations caused by wind farms. This model should allow the interplay between these two factors to be understood and predicted better, with one of the aims being to make the noise emitted by wind turbines more pleasant for those affected. To this end, acoustic and seismic measurements, as well as surveys covering aspects of environmental psychology and medicine are being conducted at two wind farms.

https://www.sciencedaily.com/releases/2018/01/180124111143.htm

Paving the way for safer, smaller batteries and fuel cells

May 31, 2018

Summary: Engineers have found a new and versatile kind of solid polymer electrolyte (SPE) that has twice the proton conductivity of the current state-of-the-art material. Such SPEs are currently found in proton-exchange membrane fuel cells, but the researchers' new design could also be adapted to work for the lithium or sodium-ion batteries found in consumer electronics.

Fuel cells and batteries provide electricity by generating and coaxing positively charged ions from a positive to a negative terminal which frees negatively charged electrons to power cellphones, cars, satellites, or whatever else they are connected to. A critical part of these devices is the barrier between these terminals, which must be separated for electricity to flow.

Improvements to that barrier, known as an electrolyte, are needed to make energy storage devices thinner, more efficient, safer, and faster to recharge. Commonly used liquid electrolytes are bulky and prone to shorts, and can present a fire or explosion risk if they're punctured.

Research led by University of Pennsylvania engineers suggests a different way forward: a new and versatile kind of solid polymer electrolyte (SPE) that has twice the proton conductivity of the current state-of-the-art material. Such SPEs are currently found in proton-exchange membrane fuel cells, but the researchers' new design could also be adapted to work for the lithium-ion or sodium-ion batteries found in consumer electronics.

The study, published in *Nature Materials*, was led by Karen I. Winey, TowerBrook Foundation Faculty Fellow, professor and chair of the Department of Materials Science and Engineering, and Edward B. Trigg, then a doctoral student in her lab. Demi E. Moed, an undergraduate member of the Winey lab, was a coauthor.

They collaborated with Kenneth B. Wagener, George B. Butler Professor of Polymer Chemistry at the University of Florida, Gainesville, and Taylor W. Gaines, a graduate student in his group. Mark J. Stevens, of Sandia National Laboratories, also contributed to this study, as well as Manuel Maréchal and Patrice Rannou, of the French National Center for Scientific Research, the French Alternative Energies and Atomic Energy Commission, and the Université Grenoble Alpes.

A variety of SPEs already exists. Nafion, which is widely used in proton-exchange membrane fuel cells, is a sheet of flexible plastic that is permeable to protons and impermeable to electrons. After absorbing water, protons can flow through microscopic channels that span the film.

A thin, SPE like Nafion is especially enticing for fuel cells in aerospace applications, where every kilogram counts. Much of the bulk of portable batteries comes from shielding designed to protect liquid electrolytes from punctures. Systems using liquid electrolytes must separate the electrodes further apart then their solid electrolyte counterparts, as metal build-up on the electrodes can eventually cross the channel and cause a short.

Nafion addresses those problems, but there is still much room for improvement.

"Nafion is something of a fluke," Winey says. "Its structure has been the subject of debate for decades, and will likely never be fully understood or controlled."

Nafion is hard to study because its structure is random and disordered. This fluorinated polymer occasionally branches off into side chains that end with sulfonic acid groups. It's these sulfonic acids that draw in water and form the channels that allow for proton transport from one side of the film to the other. But because these side chains occur at random positions and are of different lengths, the resulting channels through the disordered polymer are a twisty maze that transports ions.

With an eye toward cutting through this maze, Winey's group recently collaborated with Stevens to discover a new proton-transporting structure that has ordered layers. These layers feature many parallel acid-lined channels through which protons can quickly flow.

"It's like superhighways versus the country roads of Provence," Winey says.

This new structure is the result of a special chemical synthesis route developed by Wagener's group at the University of Florida. This route evenly places the acid groups along a polymer chain such that the spacing between the functional groups is long enough to crystallize. The most detailed structural analysis to date was on a polymer with exactly

21 carbons atoms between carboxylic acid groups, the polymer that initiated the Penn-Florida collaboration a decade ago.

While Winey's group and Stevens were working out the structure and noting it's potential for transporting ions, Wagener's group was working to incorporate sulfonic acid groups to demonstrate the diversity of chemical groups that could be attached to polyethylenes. Both teams realized that proton conductivity would require the stronger acid.

"Precisely placing the sulfonic acid groups along polyethylene proved to be our biggest synthetic challenge," Wagener says. "Success finally happened in the hands of Taylor Gaines, who devised a scheme we call 'heterogeneous to homogeneous deprotection' of the sulfonic acid group ester. It was this synthetic process which finally led to the formation of the precision sulfonic acid polymers."

The details of this process were also recently published in the journal Macromolecular Chemistry and Physics.

With the chains forming a series of hairpin shapes with a sulfonic acid group at each turn, the polymer assembles into orderly layers, forming straight channels instead of the tortuous maze found in Nafion.

There are, literally, still some kinks to work out. The group's next step is to orient these layers in the same direction throughout the film.

"We're already faster than Nafion by a factor of two, but we could be even faster if we aligned all of those layers straight across the electrolyte membrane," Winey says.

More than improving fuel cells where Nafion is currently employed, the crystallization-induced layers described in the researchers' study could be extended to work with functional groups compatible with other kinds of ions.

"Better proton conduction is definitely valuable, but I think the versatility of our approach is what is ultimately most important," Winey says. "There's still no sufficiently good solid electrolyte for lithium or for hydroxide, another common fuel cell ion, and everyone who is trying to design new SPEs is using a very different approach than ours."

Cellphone batteries made with this type of SPE could be thinner and safer, with the superhighway-style ion channels enabled by the researchers' design, recharge much faster.

"Precision synthesis has been one of the grand challenges in polymer science, and this remarkable work demonstrates how it can open doors to novel materials of great promise," says Linda Sapochak, director of the National Science Foundation's Division of Materials Research. "NSF is excited to see that its support at both universities for this integrative collaboration has led to a synergistic breakthrough."

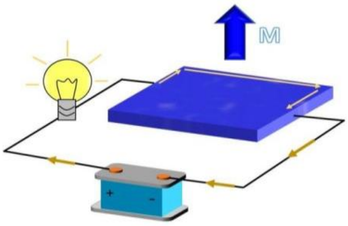
At the University of Pennsylvania, this study was supported by the National Science Foundation through grants DMR 1506726 and PIRE 1545884, and by the Army Research Office through grant W911NF-13-1-0363.

https://www.sciencedaily.com/releases/2018/05/180531114629.htm

Findings could spur energy-saving electronics, quantum computing

June 4, 2018

Summary: Physicists has demonstrated a way to conduct electricity between transistors without energy loss, opening the door to low-power electronics and, potentially, quantum computing that would be far faster than today's computers. Their findings involved using a special mix of materials with magnetic and insulator properties.



An exotic magnetic insulator conducts electricity along its edges without energy loss.

The M stands for magnetization of the magnet

A Rutgers-led team of physicists has demonstrated a way to conduct electricity between transistors without energy loss, opening the door to low-power electronics and, potentially, quantum computing that would be far faster than today's computers.

Their findings, which involved using a special mix of materials with magnetic and insulator properties, are published online in *Nature Physics*.

"This material, although it's much diluted in terms of magnetic properties, can still behave like a magnet and conducts electricity at low temperature without energy loss," said Weida Wu, senior author of the study and associate professor in the Department of Physics and Astronomy at Rutgers University-New Brunswick. "At least in principle, if you can make it work at a higher temperature, you can use it for electronic interconnections within silicon chips used in computers and other devices."

Study co-authors in China combined chromium and vanadium as magnetic elements with an insulator consisting of bismuth, antimony and tellurium. When electrons in this special material are aligned in one direction -- like a compass needle pointing north -- an electric current can only flow along its edges in one direction, leading to zero energy loss. That means electricity could be conducted between transistors within silicon chips used in computers and other electronics with maximum efficiency.

Current silicon chips use primarily metal for electrical interconnections in transistors, but that leads to substantial energy loss, Wu said.

The scientists demonstrated the uniform alignment of spinning electrons in the special magnetic insulator -- called the quantum anomalous Hall insulator. It conducts electricity without energy loss when the temperature is close to absolute zero: minus 459.67 degrees Fahrenheit. Next steps would include demonstrating the phenomenon at a much higher and more practical temperature for electronics, along with building a platform for quantum computing.

https://www.sciencedaily.com/releases/2018/06/180604124859.htm

2-D materials can conduct electricity at almost the speed of light

Substances have the potential to revolutionize electronic and computing devices

April 26, 2017

Summary: New two-dimensional quantum materials have been created with breakthrough electrical and magnetic attributes that could make them building blocks of future quantum computers and other advanced electronics. The researchers explored the physics behind the 2-D states of novel materials and determined they could push computers to new heights of speed and power.

Physicists at the University of California, Irvine and elsewhere have fabricated new two-dimensional quantum materials with breakthrough electrical and magnetic attributes that could make them building blocks of future quantum computers and other advanced electronics.

In three separate studies appearing this month in *Nature*, *Science Advances* and *Nature Materials*, UCI researchers and colleagues from UC Berkeley, Lawrence Berkeley National Laboratory, Princeton University, Fudan University and the University of Maryland explored the physics behind the 2-D states of novel materials and determined they could push computers to new heights of speed and power.

The common threads running through the papers are that the research is conducted at extremely cold temperatures and that the signal carriers in all three studies are not electrons -- as with traditional silicon-based technologies -- but Dirac or Majorana fermions, particles without mass that move at nearly the speed of light.

"Finally, we can take exotic, high-end theories in physics and make something useful," said UCI associate professor of physics & astronomy Jing Xia, a corresponding author on two of the studies. "We're exploring the possibility of making topological quantum computers [currently theoretical] for the next 100 years."

One of the key challenges of such research is handling and analyzing miniscule material samples, just two atoms thick, several microns long and a few microns across. Xia's lab at UCI is equipped with a fiber-optic Sagnac interferometer microscope that he built. (The only other one in existence is at Stanford University, assembled by Xia when he was a graduate student there.) Calling it the most sensitive magnetic microscope in the world, Xia compares it to a telescope that an ornithologist in Irvine could use to inspect the eye of a bird in New York.

"This machine is the ideal measurement tool for these discoveries," said UCI graduate student Alex Stern, lead author on two of the papers. "It's the most accurate way to optically measure magnetism in a material."

In a study to be published April 24 in *Nature*, the researchers detail their observation -- via the Sagnac interferometer -- of magnetism in a microscopic flake of chromium germanium telluride. The compound, which they created, was viewed at minus 387 degrees Fahrenheit. CGT is a cousin of graphene, a superthin atomic carbon film. Since its discovery, graphene has been considered a potential replacement for silicon in next-generation computers and other devices because of the speed at which electronic signals skitter across its almost perfectly flat surface.

But there's a catch: Certain computer components, such as memory and storage systems, need to be made of materials that have both electronic and magnetic properties. Graphene has the former but not the latter. CGT has both.

His lab also used the Sagnac interferometer for a study published in *Science Advances* examining what happens at the precise moment bismuth and nickel are brought into contact with one another -- again at a very low temperature (in this case, minus 452 degrees Fahrenheit). Xia said his team found at the interface between the two metals "an exotic superconductor that breaks time-reversal symmetry."

"Imagine you turn back the clock and a cup of red tea turns green. Wouldn't that make this tea very exotic? This is indeed exotic for superconductors," he said. "And it's the first time it's been observed in 2-D materials."

The signal carriers in this 2-D superconductor are Majorana fermions, which could be used for a braiding operation that theorists believe is vital to quantum computing.

"The issue now is to try to achieve this at normal temperatures," Xia said. The third study shows promise in overcoming that hurdle.

In 2012, Xia's lab delivered to the Defense Advanced Research Projects Agency a radio-frequency oscillator built around samarium hexaboride. The substance is an insulator on the inside but allows signal-carrying current made of Dirac fermions to flow freely on its 2-D surface.

Using a special apparatus built in the Xia lab -- also one of only two in the world -- UCI researchers applied tensile strain to the samarium hexaboride sample and demonstrated in the *Nature Materials* study that they could stabilize the 2-D surface state at minus 27 degrees Fahrenheit.

"Believe it or not, that's hotter than some parts of Canada," Xia quipped. "This work is a big step toward developing future quantum computers at nearly room temperature."

https://www.sciencedaily.com/releases/2017/04/170426131013.htm

Making the switch, this time with an insulator

September 1, 2016

Summary: Physicists have demonstrated a new approach to low-power computer memory. They've demonstrated a new way to switch magnetic moments - or direction of magnetization - of electrons in a thin film of a barium ferrite, which is a magnetic insulator. Until this point, scientists have only demonstrated this switching behavior in metal thin films.

The growing field of spin electronics - spintronics - tells us that electrons spin like a top, carry angular momentum, and can be controlled as units of power, free of conventional electric current. Nonvolatile magnetic memory based on the "spin torques" of these spinning electrons has been recently commercialized as STT-MRAM (spin transfer torque-magnetic random access memory).

Colorado State University physicists, joining the fundamental pursuit of using electron spins to store and manipulate information, have demonstrated a new approach to doing so, which could prove useful in the application of low-power computer memory. Publishing Sept. 1 in *Nature Communications*, they've demonstrated a new way to switch magnetic moments -- or direction of magnetization -- of electrons in a thin film of a barium ferrite, which is a magnetic insulator. Until this point, scientists have only demonstrated this switching behavior -- the key to writing information as memory -- in metal thin films.

The work was led by Mingzhong Wu, professor in the Department of Physics, with first author Peng Li, a former postdoctoral researcher now at Seagate, and second author Tao Liu, a current postdoc at CSU. The work was performed in collaboration with researchers at University of Alabama, Argonne National Laboratory, University of Notre Dame, and University of Wyoming. Other CSU authors include faculty members Stuart Field and Mario Marconi, and graduate students Houchen Chang and Daniel Richardson.

Switching magnetic moments of electrons in an insulator instead of a metal could prove to be a major breakthrough in spintronics, by allowing a spin current-based memory storage device to be simpler, and also maintain more efficiency per electron. A property known as perpendicular magnetic anisotropy (PMA), key for information storage, in this case originates from the intrinsic magneto-crystalline anisotropy of the insulator, rather than interfacial anisotropy in other cases, Wu said.

"Higher efficiency and lower power than the standard are always the goal in memory applications," Wu said.

Beyond the application for computer memory, which captivates most spintronics researchers today, the CSU researchers' device does something bigger: It demonstrates the possibility of a new class of materials for spintronics. "What's exciting about this is that it's an enabling technology for exploring an entirely different class of configurations, some of which are theorized to be useful," said Jake Roberts, professor and chair of the Department of Physics.

In the CSU researchers' device, the spin current does the job of assisting magnetic switching. Next, they will attempt to further refine their device for more efficient switching, including using a topological insulator or the photo-spin-voltaic effect to produce spin currents. The photo-spin-voltaic effect was discovered by Wu and colleagues, and reported in *Nature Physics*.

https://www.sciencedaily.com/releases/2016/09/160901102157.htm

Huge energy potential in open ocean wind farms in the North Atlantic

In wintertime, North Atlantic wind farms could provide sufficient energy to meet all of civilization's current needs

October 9, 2017

Summary: Because wind speeds are higher on average over ocean than over land, wind turbines in the open ocean could in theory intercept more than five times as much energy as wind turbines over land. This presents an enticing opportunity for generating renewable energy through wind turbines. But it was unknown whether the faster ocean winds could actually be converted to increased amounts of electricity.

There is considerable opportunity for generating wind power in the open ocean, particularly the North Atlantic, according to new research from Carnegie's Anna Possner and Ken Caldeira. Their work is published by *Proceedings of the National Academy of Sciences*.

Because wind speeds are higher on average over ocean than over land, wind turbines in the open ocean could in theory intercept more than five times as much energy as wind turbines over land. This presents an enticing opportunity for generating renewable energy through wind turbines. But it was unknown whether the faster ocean winds could actually be converted to increased amounts of electricity.

"Are the winds so fast just because there is nothing out there to slow them down? Will sticking giant wind farms out there just slow down the winds so much that it is no better than over land?" Caldeira asked.

Most of the energy captured by large wind farms originates higher up in the atmosphere and is transported down to the surface where the turbines may extract this energy. Other studies have estimated that there is a maximum rate of electricity generation for land-based wind farms, and have concluded that this maximum rate of energy extraction is limited by the rate at which energy is moved down from faster, higher up winds.

"The real question is," Caldeira said, "can the atmosphere over the ocean move more energy downward than the atmosphere over land is able to?"

Possner and Caldeira's sophisticated modeling tools compared the productivity of large Kansas wind farms to massive, theoretical open-ocean wind farms and found that in some areas ocean-based wind farms could generate at least three times more power than the ones on land.

In the North Atlantic, in particular, the drag introduced by wind turbines would not slow down winds as much as they would on land, Possner and Caldeira found. This is largely due to the fact that large amounts of heat pour out of the North Atlantic Ocean and into the overlying atmosphere, especially during the winter. This contrast in surface warming along the U.S. coast drives the frequent generation of cyclones, or low-pressure systems, that cross the Atlantic and are very efficient in drawing the upper atmosphere's energy down to the height of the turbines.

"We found that giant ocean-based wind farms are able to tap into the energy of the winds throughout much of the atmosphere, whereas wind farms onshore remain constrained by the near-surface wind resources," Possner explained.

However, this tremendous wind power is very seasonal. While in the winter, North Atlantic wind farms could provide sufficient energy to meet all of civilization's current needs, in the summer such wind farms could merely generate enough power to cover the electricity demand of Europe, or possibly the United States alone.

Wind power production in the deep waters of the open ocean is in its infancy of commercialization. The huge wind power resources identified by the Possner and Caldeira study provide strong incentives to develop lower-cost technologies that can operate in the open-ocean environment and transmit this electricity to land where it can be used.

https://www.sciencedaily.com/releases/2017/10/171009154949.htm

Stormy weather ahead for wind farms?

March 30, 2015

Summary: Researchers will study the vibrations of wind turbines at a large Chilean wind farm along with health impacts on nearby residents. The goal is to make wind turbines more acceptable. Currently, scientists lack sufficient understanding of wind turbines' noise and best ways to mitigate the effects, they say.

Wind turbines provide clean, abundant energy and bolster America's power grid. But across the world people are banding together to fight wind farms, blaming noise for interrupted sleep and a host of health problems.

Scientists lack sufficient understanding of wind turbines' noise and best ways to mitigate the effects, says Jorge Arenas, a faculty member in the Universidad Austral de Chile's College of Engineering Sciences and director of its Institute of Acoustics.

Noise is annoying and, worse, linked to health problems, many researchers say. A newspaper in the U.K. captures the sensation: "Residents near some wind farms have likened the noise to a cement-mixer or a shoe stuck in a tumble-dryer," writes energy editor Emily Gosden in a story in The Telegraph.

"The noise from wind turbines is not very loud," says Virginia Tech's Richardo Burdisso, a professor of mechanical engineering and Arenas' colleague in Blacksburg. "However, it is annoying because of its amplitude modulated characteristic. That is, the noise fluctuates in levels with a period of 0.7 to 1.5 seconds, depending on the size of the turbine. The fluctuation in levels can be as high as 10 to 12 decibels."

Arenas and Virginia Tech colleagues who are known for their wind tunnel research will study the vibrations of wind turbines at a large Chilean wind farm along with health impacts on nearby residents. The goal is to make wind turbines more acceptable.

Last year Ohio legislators passed a law requiring wind turbine blades to be at least a quarter-mile from the nearest property line. That's because sounds in the low frequency range can travel great distances; they "are not well attenuated by air," Arenas says. "Low frequency noise is hard to mitigate."

Are restrictive noise laws a setback for the industry? Dayna Baird Payne, a lobbyist in Columbus who represents the American Wind Energy Association, says developers of large-scale wind farms in Ohio "are in a pretty bad hurt," according to an Associated Press report.

Clashes over wind farms have spread across the country -- from Minnesota to Missouri, Alabama, Maryland and Massachusetts, writes Bonner R. Cohen, a senior fellow with the National Center for Public Policy Research.

And on the shore of Lake Michigan, residents filed suit claiming that Consumers Energy's Lake Wind Energy Park's two years of operations caused headaches, sleeplessness, nausea, dizziness, stress, and fatigue, Cohen reports.

Europe is the site of pitched battles as well. In early March, politicians in Northern Ireland called for better monitoring of noise as well as limits on how many wind turbines could be spread across the landscape.

Arenas hopes to develop a model to predict a turbine's noise levels. The interaction of blades with air "is a very challenging research problem," he says. The layout of wind farms might be amenable to better design -- but first things first. The current approach is to first study and understand "the effect of the noise on people" and then find solutions.

https://www.sciencedaily.com/releases/2015/03/150330162417.htm

Americans using more energy, according to new analysis

April 2, 2014

Summary: Americans used more renewable, fossil and even nuclear energy in 2013, according to the most recent energy flow charts. Wind energy continued to grow strongly, increasing 18 percent from 1.36 quadrillion BTUs, or quads, in 2012 to 1.6 quads in 2013. New wind farms continue to come on line with bigger, more efficient turbines. Most new wind turbines can generate 2 to 2.5 megawatts of power.

Americans used more renewable, fossil and even nuclear energy in 2013, according to the most recent energy flow charts released by Lawrence Livermore National Laboratory.

Each year, the Laboratory releases energy flow charts that illustrate the nation's consumption and use of energy.Overall, Americans used 2.3 quadrillion thermal units more in 2013 than the previous year.

The Laboratory also has released a companion chart illustrating the nation's energy-related carbon dioxide emissions. Americans' carbon dioxide emissions increased to 5,390 million metric tons, the first annual increase since 2010.

Wind energy continued to grow strongly, increasing 18 percent from 1.36 quadrillion BTUs, or quads, in 2012 to 1.6 quads in 2013 (a BTU or British Thermal Unit is a unit of measurement for energy; 3,400 BTU is equivalent to about 1 kilowatt-hour). New wind farms continue to come on line with bigger, more efficient turbines. Most new wind turbines can generate 2 to 2.5 megawatts of power.

Natural gas prices rose slightly in 2013, reversing some of the recent shift from coal to gas in the electricity production sector.Although this did cause carbon dioxide emissions to increase in 2013, "the power industry is building a lot of natural gas plants," said A.J. Simon, group leader for Energy at Lawrence Livermore National Laboratory."Gas plants are cheaper than coal plants.Natural gas is going to be a winner into the foreseeable future."

Overall natural gas use increased by 0.6 quads.Losses in the electricity sector were more than offset by greater gas use in the residential, commercial and industrial sectors."2013 was a cold winter," Simon said."We expect to see continued high gas consumption in 2014, due to another tough winter on the East Coast."

Nuclear energy was greater in 2013 than in 2012. "The use of nuclear energy fluctuates a little from year to year," Simon said. "It's likely that in 2013, fewer reactors were down for refueling than in previous years."However, a few of the nation's about 100 reactors have recently closed for good, such as the San Onofre Nuclear Generating Station in Pendleton, Calif.

The transportation sector is using more renewable energy, specifically biomass that is converted to ethanol. "This has been going up over time," Simon said. "We're expecting the fraction of biomass in transportation to remain relatively steady."

The majority of energy use in 2013 was used for electricity generation (38.2 quads), followed by transportation, industrial, residential and commercial. Energy use in the residential, commercial transportation and industrial sectors all increased slightly.

Petroleum use increased in 2013 from the previous year. Simon estimates that, with oil prices remaining relatively constant, this is likely due to the modest economic expansion. However,"The increase isn't as sharp as it might have been because Americans are buying more efficient cars, which are slowly replacing older, less efficient automobiles.."

Rejected energy increased to 59 quads in 2013 from 58.1 in 2012, rising in proportion to the total energy consumed. "Not all of the energy that we consume is put to use," Simon explained. "Heat you feel when you put your hand on your water heater and the warm exhaust from your car's tailpipe are examples of rejected energy."Comparing energy services to rejected energy gives a rough estimate of each sector's energy efficiency.

https://www.sciencedaily.com/releases/2014/04/140402133951.htm

Impact of offshore wind farms on marine species

October 16, 2014

Summary: Offshore wind power is a valuable source of renewable energy that can help reduce carbon emissions. Technological advances are allowing higher capacity turbines to be installed in deeper water, but there is still much unknown about the effects on the environment. Scientists have now reviewed the potential impacts of offshore wind developments on marine species and make recommendations for future monitoring and assessment as interest in offshore wind energy grows around the world.

Offshore wind power is a valuable source of renewable energy that can help reduce carbon emissions. Technological advances are allowing higher capacity turbines to be installed in deeper water, but there is still much unknown about the effects on the environment. In a recent paper, University of Maryland Center for Environmental Science researcher Helen Bailey and colleagues review the potential impacts of offshore wind developments on marine species and make recommendations for future monitoring and assessment as interest in offshore wind energy grows around the world.

"As the number and size of offshore wind developments increases, there is a growing need to consider the consequences and cumulative impacts of these activities on marine species," said Helen Bailey, lead author and research assistant professor at the University of Maryland Center for Environmental Science's Chesapeake Biological Laboratory. "It is essential to identify where whales, dolphins and other species occur to help avoid adverse impacts and to continue to monitor their response to the construction and operation of wind turbines."

The loud sounds emitted during pile driving could potentially cause hearing damage, mask communication or disorient animals and fish as they move out of the area to avoid the noise. There is also a risk of marine animals being injured by ships or being disturbed by vessel movements associated with surveying and installation activities. On the other hand, wind turbines may act as artificial reefs and increase food sources. They could also potentially provide a de facto marine reserve thanks to restrictions on boating and fishing surrounding the wind turbines.

"A critical element of wind energy planning is developing projects in such a way that we avoid or minimize negative environmental impacts those installations may cause," said Tom Miller, director of the University of Maryland Center for Environmental Science's Chesapeake Biological Laboratory. "Making these decisions requires a year-round understanding of the species that frequent the area, particularly for protected species that are sensitive to sound, such as marine mammals."

Few studies have measured the response of marine species to offshore wind farm construction and operation, and none yet have assessed the longer terms impacts to the population of marine animals. The researchers recommend strategically targeted data collection and modeling to answer questions about impacts on marine species to help regulators make decisions, particularly in countries where the implementation of offshore wind energy is still in its early stages, such as the United States.

One such project begins this fall off the coast of Maryland as underwater microphones will be anchored to the ocean floor to continuously record sounds produced by large whales and other marine mammals. Led by Dr. Bailey, the study will collect two-years of baseline data that can be used to inform the design of wind farms, how to minimize the impact of construction noise and environmental impacts, and how to facilitate ocean planning in the area.

"It is becoming increasingly clear that the most significant impact of offshore wind farms on marine mammals is the avoidance of construction noise," said Bailey. "There needs to be a greater focus on assessing the longer-term impact of any behavioral responses."

https://www.sciencedaily.com/releases/2014/10/141016123608.htm

Can we get 100 percent of our energy from renewable sources?

May 17, 2018

Summary: Some researchers doubted the feasibility of many of the recent scenarios for high shares of renewable energy. Now scientists have hit back with their response to the points raised. They demonstrate that there are no roadblocks on the way to a 100 percent renewable future.

Is there enough space for all the wind turbines and solar panels to provide all our energy needs? What happens when the sun doesn't shine and the wind doesn't blow? Won't renewables destabilise the grid and cause blackouts?

In a review paper last year in the high-ranking journal *Renewable and Sustainable Energy Reviews*, Master of Science Benjamin Heard and colleagues presented their case against 100% renewable electricity systems. They doubted the feasibility of many of the recent scenarios for high shares of renewable energy, questioning everything from whether renewables-based systems can survive extreme weather events with low sun and low wind, to the ability to keep the grid stable with so much variable generation.

Now scientists have hit back with their response to the points raised by Heard and colleagues. The researchers from the Karlsruhe Institute of Technology, the South African Council for Scientific and Industrial Research, Lappeenranta University of Technology, Delft University of Technology and Aalborg University have analysed hundreds of studies from across the scientific literature to answer each of the apparent issues. They demonstrate that there are no roadblocks on the way to a 100% renewable future.

"While several of the issues raised by the Heard paper are important, you have to realise that there are technical solutions to all the points they raised, using today's technology," says the lead author of the response, Dr. Tom Brown of the Karlsruhe Institute of Technology.

"Furthermore, these solutions are absolutely affordable, especially given the sinking costs of wind and solar power," says Professor Christian Breyer of Lappeenranta University of Technology, who co-authored the response.

Brown cites the worst-case solution of hydrogen or synthetic gas produced with renewable electricity for times when imports, hydroelectricity, batteries, and other storage fail to bridge the gap during low wind and solar periods during the winter. For maintaining stability there is a series of technical solutions, from rotating grid stabilisers to newer electronics-based solutions. The scientists have collected examples of best practice by grid operators from across the world, from Denmark to Tasmania.

Furthermore, these solutions are absolutely affordable, especially given the sinking costs of wind and solar power.

The response by the scientists has now appeared in the same journal as the original article by Heard and colleagues.

"There are some persistent myths that 100% renewable systems are not possible," says Professor Brian Vad Mathiesen of Aalborg University, who is a co-author of the response.

"Our contribution deals with these myths one-by-one, using all the latest research. Now let's get back to the business of modelling low-cost scenarios to eliminate fossil fuels from our energy system, so we can tackle the climate and health challenges they pose."

https://www.sciencedaily.com/releases/2018/05/180517113812.htm

Kicking the car(bon) habit better for air pollution than technology revolution

May 30, 2018

Summary: Changing our lifestyles and the way we travel could have as big- if not more of an impact on carbon dioxide transport emissions, as electric vehicles and the transport technology revolution, according to new research. The study uses Scotland as an example and suggests that, radical lifestyle change can show quicker results than the gradual transition to Electric Vehicles and phasing out of conventional petrol and diesel vehicles.

Changing our lifestyles and the way we travel could have as big - if not more of an impact on CO2 transport emissions, as electric vehicles and the transport technology revolution, according to new Oxford University research.

Published in *Energy Efficiency*, the study uses Scotland as an example and suggests that, radical lifestyle change can show quicker results than the gradual transition to Electric Vehicles and phasing out of conventional petrol and diesel vehicles.

Scotland has committed itself to reduce carbon emissions by 80% of 1990 levels by 2050. For transport, this includes international aviation and shipping which makes the targets more difficult to achieve.

Led by Dr Christian Brand, Senior Research Fellow and Associate Professor at the Environmental Change Institute and Transport Studies Unit, in collaboration with colleagues Jillian Anable from the University of Leeds and Craig Morton at the University of Loughborough, the paper explores how plausible changes in the way we travel might reduce energy use and emissions in Scotland over the next three decades, in light of the 5-year carbon budgets up to 2050 and beyond.

"Our study explores how Scotland might achieve these targets in the transport sector. We find that both lifestyle change -- such as making fewer and shorter journeys, sharing existing journeys, or shifting to walking, cycling and clean public transport -- and a comprehensive strategy around zero emission technologies are needed, but that they have limits to meeting our CO2 targets, in particular beyond 2030" explains lead author, Oxford Scientist Dr Christian Brand.

The findings suggest that, only through prioritisation of both demand- (lifestyle, social and cultural change) and supply-side (new technology) transport solutions, might we have a chance of curbing carbon emissions in line with the United Nation's 1.5C Climate Change Agreement. The co-benefits of such change to human health and the NHS are enormous.

"The newfound urgency of 'cleaning up our act' since the Paris Climate Change Agreement in 2016 and Dieselgate scandal suggests that we cannot just wait for the technology fix," says Dr Christian Brand.

Traditionally governments have prioritised technology fixes and supply-side transport solutions to the carbon emission problem.

However, the authors suggest that a long-term carbon and air quality emission-cutting strategy should consider both demand- and supply-side transport solutions, for the best chance of success.

Change will need to be led by consumers, policy makers and industry alike, they say.

"We need to look at how we can inspire and support consumer lifestyle changes -- in travel patterns, mode and vehicle choice, vehicle occupancy -- to be in with a chance of reducing our carbon emissions in line with legislated targets and travelling on the 'Road to Zero' faster, further and more flexible."

https://www.sciencedaily.com/releases/2018/05/180530113059.htm

America has fallen behind on offshore wind power

September 29, 2015

Summary: The United States has fallen behind on offshore wind power, experts say. Their findings show that while offshore wind turbines have been successfully deployed in Europe since 1991, the U.S. is further from commercial-scale offshore wind deployment today than it was in 2005.

Offshore wind turbines have been a successful source of sustainable energy in Europe since 1991, but offshore wind is a 'missed opportunity' in the United States, according to researchers at the University of Delaware's Center for Carbon-Free Power Integration. In a paper for the Proceedings of the National Academy of Sciences, they argue for changes in outdated policy and a new focus for research

University of Delaware faculty from the College of Earth, Ocean, and Environment (CEOE), the College of Engineering and the Alfred Lerner School of Business and Economics say that the U.S. has fallen behind in offshore wind power.

The UD professors, who are all affiliated with UD's Center for Carbon Free Power Integration (CCPI), reported their findings in the journal *Proceedings of the National Academy of Sciences*.

Titled "The Time Has Come for Offshore Wind Power in the U.S.," the paper asserts that while offshore wind turbines have been successfully deployed in Europe since 1991, the U.S. is further from commercial-scale offshore wind deployment today than it was in 2005.

"As we celebrate the 10-year anniversary of the U.S. Energy Policy Act of 2005, it is disheartening to see that while land-based wind and solar have reached new heights, U.S. offshore wind has remained a missed opportunity," says the paper's lead author, Jeremy

Firestone, who is a professor in CEOE's School of Marine Science and Policy and directs CCPI.

Collectively, Firestone and his UD colleagues have decades of experience in offshore wind power research, teaching and policy advice.

Firestone contends that regulatory, tax and finance policy and planning changes, as well as a refocused research effort, are required to advance U.S. offshore wind development.

Offshore wind development, he says, is currently predicated on a model originally developed for offshore oil. But while offshore oil can be sold to refineries throughout the U.S. and its price is influenced by global markets, electricity from renewable energy such as offshore wind is tied to local markets and is part of a regional grid system.

"Electricity markets are different than oil and gas, it's like trying to put a square peg in a round hole," says Firestone.

Tax policy and financial incentives, including long-term tax credits for implementation, he continues, are important with projects like offshore wind, which are very capital intensive, as are loan guarantees.

Offshore wind power has tremendous potential to help the U.S. reduce its dependence on fossil fuels. By displacing coal and natural gas, offshore wind will reduce health costs and contribute to improved air quality and reduced climatic impacts.

Other motivations for offshore wind development include creating local manufacturing and other jobs, reducing common air pollutants, providing energy security and price stability, and improving U.S. economic competitiveness.

To help overcome current barriers to offshore wind implementation, the UD professors also advocate that research focus on impediments specific to the U.S.

"Given that research dollars are limited, it is important to target those funds to areas that will result the greatest value-added to the United States," Firestone says.

For example, the United States experiences more extreme wind and wave loading due to hurricanes and northeasters, as well as icing in the Great Lakes areas, creating U.S. specific research opportunities.

Similarly, research aimed at better understanding the wind regime specific to the Atlantic Ocean's Mid-Atlantic Bight -- how windy it is and where -- will provide important information about how much power can be generated in different segments of the ocean, which in turn affects prices that people would have to pay.

Social and cultural concerns of coastal residents also can impede offshore wind power development progress.

"Individuals often have deep and meaningful experiences with the ocean and long-standing ties to coastal communities, and as a result, may be resistant to changes to the coastal landscape. Attention also should be devoted to research that seeks to understand these social and cultural barriers to change," Firestone notes.

https://www.sciencedaily.com/releases/2015/09/150929113049.htm

Instrumented drone measurements help wind farmers site turbines to achieve greater efficiency

November 21, 2016

Summary: Wind energy is a key part of the global energy future, expanding rapidly throughout the world in onshore and offshore settings. But to be sustainable, large scale, multi-megawatt (multi-MW) wind farming's economic efficiencies need to be maximized and knowing where to place the turbines within the wind farm is a first step.

Wind energy is a key part of the global energy future, expanding rapidly throughout the world in onshore and offshore settings. But to be sustainable, large scale, multi-megawatt (multi-MW) wind farming's economic efficiencies need to be maximized and knowing where to place the turbines within the wind farm is a first step.

Without proper and strategic placement of wind turbines, the low-speed wind behind turbines, called a wake, decreases the efficiency of the wind farm. Wind tunnel tests have been used to guide placement, but their conditions are not representative of the complex flow behaviors in the field conditions of actual wind farms. So the question is, how to overcome this?

Bring on the drones. Moreover, design novel instrumented drones with a suite of sensors capable of gathering precise field data in the complex flow and terrain of an actual wind farm.

This was the approach of researchers from Switzerland. Team members with the Swiss Federal Institute of Technology Zurich developed novel instrumented drones that made high-resolution measurements of wind speed, wind direction and turbulence encountered in actual wind farms. Results show detailed flow behaviors around the wind turbines, useful for developing simulation tools that can be used to optimize placement of wind turbines within the wind farms. This offers the turbines the most efficient use of the wind resource.

The researchers represent an interdisciplinary collaboration of hardware and software experts including aerodynamics, atmospheric flow physics, energy technology and materials science. They present their findings at the American Physical Society's Division of Fluid Dynamics annual meeting, Nov. 20-22, in Portland, Oregon.

"In wind farms, the power output of wind turbines can decrease by up to 40 percent if the wind turbines are in the wake of upstream wind turbines, so there are intensive efforts to develop simulation tools that can be used to optimize the placement of wind turbines within wind farms," said lead researcher Ndaona Chokani, lead researcher of the study.

In particular, the team is the first to develop and field test an instrumented drone used to measure, in detail, the airflow and mixing near and downwind of the wind farm. Chokani said, "These measurements shall accelerate the development of simulation tools that can be used to optimize the placement of wind turbines in onshore and offshore wind farms."

The key to the current work is a seven-sensor, fast-response, aerodynamic probe used to make the time-resolved wind measurements. The probe is based on measuring technology used in conventional power plants, which was developed over the past two decades at the Swiss Federal Institute of Technology Zurich.

Developing tools that can guide decision-making on where to place wind turbines for maximum effect is a desirable goal because through improved efficiencies, clean energy prices will come down and environmental impacts will be reduced. "This will substantially reduce CO2 emissions and the usage of water in the electricity generation sector, and further diversify the electrical energy mix," Chokani said.

The European Union's 2020 energy targets require 15 to 17 percent electricity from wind, up from 8 percent at end of 2013. In the U.S., energy goals for wind power call for wind supplying 10 percent of the nation's electrical demand in 2020.

Next, Chokani and his colleagues intend to extend the proof-of-concept established by their drone's measurements. They will use multiple instrumented drones flying in a swarm to make simultaneous measurements.

https://www.sciencedaily.com/releases/2016/11/161121090726.htm

Sustainability criteria for transport biofuels need improvements

June 14, 2016

Summary: In its Renewable Energy Directive, the European Union has set a 10% goal for the use of renewable energy in transport by 2020. Only biofuels meeting certain sustainability criteria are included in the renewable energy goals and are allowed to take advantage of national support systems. In her doctoral dissertation, a scientist proposes several areas of development for the greenhouse gas assessment method of the criteria.

In its Renewable Energy Directive, the European Union has set a 10% goal for the use of renewable energy in transport by 2020. Only biofuels meeting certain sustainability criteria are included in the renewable energy goals and are allowed to take advantage of national support systems. In her doctoral dissertation, VTT's Research Scientist Kati Koponen proposes several areas of development for the greenhouse gas assessment method of the criteria.

The calculation of greenhouse gas emissions from biofuels is based on life cycle assessment. It is often used for defining the sustainability of biofuels. In her doctoral dissertation, Kati Koponen has studied how a tool, based on life cycle assessment, can be applied to policy-driven decision-making related to biofuels and what challenges the assessment entails.

While life cycle assessment has been widely used for assessing the environmental impacts of products, the method still entails challenges related to, for instance, system boundary setting, allocation of emissions between different products as well as the definition of calculation parameters. When life cycle assessment is used in political decision-making, the required simplifications may cause further method-related problems. The research results show that the current EU calculation method alone cannot ensure the climate benefits of biofuels.

In her dissertation, Kati Koponen proposes that the sustainability criteria should be developed as follows:

− The calculation method presented in the current sustainability criteria does not take into account emissions due to indirect market impacts that may result from an increase in biofuel production. These include, for instance, indirect changes in land use and impacts on the fuel market. To simplify the determination of sustainability criteria, these impacts should be comprehensively evaluated when bioenergy goals are set.

− Currently, the calculation method ignores uncertainties related to greenhouse gas calculation, stemming from, for instance, deficient background information or poor knowledge of emission impacts. These uncertainties should be identified and taken into account as life cycle assessment is only an assessment of the reality.

− In many cases, the production of biofuels creates by-products. Currently, emissions are divided between products on the basis of their energy content, even if the by-product is utilised as, for instance, animal feed. Price-based allocation would clarify the economic cause and effect relationships between products as well as the double counting rule that is proposed in the directive for raw materials based on waste and residues. The double counting rule means that biofuels produced from waste and residue based raw materials may be counted as double in the national biofuel goal.

− The calculation of greenhouse gas emissions due to biofuel production should identify possible decreases in ecosystem carbon stocks, as well as forgone carbon sequestration. These impacts can be identified by including land use reference system in the life cycle assessment of bioenergy.

The EU sustainability criteria should be further developed, to ensure the use of bioenergy systems that most effectively support climate change mitigation.

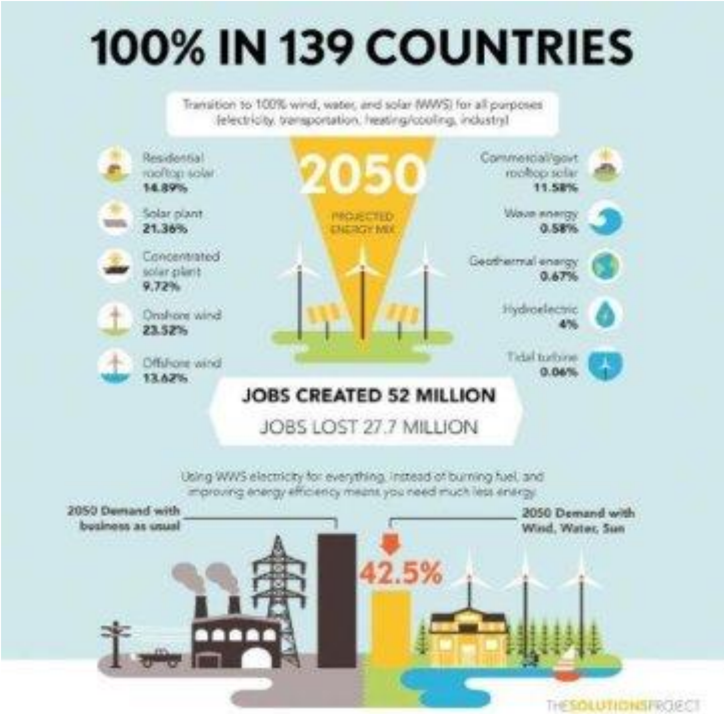
https://www.sciencedaily.com/releases/2016/06/160614083837.htm

How 139 countries could be powered by 100 percent wind, water, and solar energy by 2050

August 23, 2017

Summary: The latest roadmap to a 100 percent renewable energy future outlines infrastructure changes that 139 countries can make to be entirely powered by wind, water, and sunlight by 2050 after electrification of all energy sectors. Such a transition could mean less worldwide energy consumption due to the efficiency of clean, renewable electricity; and a net increase of over 24 million long-term jobs.

The latest roadmap to a 100% renewable energy future from Stanford's Mark Z. Jacobson and 26 colleagues is the most specific global vision yet, outlining infrastructure changes that 139 countries can make to be entirely powered by wind, water, and sunlight by 2050 after electrification of all energy sectors. Such a transition could mean less worldwide energy consumption due to the efficiency of clean, renewable electricity; a net increase of over 24 million long-term jobs; an annual decrease in 4-7 million air pollution deaths per year; stabilization of energy prices; and annual savings of over $20 trillion in health and climate costs. The work appears August 23 in the journal *Joule*, Cell Press's new publication focused on sustainable energy.



The challenge of moving the world toward a low-carbon future in time to avoid exacerbating global warming and to create energy self-sufficient countries is one of the greatest of our time. The roadmaps developed by Jacobson's group provide one possible endpoint. For each of the 139 nations, they assess the raw renewable energy resources available to each country, the number of wind, water, and solar energy generators needed to be 80% renewable by 2030 and 100% by 2050, how much land and rooftop area these power sources would require (only around 1% of total available, with most of this open space between wind turbines that can be used for multiple purposes), and how this approach would reduce energy demand and cost compared with a business-as-usual scenario.

"Both individuals and governments can lead this change. Policymakers don't usually want to commit to doing something unless there is some reasonable science that can show it is possible, and that is what we are trying to do," says Jacobson, director of Stanford University's Atmosphere and Energy Program and co-founder of the Solutions Project, a U.S. non-profit educating the public and policymakers about a transition to 100% clean, renewable energy. "There are other scenarios. We are not saying that there is only one way we can do this, but having a scenario gives people direction."

The analyses specifically examined each country's electricity, transportation, heating/cooling, industrial, and agriculture/forestry/fishing sectors. Of the 139 countries -- selected because they were countries for which data were publically available from the International Energy Agency and collectively emit over 99% of all carbon dioxide worldwide -- the places the study showed that had a greater share of land per population (e.g., the United States, China, the European Union) are projected to have the easiest time making the transition to 100% wind, water, and solar. Another learning was that the most difficult places to transition may be highly populated, very small countries surrounded by lots of ocean, such as Singapore, which may require an investment in offshore solar to convert fully.

As a result of a transition, the roadmaps predict a number of collateral benefits. For example, by eliminating oil, gas, and uranium use, the energy associated with mining, transporting and refining these fuels is also eliminated, reducing international power demand by around 13%. Because electricity is more efficient than burning fossil fuels, demand should go down another 23%. The changes in infrastructure would also mean that countries wouldn't need to depend on one another for fossil fuels, reducing the frequency of international conflict over energy. Finally, communities currently living in energy deserts would have access to abundant clean, renewable power.

"Aside from eliminating emissions and avoiding 1.5 degrees Celsius global warming and beginning the process of letting carbon dioxide drain from the Earth's atmosphere, transitioning eliminates 4-7 million air pollution deaths each year and creates over 24 million long-term, full-time jobs by these plans," Jacobson says. "What is different between this study and other studies that have proposed solutions is that we are trying to examine not only the climate benefits of reducing carbon but also the air pollution benefits, job benefits, and cost benefits"

The *Joule* paper is an expansion of 2015 roadmaps to transition each of the 50 United States to 100% clean, renewable energy and an analysis of whether the electric grid can stay stable upon such a transition. Not only does this new study cover nearly the entire world, there are also improved calculations on the availability of rooftop solar energy, renewable energy resources, and jobs created versus lost.

The 100% clean, renewable energy goal has been criticized by some for focusing only on wind, water, and solar energy and excluding nuclear power, "clean coal," and biofuels. However, the researchers intentionally exclude nuclear power because of its 10-19 years between planning and operation, its high cost, and the acknowledged meltdown, weapons proliferation, and waste risks. "Clean coal" and biofuels are neglected because they both cause heavy air pollution, which Jacobson and coworkers are trying to eliminate, and emit over 50 times more carbon per unit of energy than wind, water, or solar power.

The 100% wind, water, solar studies have also been questioned for depending on some technologies such as underground heat storage in rocks, which exists only in a few places, and the proposed use of electric and hydrogen fuel cell aircraft, which exist only in small planes at this time. Jacobson counters that underground heat storage is not required but certainly a viable option since it is similar to district heating, which provides 60% of Denmark's heat. He also says that space shuttles and rockets have been propelled with hydrogen, and aircraft companies are now investing in electric airplanes. Wind, water, and solar can also face daily and seasonal fluctuation, making it possible that they could miss large demands for energy, but the new study refers to a new paper that suggests these stability concerns can be addressed in several ways.

These analyses have also been criticized for the massive investment it would take to move a country to the desired goal. Jacobson says that the overall cost to society (the energy, health, and climate cost) of the proposed system is one-fourth of that of the current fossil fuel system. In terms of upfront costs, most of these would be needed in any case to replace existing energy, and the rest is an investment that far more than pays itself off over time by nearly eliminating health and climate costs.

"It appears we can achieve the enormous social benefits of a zero-emission energy system at essentially no extra cost," says co-author Mark Delucchi, a research scientist at the Institute of Transportation Studies, University of California, Berkeley. "Our findings suggest that the benefits are so great that we should accelerate the transition to wind, water, and solar, as fast as possible, by retiring fossil-fuel systems early wherever we can."

"This paper helps push forward a conversation within and between the scientific, policy, and business communities about how to envision and plan for a decarbonized economy," writes Mark Dyson of Rocky Mountain Institute, in an accompanying preview of the paper. "The scientific community's growing body of work on global low-carbon energy transition pathways provides robust evidence that such a transition can be accomplished, and a growing understanding of the specific levers that need to be pulled to do so. Jacobson et al.'s present study provides sharper focus on one scenario, and refines a set of priorities for near-term action to enable it."

https://www.sciencedaily.com/releases/2017/08/170823121339.htm

Running on renewables: How sure can we be about the future?

March 6, 2018

Summary: A variety of models predict the role renewables will play in 2050, but some may be over-optimistic, and should be used with caution, say researchers.

The proportion of UK energy supplied by renewable energies is increasing every year; in 2017 wind, solar, biomass and hydroelectricity produced as much energy as was needed to power the whole of Britain in 1958.

However, how much the proportion will rise by 2050 is an area of great debate. Now, researchers at Imperial College London have urged caution when basing future energy decisions on over-optimistic models that predict that the entire system could be run on renewables by the middle of this century.

Mathematical models are used to provide future estimates by taking into account factors such as the development and adoption of new technologies to predict how much of our energy demand can be met by certain energy mixes in 2050.

These models can then be used to produce 'pathways' that should ensure these targets are met -- such as through identifying policies that support certain types of technologies.

However the models are only as good as the data and underlying physics they are based on, and some might not always reflect 'real-world' challenges. For example, some models do not consider power transmission, energy storage, or system operability requirements.

Now, in a paper published today in the journal *Joule*, Imperial researchers have shown that studies that predict whole systems can run on near-100% renewable power by 2050 may be flawed as they do not sufficiently account for reliability of the supply.

Using data for the UK, the team tested a model for 100% power generation using only wind, water and solar (WWS) power by 2050. They found that the lack of firm and dispatchable 'backup' energy systems -- such as nuclear or power plants equipped with carbon capture systems -- means the power supply would fail often enough that the system would be deemed inoperable.

The team found that even if they added a small amount of backup nuclear and biomass energy, creating a 77% WWS system, around 9% of the annual UK demand could remain unmet, leading to considerable power outages and economic damage.

Lead author Clara Heuberger, from the Centre for Environmental Policy at Imperial, said: "Mathematical models that neglect operability issues can mislead decision makers and the public, potentially delaying the actual transition to a low carbon economy. Research that proposes 'optimal' pathways for renewables must be upfront about their limitations if policymakers are to make truly informed decisions."

Co-author Dr Niall Mac Dowell, from the Centre for Environmental Policy at Imperial, said: "A speedy transition to a decarbonised energy system is vital if the ambitions of the 2015 Paris Agreement are to be realised.

"However, the focus should be on maximising the rate of decarbonisation, rather than the deployment of a particular technology, or focusing exclusively on renewable power. Nuclear, sustainable bioenergy, low-carbon hydrogen, and carbon capture and storage are vital elements of a portfolio of technologies that can deliver this low carbon future in an economically viable and reliable manner.

"Finally, these system transitions must be socially viable. If a specific scenario relies on a combination of hypothetical and potentially socially challenging adaptation measures, in addition to disruptive technology breakthroughs, this begins to feel like wishful thinking."

https://www.sciencedaily.com/releases/2018/03/180306115759.htm

How biofuels from plant fibers could combat global warming

February 26, 2018

Summary: Research finds new promise for biofuels produced from switchgrass, a non-edible native grass that grows in many parts of North America.

Scientists, companies and government agencies are hard at work on decreasing greenhouse gas emissions that cause climate change. In recent years, biofuels produced from corn have emerged as a fuel source to power motor vehicles and, perhaps, airplanes.

But corn is problematic as a biofuel source material. It's resource-intensive to grow, creates many environmental impacts, and is more useful as food.

A study from Colorado State University finds new promise for biofuels produced from switchgrass, a non-edible native grass that grows in many parts of North America. Scientists used modeling to simulate various growing scenarios, and found a climate footprint ranging from -11 to 10 grams of carbon dioxide per mega-joule -- the standard way of measuring greenhouse gas emissions.

To compare with other fuels, the impact of using gasoline results in 94 grams of carbon dioxide per mega-joule.

The study, "High resolution techno-ecological modeling of a bioenergy landscape to identify climate mitigation opportunities in cellulosic ethanol production," was published online Feb. 19 in *Nature Energy*.

John Field, research scientist at the Natural Resource Ecology Lab at CSU, said what the team found is significant. "What we saw with switchgrass is that you're actually storing carbon in the soil," he said. "You're building up organic matter and sequestering carbon."

His CSU research team works on second-generation cellulosic biofuels made from non-edible plant material such as grasses. Cellulose is the stringy fiber of a plant. These grasses, including switchgrass, are potentially more productive as crops and can be grown with less of an environmental footprint than corn.

"They don't require a lot of fertilizer or irrigation," Field said. "Farmers don't have to plow up the field every year to plant new crops, and they're good for a decade or longer."

Researchers chose a study site in Kansas since it has a cellulosic biofuel production plant, one of only three in the United States.

The team used DayCent, an ecosystem modeling tool that tracks the carbon cycle, plant growth, and how growth responds to weather, climate and other factors at a local scale. It was developed at CSU in the mid-1990s. The tool allows scientists to predict whether crop production contributes to or helps combat climate change, and how feasible it is to produce certain crops in a given area.

Previous studies on cellulosic biofuels have focused on the engineering details of the supply chain. These details have included analyzing the distance between the farms where the plant material is produced, and the biofuel production plant to which it must be transported. However, the CSU analysis finds that the details of where and how you grow the plant material is just as significant or even more significant for the greenhouse gas footprint of the biofuel, said Field.

The biofuel industry is experiencing challenges, due to low oil prices. The production plant referenced above has new owners and is undergoing a reorganization.

But the future looks bright for biofuels and bioenergy, said Field.

"Biofuels have some capabilities that other renewable energy sources like wind and solar power just don't have," said Field. "If and when the price of oil gets higher, we'll see continued interest and research in biofuels, including the construction of new facilities."

Study co-authors include Samuel Evans (University of California-Berkeley), Ernie Marx, Mark Easter (Natural Resource Ecology Laboratory at CSU), Paul Adler (United States Department of Agriculture), Thai Dinh (University of Oklahoma), Bryan Willson (Energy Institute and Department of Mechanical Engineering, CSU) and Keith Paustian (Department of Soil and Crop Science, CSU).

https://www.sciencedaily.com/releases/2018/02/180226181548.htm

Banking on sunshine: World added far more solar than fossil fuel power generating capacity in 2017

April 5, 2018

Summary: Solar energy dominated global investment in new power generation like never before in 2017.

The world installed a record 98 gigawatts of new solar capacity, far more than the net additions of any other technology -- renewable, fossil fuel or nuclear.

Solar power also attracted far more investment, at $160.8 billion, up 18 per cent, than any other technology. It made up 57 per cent of last year's total for all renewables (excluding large hydro) of $279.8 billion, and it towered above new investment in coal and gas generation capacity, estimated at $103 billion.

A driving power behind last year's surge in solar was China, where an unprecedented boom saw some 53 gigawatts added -- more than half the global total -- and $86.5 billion invested, up 58 per cent.

The Global Trends in Renewable Energy Investment 2018 report, released today by UN Environment, Frankfurt School -- UNEP Collaborating Centre, and Bloomberg New Energy Finance, finds that falling costs for solar electricity, and to some extent wind power, is continuing to drive deployment. Last year was the eighth in a row in which global investment in renewables exceeded $200 billion -- and since 2004, the world has invested $2.9 trillion in these green energy sources.

"The extraordinary surge in solar investment shows how the global energy map is changing and, more importantly, what the economic benefits are of such a shift," said UN Environment head Erik Solheim. "Investments in renewables bring more people into the economy, they deliver more jobs, better quality jobs and better paid jobs. Clean energy also means less pollution, which means healthier, happier development."

Overall, China was by far the world's largest investing country in renewables, at a record $126.6 billion, up 31 per cent on 2016.

There were also sharp increases in investment in Australia (up 147 per cent to $8.5 billion), Mexico (up 810 per cent to $6 billion), and in Sweden (up 127 per cent to $3.7 billion).

A record 157 gigawatts of renewable power were commissioned last year, up from 143 gigawatts in 2016 and far out-stripping the net 70 gigawatts of fossil-fuel generating capacity added (after adjusting for the closure of some existing plants) over the same period.

"The world added more solar capacity than coal, gas, and nuclear plants combined," said Nils Stieglitz, President of Frankfurt School of Finance & Management. "This shows where we are heading, although the fact that renewables altogether are still far from providing the majority of electricity means that we still have a long way to go."

Some big markets, however, saw declines in investment in renewables. In the United States, investment dropped 6 per cent, coming in at $40.5 billion. In Europe there was a fall of 36 per cent, to $40.9 billion, with big drops in the United Kingdom (down 65 per cent to $7.6 billion) and Germany (down 35 per cent to $10.4 billion). Investment in Japan slipped 28 per cent to $13.4 billion.

Angus McCrone, Chief Editor of Bloomberg New Energy Finance and lead author of the report, said: "In countries that saw lower investment, it generally reflected a mixture of changes in policy support, the timing of large project financings, such as in offshore wind, and lower capital costs per megawatt."

Global investments in renewable energy of $2.7 trillion from 2007 to 2017 (11 years inclusive) have increased the proportion of world electricity generated by wind, solar, biomass and waste-to-energy, geothermal, marine and small hydro from 5.2 per cent to 12.1 per cent.

The current level of electricity generated by renewables corresponds to about 1.8 gigatonnes of carbon dioxide emissions avoided -- roughly equivalent to those produced by the entire U.S. transport system.

The Global Trends in Renewable Energy Investment 2018 report was funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

https://www.sciencedaily.com/releases/2018/04/180405093247.htm

New ray of hope for solar fuel

April 27, 2018

Summary: The quest to develop the 'Holy Grail' of affordable, viable and environmentally-friendly fuels using sunlight has taken an exciting new twist.

A team of Renewable Energy experts from the University of Exeter has pioneered a new technique to produce hydrogen from sunlight to create a clean, cheap and widely-available fuel.

The team developed an innovative method to split water into its constituent parts -- hydrogen and oxygen -- using sunlight. The hydrogen can then be used as a fuel, with the potential to power everyday items such as homes and vehicles.

Crucially, hydrogen fuel that can be created through this synthetic photosynthesis method would not only severely reduce carbon emissions, but would also create a virtually limitless energy source.

The ground-breaking new research centres on the use of a revolutionary photo-electrode -- an electrode that absorbs light before initializing electrochemical transformations to extract the hydrogen from water -- made from nanoparticles of the elements lanthanum, iron and oxygen.

The researchers believe this new type of photo-electrode is not only cheap to produce, but can also be recreated on a larger scale for mass and worldwide use.

The research is published in leading journal, *Scientific Reports*.

Govinder Pawar, lead author on the paper and based at the University of Exeter's Environment and Sustainability Institute on the Penryn Campus in Cornwall said: "With growing economies and population, fossil fuels will not be able to sustain the global energy demand in a "clean" manner as they are being exhausted at an alarming rate.

"Alternative renewable fuels sources must be found which can sustain the global energy demand. Hydrogen is a promising alternative fuel source capable of replacing fossil fuels as it has a higher energy density than fossil fuels (more than double), zero carbon emissions and the only by-product is water."

At present, around 85 per cent of the global energy provisions come from the burning of fossil fuels. Therefore the need and desire to find a sustainable, cost-effective renewable fuel source is growing in urgency.

Perhaps unsurprisingly, the sun is earth's most abundant renewable energy source, with the potential to provide 100,000 terawatts of power each year -- meaning one hour's worth of solar energy is equal to an entire year of total energy consumption worldwide.

However, efforts to produce efficient stable semiconductor material, in order to effectively convert sunlight to a storable widespread energy source, have so far proved elusive.

One of the most significant hindrances to the development of viable solar energy has been an inability to produce a semiconducting material suitable for the process.

In this new research, the team utilised lanthanum iron oxide to create a semiconducting material that gave the ideal results for the production of hydrogen from water using sunlight, making it the strongest candidate yet for renewable hydrogen generation.

Govinder Pawar added: "We have shown that our LaFeO3 photo-electrode has ideal band alignments needed to split water into its constituents (H_2 and O_2) spontaneously, without the need of an external bias. Moreover, our material has excellent stability where after 21 hours of testing it does not degrade, ideal for water splitting purpose. We are currently working on further improving our material to make it more efficient to produce more hydrogen."

https://www.sciencedaily.com/releases/2018/04/180427100240.htm

Manure could heat your home

March 8, 2018

Researchers at the University of Waterloo are developing technology to produce renewable natural gas from manure so it can be added to the existing energy supply system for heating homes and powering industries. That would eliminate particularly harmful gases released by naturally decomposing manure when it is spread on farm fields as fertilizer and partially replace fossil natural gas, a significant contributor to global warming.

"There are multiple ways we can benefit from this single approach," said David Simakov, a professor of chemical engineering at Waterloo. "The potential is huge."

Simakov said the technology could be viable with several kinds of manure, particularly cow and pig manure, as well as at landfill sites.

In addition to being used by industries and in homes, renewable natural gas could replace diesel fuel for trucks in the transportation sector, a major source of greenhouse gas emissions.

To test the concept, researchers built a computer model of an actual 2,000-head dairy farm in Ontario that collects manure and converts it into biogas in anaerobic digesters. Some of that biogas is already used to produce electricity by burning it in generators, reducing the environmental impact of manure while also yielding about 30 to 40 percent of its energy potential.

Researchers want to take those benefits a significant step further by upgrading, or converting, biogas from manure into renewable natural gas. That would involve mixing it with hydrogen, then running it through a catalytic converter. A chemical reaction in the converter would produce methane from carbon dioxide in the biogas.

Known as methanation, the process would require electricity to produce hydrogen, but that power could be generated on-site by renewable wind or solar systems, or taken from the electrical grid at times of low demand. The net result would be renewable natural gas that yields almost all of manure's energy potential and also efficiently stores electricity, but has only a fraction of the greenhouse gas impact of manure used as fertilizer.

"This is how we can make the transition from fossil-based energy to renewable energy using existing infrastructure, which is a tremendous advantage," said Simakov, who collaborates with fellow chemical engineering professor Michael Fowler.

The modelling study showed that a $5-million investment in a methanation system at the Ontario farm would, with government price subsidies for renewable natural gas, have about a five-year payback period.

A paper on modelling of a renewable natural gas generation facility at the Ontario farm, which also involved a post-doctoral researcher and several Waterloo students, was recently published in the *International Journal of Energy Research*.

https://www.sciencedaily.com/releases/2018/03/180308085532.htm

Actual fossil fuel emissions checked with new technique

April 12, 2018

Summary: Researchers have measured CO2 emissions from fossil fuel use in California and compared them to reported emissions. This is the first time fossil fuel emissions have been independently checked for such a large area.

Researchers have measured CO_2 emissions from fossil fuel use in California and compared them to reported emissions.

This is the first time fossil fuel emissions have been independently checked for such a large area.

Carbon dioxide (CO_2) from fossil fuel combustion is the primary driver of climate change, and many governments, companies and citizens are making efforts to curb their emissions. A key part of this effort is measuring the change in emissions.

Countries and regions report their CO_2 emissions from fossil fuels by counting what they have used, such as the amount of oil, coal or gas they have burned. However, there may be uncertainty in these estimates, for example depending on the composition of the fuel.

Now, a team of researchers, led by members from Imperial College London, have reported a technique to estimate CO_2emissions from fossil fuels using atmospheric measurements, tested over three months in California.

In this case the reported and actual emissions matched up well -- but researchers warn this may not be the case everywhere else in the world.

The study, funded by NASA and published today in *Environmental Research Letters*, is the first time scientists have been able to measure fossil fuel CO_2 emissions over a large area like California. The researchers suggest the technique could also be used in other regions, strengthening the ability to report and monitor efforts to curb emissions.

The Paris Agreement, which came into force in November 2016, aims to keep the global temperature rise below two degrees Celsius above pre-industrial levels. As part of this, most countries around the world have agreed to reduce their CO_2 emissions. Individual regions like California have also set their own emissions reduction goals and policies.

Lead author Dr Heather Graven, from the Department of Physics at Imperial, said: "The Paris Agreement requires that 'stocktakes' are conducted every five years, but the details of how these will be conducted are not settled and are in need of input from researchers.

"Our study is the first example of how atmospheric measurements can help to check on fossil fuel CO_2 emissions over an area large enough to encompass nations, provinces or states."

While there are many instruments that can measure CO_2concentration in the atmosphere, the difficulty is in separating natural CO_2 from plant life from humanmade

CO_2 emitted by fossil fuel burning. However, because gas, coal and oil are millions of years old, their carbon has a key difference compared to the carbon cycling through plants.

Fossil fuels lack a type of radioactive carbon, an isotope called carbon-14, which decays over time. By measuring the ratio of carbon isotopes in the samples the team collected, they were able to tell how much carbon was from fossil fuel combustion.

The team, which included researchers from ten different laboratories in the US, made their measurements at nine monitoring stations around California. They combined the data with a California-specific atmospheric circulation model, which shows how air moves around the state.

They then compared their results with other estimates of fossil fuel emissions, including estimates from the California Air Resources Board, who assisted with the study. The researchers found there was a good match between the different estimates.

California's estimates are based on calculating what has been burnt and this study provided a way to check that their reported emissions are unlikely to have any large biases.

The researchers say that adding this atmospheric monitoring technique to the suite of tools used to monitor climate change can help to better understand greenhouse gas emissions from specific regions and how they are changing over time.

https://www.sciencedaily.com/releases/2018/04/180412130826.htm

New materials for sustainable, low-cost batteries

April 30, 2018

Summary: A new conductor material and a new electrode material could pave the way for inexpensive batteries and therefore the large-scale storage of renewable energies.

The energy transition depends on technologies that allow the inexpensive temporary storage of electricity from renewable sources. A promising new candidate is aluminium batteries, which are made from cheap and abundant raw materials.

Scientists from ETH Zurich and Empa -- led by Maksym Kovalenko, Professor of Functional Inorganic Materials -- are among those involved in researching and developing batteries of this kind. The researchers have now identified two new materials that could bring about key advances in the development of aluminium batteries. The first is a corrosion-resistant material for the conductive parts of the battery; the second is a novel material for the battery's positive pole that can be adapted to a wide range of technical requirements.

Aggressive electrolyte fluid

As the electrolyte fluid in aluminium batteries is extremely aggressive and corrodes stainless steel, and even gold and platinum, scientists are searching for corrosion-resistant materials for the conductive parts of these batteries. Kovalenko and his colleagues have found what they are looking for in titanium nitride, a ceramic material that exhibits sufficiently high conductivity. "This compound is made up of the highly abundant elements titanium and nitrogen, and it's easy to manufacture," explains Kovalenko.

The scientists have successfully made aluminium batteries with conductive parts made of titanium nitride in the laboratory. The material can easily be produced in the form of thin films, also as a coating over other materials such as polymer foils. Kovalenko believes it would also be possible to manufacture the conductors from a conventional metal and coat them with titanium nitride, or even to print conductive titanium nitride tracks on to plastic. "The potential applications of titanium nitride are not limited to aluminium batteries. The material could also be used in other types of batteries; for example, in those based on magnesium or sodium, or in high-voltage lithium-ion batteries," says Kovalenko.

An alternative to graphite

The second new material can be used for the positive electrode (pole) of aluminium batteries. Whereas the negative electrode in these batteries is made of aluminium, the positive electrode is usually made of graphite. Now, Kovalenko and his team have found a new material that rivals graphite in terms of the amount of energy a battery is able to store. The material in question is polypyrene, a hydrocarbon with a chain-like (polymeric) molecular structure. In experiments, samples of the material -- particularly those in which the molecular chains congregate in a disorderly manner -- proved to be ideal. "A lot of space remains between the molecular chains. This allows the relatively large ions of the electrolyte fluid to penetrate and charge the electrode material easily," Kovalenko explains.

One of the advantages of electrodes containing polypyrene is that scientists are able to influence their properties, such as the porosity. The material can therefore be adapted perfectly to the specific application. "In contrast, the graphite used at present is a mineral. From a chemical engineering perspective, it cannot be modified," says Kovalenko.

As both titanium nitride and polypyrene are flexible materials, the researchers believe they are suitable for use in "pouch cells" (batteries enclosed in a flexible film).

Batteries for the energy transition

An increasing amount of electricity is generated from solar and wind energy. However, as electricity is needed even when the sun is not shining and the wind is not blowing, new technologies will be needed, such as new types of batteries, to store this electricity in a cost-effective manner. Although existing lithium-ion batteries are ideal for electromobility due to their low weight, they are also quite expensive and therefore unsuitable for economical large-scale, stationary power storage.

Furthermore, lithium is a relatively rare metal and is hard to extract -- unlike aluminium, magnesium or sodium. Batteries based on one of the latter three elements are thus seen as a promising option for stationary power storage in the future. However, such batteries are still at the research stage and have not yet entered industrial use.

https://www.sciencedaily.com/releases/2018/04/180430075631.htm

Advanced biofuels can be produced extremely efficiently, confirms industrial demonstration

May 21, 2018

Summary: Researchers have developed new technologies that can be used to convert industrial plants to produce fossil-free heat, electricity, fuel, chemicals and materials. The technical potential is enormous -- using only Sweden's currently existing power plants, renewable fuels equivalent to 10 percent of the world's aviation fuel could be produced.

A chance to switch to renewable sources for heating, electricity and fuel, while also providing new opportunities for several industries to produce large numbers of renewable products. This is the verdict of researchers from Chalmers University of Technology, Sweden, who now, after ten years of energy research into gasification of biomass, see an array of new technological achievements.

"The potential is huge! Using only the already existing Swedish energy plants, we could produce renewable fuels equivalent to 10 percent of the world's aviation fuel, if such a conversion were fully implemented," says Henrik Thunman, Professor of Energy Technology at Chalmers.

How to implement a switch from fossil-fuels to renewables is a tricky issue for many industries. For heavy industries, such as oil refineries, or the paper and pulp industry, it is especially urgent to start moving, because investment cycles are so long. At the same time, it is important to get the investment right because you may be forced to replace boilers or facilities in advance, which means major financial costs. Thanks to long-term strategic efforts, researchers at Sweden´s Chalmers University of Technology have now paved the way for radical changes, which could be applied to new installations, as well as be implemented at thousands of existing plants around the globe.

The solution presented involves widespread gasification of biomass. This technology itself is not new. Roughly explained, what is happening is that at high temperatures, biomass is converted into a gas. This gas can then be refined into end-products which are currently manufactured from oil and natural gas. The Chalmers researchers have shown that one possible end-product is biogas that can replace natural gas in existing gas networks.

Previously, the development of gasification technology has been hampered by major problems with tar being released from the biomass, which interferes with the process in several ways. Now, the researchers from Chalmers' division of Energy Technology have shown that they can improve the quality of the biogas through chemical processes, and the tar can also be managed in completely new ways. This, in combination with a parallel development of heat-exchange materials, provides completely new possibilities for converting district heating boilers to biomass gasifiers.

"What makes this technology so attractive to several industries is that it will be possible to modify existing boilers, which can then supplement heat and power production with the production of fossil-free fuels and chemicals.," says Martin Seemann, Associate Professor in Energy Technology at Chalmers.

"We rebuilt our own research boiler in this way in 2007, and now we have more than 200 man-years of research to back us up," says Professor Henrik Thunman. "Combined with industrial-scale lessons learned at the GoBiGas (Gothenburg Biomass Gasification) demonstration project, launched in 2014, it is now possible for us to say that the technology is ready for the world."

The plants which could be converted to gasification are power and district heating plants, paper and pulp mills, sawmills, oil refineries and petrochemical plants.

"The technical solutions developed by the Chalmers researchers are therefore relevant across several industrial fields," says Klara Helstad, Head of the Sustainable Industry Unit at the Swedish Energy Agency. "Chalmers´ competence and research infrastructure have played and crucial role for the demonstration of advanced biofuels within the GoBiGas-project."

The Swedish Energy Agency has funded energy research and infrastructure at Chalmers for many years.

More about: Potential for fossil-free fuels via gasification, by modification of existing plants

- The facilities that could be modified have a type of combustion boiler called a fluidised bed. It is the most common technology in Swedish power and district heating plants, and is also common in many paper and pulp mills and sawmills. In total, over 100 plants in Sweden have fluidised bed boilers.
- If all of these plants were modified to biomass gasifiers, they would be able to produce 346 TWh of biogas (methane) per year, given sufficient biomass availability. This corresponds to approximately one percent of the world's total natural gas consumption in 2013.
- Alternatively, the plants could produce 278 TWh of aviation fuel per year, equivalent to approximately 10 percent of the world's total aviation fuel consumption in 2014.
- The biomass consumption in the above scenarios exceeds the production estimates of the Swedish agriculture and forestry industry, so a major conversion to biomass gasification would probably require a mixture of domestic and imported biomass.
- Globally, there are thousands of plants that have fluidised bed combustion, and could therefore be modified to biomass gasification.

More about: Chemicals, materials and electrical fuels as end-products

- The technology is very flexible when it comes to end-products. Gasification of biomass produces syngas -- a mixture of hydrogen, carbon monoxide and carbon dioxide -- which can then be converted to a variety of hydrocarbons. In addition to biogas and aviation fuel, you can, for example, produce methanol, gasoline and diesel.
- In addition to power and district heating plants and paper-, pulp- and sawmills, the conversion could also include oil refineries and petrochemical plants. The gasification

process could provide renewable hydrocarbons that can replace oil in the production of fuels, chemicals and materials. But also, it offers the possibility of supplementing their operations with their own combustion of biomass.

- The technology can also be used to produce electro fuels. These are synthetic vehicle fuels that are produced with carbon dioxide captured from biomass combustion, electricity and water. In a future energy system, with a high proportion of electricity from solar cells and wind power, it could be a method of utilising electricity during surplus periods. An installation can be designed to switch between the production of electric fuel and other fuel, depending on the current electricity price.
- With sufficient access to biomass, the expanded production could coexist with existing production in the facilities, and provide an increased degree of utilisation for today's infrastructure.

More about: The availability of sustainably produced biomass

There are differences in opinion over how much biomass can be produced in a sustainable way.

"My assessment is that biomass can make a significant contribution to the energy supply. But it is not enough to provide for all the applications that currently require fossil fuels," says Göran Berndes, Professor of Biomass and Land use at Chalmers. "In this perspective, the conversion to gasification is very interesting, as it enables biomass to be used very efficiently to meet several different needs in society."

Göran Berndes continues, "regardless of how biomass is used in the end, it is important to ensure that it comes from sustainable forestry and agriculture. Laws, regulations and market-based sustainability certification schemes provide better conditions for sustainable production, but countries and individual actors differ in terms of sustainability priorities. It is therefore likely that the changeover to renewability will still be characterised by a debate regarding the sustainability of different solutions."

https://www.sciencedaily.com/releases/2018/05/180521131127.htm

Switching with molecules for pioneering electro-optical devices

May 24, 2018

Summary: An international research team has developed molecules that can be switched between two structurally different states using an applied voltage. Such nanoswitches can serve as the basis for a pioneering class of devices that could replace silicon-based components with organic molecules.

An international research team led by physicists at the Technical University of Munich (TUM) has developed molecules that can be switched between two structurally different states using an applied voltage. Such nanoswitches can serve as the basis for a pioneering class of devices that could replace silicon-based components with organic molecules.

The development of new electronic technologies drives the incessant reduction of functional component sizes. In the context of an international collaborative effort, a team of physicists at the Technical University of Munich has successfully deployed a single molecule as a switching element for light signals.

"Switching with just a single molecule brings future electronics one step closer to the ultimate limit of miniaturization," says nanoscientist Joachim Reichert from the Physics Department of the Technical University of Munich.

Different structure -- different optical properties

The team initially developed a method that allowed them to create precise electrical contacts with molecules in strong optical fields and to control them using an applied voltage. At a potential difference of around one volt, the molecule changes its structure: It becomes flat, conductive and scatters light.

This optical behavior, which differs depending on the structure of the molecule, is quite exciting for the researchers because the scattering activity -- Raman scattering, in this case -- can be both observed and, at the same time, switched on and off via an applied voltage.

Challenging technology

The researchers used molecules synthesized by teams based in Basel and Karlsruhe. The molecules can change their structure in specific ways when they are charged. They are arranged on a metal surface and contacted using the corner of a glass fragment with a very thin metal coating as a tip..

This serves as an electrical contact, light source and light collector, all in one. The researchers used the fragment to direct laser light to the molecule and measure tiny spectroscopic signals that vary with the applied voltage.

Contacting individual molecules electrically is extremely challenging from a technical point of view. The scientists have now successfully combined this procedure with single-molecule spectroscopy, allowing them to observe even the smallest structural changes in molecules with great precision.

Competition for Silicon

One goal of molecular electronics is to develop novel devices that can replace traditional silicon-based components using integrated and directly controllable molecules.

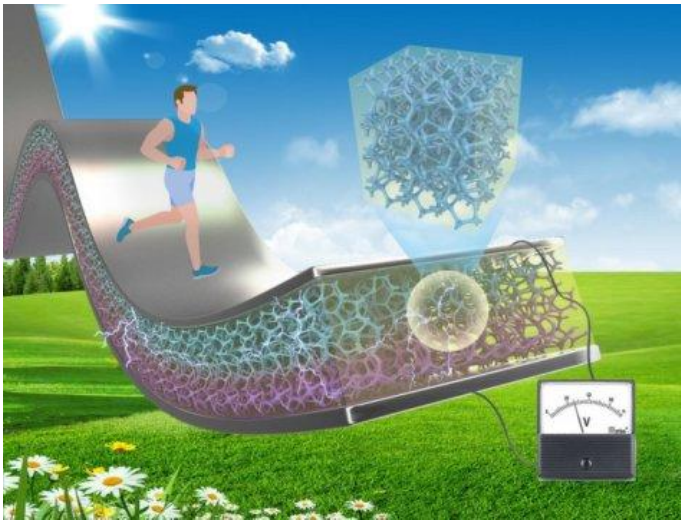
Thanks to its tiny dimensions, this nanosystem is suitable for applications in optoelectronics, in which light needs to be switched using variations in electrical potential.

https://www.sciencedaily.com/releases/2018/05/180524104101.htm

Flexible, highly efficient multimodal energy harvesting

May 21, 2018

Summary: A 10-fold increase in the ability to harvest mechanical and thermal energy over standard piezoelectric composites may be possible using a piezoelectric ceramic foam supported by a flexible polymer support, according to researchers.



A 10-fold increase in the ability to harvest mechanical and thermal energy over standard piezoelectric composites may be possible using a piezoelectric ceramic foam supported by a flexible polymer support, according to Penn State researchers.

In the search for ways to harvest small amounts of energy to run mobile electronic devices or sensors for health monitoring, researchers typically add hard ceramic nanoparticles or nanowires to a soft, flexible polymer support. The polymer provides the flexibility, while the piezo nanoparticles convert the mechanical energy into electrical voltage. But these materials are relatively inefficient, because upon mechanical loading the mechanical energy is largely absorbed by the bulk of the polymer, with a very small fraction transferred to the piezo nanoparticles. While adding more ceramic would increase the energy efficiency, it comes with the tradeoff of less flexibility.

"The hard ceramics in the soft polymer is like stones in water," said Qing Wang, professor of materials science and engineering, Penn State. "You can slap the surface of the water, but little force is transferred to the stones. We call that strain-transfer capability."

Almost three decades ago, the late Penn State materials scientist Bob Newnham came up with the concept that the connectivity of the piezo filler determined the efficiency of the piezoelectric effect. A three-dimensional material would be more efficient than what he classified as zero-dimensional nanoparticles, one-dimensional nanowires or two-dimensional films, because the mechanical energy would be transported directly through the three-dimensional material instead of dissipating into the polymer matrix.

"Bob Newnham was a legend in the field of piezoelectrics," said Wang. "so everybody in the ceramic community knew of his approach, but how to achieve that 3-D structure with a well-defined microstructure remained a mystery."

The secret ingredient to solve the mystery turned out to be a cheap polyurethane foam dusting sheet that can be purchased at any home improvement store. The small uniform protrusions on the sheet act as a template for forming the microstructure of the piezoelectric ceramic. The researchers applied the ceramic to the polyurethane sheet in the form of suspended nanoparticles in solution. When the template and solution are heated to a high enough temperature, the sheet burns out and the solution crystalizes into a solid 3-D microform foam with uniform holes. They then fill the holes in the ceramic foam with polymer.

"We see that this 3-D composite has a much higher energy output under different modes," said Wang. "We can stretch it, bend it, press it. And at the same time, it can be used as a pyroelectric energy harvester if there is a temperature gradient of at least a few degrees."

Sulin Zhang, professor of engineering science and mechanics, Penn State is the other corresponding author on the paper that appears in *Energy and Environmental Science*. Zhang and his students were responsible for extensive computational work simulating the piezoelectric performance of the 3-D composite.

"We were able to show theoretically that the piezoelectric performance of nanoparticle/nanowire composites is critically limited by the large disparity in stiffness of the polymer matrix and piezoceramics, but the 3-D composite foam is not limited by stiffness," said Zhang. "This is the fundamental difference between these composite materials, which speaks to the innovation of this new 3-D composite. Our extensive simulations further demonstrate this idea."

Currently, Wang and his collaborators are working with lead-free and more environmentally friendly alternatives to the current lead-zirconium-titanate ceramic.

"This is a very general method," said Wang. "This is to demonstrate the concept, based on Bob Newnham's work. It is good to continue the work of a Penn State legend and to advance this field." Additional authors on the article, "Flexible three-dimensional interconnected piezoelectric ceramic foam based composites for highly efficient concurrent mechanical and thermal energy harvesting," are co-lead authors Guangzu Zhang, formerly in Wang's group and now at Huazhong University of Science and Technology, China; and Peng Zhao, a doctoral student in Zhang's group. Other contributors are Xiaoshin Zhang, Kuo Han, Tiankai Zhao, Yong Zhang, Chang Kyu Jeong and Shenglin Jiang.

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https://www.sciencedaily.com/releases/2018/05/180521143839.htm

Google Cars Partner With Environmental Group to Detect Methane Gas Leaks

Google has employed its "Street View" cars for quite some time now to give Internet dwellers some perspective on America's roads. The past couple years, however, those same cars have served an additional purpose. A non-profit organization by the name of Environmental Defense Fund partnered with Google to mount air monitors on the cars in order to detect methane gas leaks in various parts of the country.

For two years now, Google's cars have been locating methane emissions in big cities like New York and Boston. In areas of central Boston the cars exposed new leaks at a frequency of one every few blocks.

New carbon emissions laws for power plants propelled climate change into the public consciousness again in recent weeks, so it will be interesting to see if a similar outcry results from news about methane leaks. Experts consider methane's potential effects on global warming to be approximately 20 times that of carbon dioxide, and the numerous leaks discovered by Google cars reveal not only a potential wide scale global warming threat, but also the possibility of natural gas explosions from faulty piping.

Earlier this year, Harlem suffered a natural gas explosion that killed eight people. To make matters worse, the data collected by the Environmental Defense Fund shows that many places dealing with methane leaks still use cast iron pipes that could be corroded and dangerous. In contrast, Indianapolis recently installed new plastic pipes, and data from those areas shows almost no leaks whatsoever.

EDF reports it will take steps to expand the reach of its programs in order to study more cities. In the meantime, the production of methane is escalating in the U.S. due to drilling and an increase in pipelines. It remains to be seen whether significant legislation will eventually be passed to deal with the growing problem.

http://www.bionomicfuel.com/google-cars-partner-with-environmental-group-to-detect-methane-gas-leaks/

How Green Are the Companies that are Touting the Title?

When Newsweek magazine announced the top green companies, I think many of us were scratching our heads when we saw names such as Apple, HP, IBM and Dell. It appears that Newsweek did not do their homework, because all four of these companies fall into the 'class B' category of green companies (as described by the US Bureau of Labor and Statistics). Class B relates only to job where the duties of the workers involve making the production process of the establishment more environmentally friendly or they use fewer natural resources. By far, this is not what the term 'green company' is all about.

We don't want to lessen the efforts of the above mentioned companies in their goal to create a much greener environment within their corporate culture, but by elevating the smaller efforts of the big name giants, we are demeaning those companies that have made incredible strides in really accomplishing the green effort. The well-known names may generate additional readership for Newsweek because the smaller names are mostly unknown. The truly green companies that have made strides of excellence include: SunEdison, First Solar, Locus Technologies and Vestas. These companies have over a fifty percent employment of their employees and/or get a fifty percent or more of the revenues from products that are involved in goods or services that benefit the environment or are involved in the conservation of natural resources.

Exposure of this attempt at green washing should make Newsweek a bit ashamed. Not only should the journalist have accomplished the in-depth research needed, but the editors should have been a bit suspicious when so many big-named companies appeared on the list. This is a typical battle between true journalism and the need to have higher readership that has gone on since the first paper went to print.

So, to assist Newsweek, we might want to define what a truly 'green' company might be. These are companies involved in all areas of renewable energy including producers of those products. They can be manufacturers of renewable and sustainable energy equipment such as wind turbines and solar panels as well as companies that are involved in battery technologies and vehicle manufacturers of all electric vehicles. Other 'green' companies can fall into the category of the corporations that are following and adopting over fifty percent of their electrical needs, as well as recycling and product generation through avenues that are sustainable and renewable energy use; and that are heavily involved in conserving natural resources. The list is pretty extensive when it comes to the truly green and encompasses all lines of business that we may not have thought of, including green building and construction as well as transportation. There is a database of around six hundred green companies listed in The Green Job Bank which not only lists the companies themselves but the top green employers.

Thanks to the myriad of complete information that is available online, we, the consumers will not allow the misrepresentation of green washing any longer and it will take a lot more than a front page article to prove that a corporation is really a green company.

http://www.bionomicfuel.com/how-green-are-the-companies-that-are-touting-the-title/

Biodiesel Production Can Help Third World Economies

Biodiesel production and an adequate world food supply do not have to compete, and the production of biodiesel can help third world economies pick up while improving living standards for the entire areas. In addition, this biofuel is non-toxic and will not harm the environment if an accidental spill did ever occur. Because biodiesel consists of simple oils and fats, the reduction in cost and the amount of waste discarded is significant because many products that are discarded can be used to make biodiesel.

Biodiesel production offers many benefits that can help third world economies. Biodiesel is a biofuel made with vegetable oils and fats and is a renewable, earth friendly fuel that can be made cheaply and efficiently from almost any biomass, as long as the biomass contains some type of oil or fat. Some leaders around the globe do not want biodiesel use to become widespread because they fear that it will drive up food prices due to food being used to produce fuel instead of being used to produce food crops alone, but this is not true. Plants that are not food stocks, such as rapeseed and castor bean plants, can grow in soil and areas where nothing else can grow, and these plants are not food sources.

Biodiesel production could actually help strengthen the economy of a community or area, especially if everything is done locally; from local crops being used and local labor, all the way up to distributing the biodiesel made to be used in the local area. Third world economies where people go hungry will not be hurt by biodiesel production; in fact, just the opposite would be true. When biodiesel plants are built, an immediate influx of money would occur for labor and materials to build the plant. Farmers in the area could grow both food and biomass plants, planting food crops on land that is fertile and using poor land for energy crops. This way, farmers could make more money and spend more in local stores and establishments.

Once biodiesel production has started, the company will need workers to run the production processes, and to bring in supplies. Taxes will be paid to the local area, increasing both revenue and growth. Many third world economies suffer from a shortage of decent paying jobs, and a biodiesel production plant might help change this. Area residents would be able to get their fuel cheaper because it would be grown and produced locally, so very little transportation would be needed. Farmers, workers, the government and economy, the environment, and the production plant would all win. With this scenario, there are no losers or hidden risks. There would also be less pollution and thus cleaner air because biodiesel is a clean-burning fuel that produces far fewer harmful emissions than regular diesel or gasoline.

Biodiesel production can help third world economies because it can use crops grown locally, which will cut the expenditure and dependence on costly fuels that are imported. It would also help the local community become self-reliant, increase the tax base and income of the area, supply both skilled and unskilled jobs, and encourage the growing of food crops. With a thriving economy, a great job base, and a booming tax base, producing biodiesel can be an economic boon to an area in a third world country with a third world economy. Biodiesel is a much better alternative to fossil fuels, and as a renewable energy source that is environmentally friendly, the demand for production would increase. Third world economies can benefit greatly from allowing biodiesel production. It is a situation where everyone wins.

http://www.bionomicfuel.com/biodiesel-production-can-help-third-world-economies/

What Does Smart Grid Mean?

A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. This system allows for monitoring, analysis, control and communication within the supply chain to help improve efficiency, reduce energy consumption and cost, and maximize the transparency and reliability of the energy supply chain. The smart grid was introduced with the aim of overcoming the weaknesses of conventional electrical grids by using smart net meters.

Many government institutions around the world have been encouraging the use of smart grids for their potential to control and deal with global warming, emergency resilience and energy independence scenarios.

Smart grid technology is an extended form of analog technology that has also been introduced for controlling the use of appliances by employing two-way communication. However, the prevalence of Internet access in most homes has made the smart grid more practically reliable to implement. Smart grid devices transmit information in such a way that enables ordinary users, operators and automated devices to quickly respond to changes in smart grid condition systems.

Smart grid is equally advantageous for enterprises, retail stores, hospitals, universities and multinational corporations. The entire smart grid system is automated for tracking the electricity consumption at all the locations. Grid architecture is also combined with energy management software for estimating the energy consumption and its associated cost for a specific enterprise. Generally, electricity prices increase along with demand. By providing consumers with information about current consumption and energy prices, smart grid energy management services help to minimize the consumption during high-cost, peak-demand times.

A modern smart grid system has the following capabilities:

- It can repair itself.
- It encourages consumer participation in grid operations.
- It ensures a consistent and premium-quality power supply that resists power leakages.
- It allows the electricity markets to grow and make business.
- It can be operated more efficiently.

A smart grid's key features include:

- Load Handling: The sum/total of the power grid load is not stable and it varies over time. In case of heavy load, a smart grid system can advise consumers to temporarily minimize energy consumption.
- Demand Response Support: Provides users with an automated way to reduce their electricity bills by guiding them to use low-priority electronic devices when rates are lower.
- Decentralization of Power Generation: A distributed or decentralized grid system allows the individual user to generate onsite power by employing any appropriate method at his or her discretion.

https://www.techopedia.com/definition/692/smart-grid

IRREGULAR VERBS

The Infinitive (Неопределенная форма)	**Past Indefinite** (Прошедшее время)	**Participle II** (Причастие прошедшего времени**)**	**Translation** (Основные значения глагола)
be	was, were	been	быть
become	became	become	становиться
begin	began	begun	начинать (ся)
blow	blew	blown	дуть
break	broke	broken	разбивать (ся)
bring	brought	brought	приносить
build	built	built	строить
buy	bought	bought	покупать
come	came	come	приходить
Catch	caught [kɔ:t]	caught [kɔ:t]	ловить, хватать
choose	chose	chosen	выбирать
cut	cut	cut	резать
do	did	done	делать
draw	drew	drawn	рисовать
drink	drank	drunk	пить
drive	drove	driven	ехать, вести (машину)
eat	ate	eaten	есть
fall	fell	fallen	падать
feed	fed	fed	кормить
feel	felt	felt	чувствовать
fight	fought	fought	бороться
find	found	found	находить
fly	flew	flown	летать
forget	forgot	forgotten	забывать
get	got	got	получать
give	gave	given	давать
go	went	gone	идти
grow	grew	grown	расти
have	had	had	иметь
hear	heard	heard	слышать
hide	hid	hidden	прятать (ся)
hold	held	held	держать
keep	kept	kept	хранить
know	knew	known	знать
learn	learnt	learnt	учить
leave	left	left	покидать
let	let	let	позволять

lie	lay	lain	лежать
lose	lost	lost	терять
make	made	made	делать
mean	meant	meant	значить, означать
meet	met	met	встречать (ся)
pay	paid	paid	платить
put	put	put	класть, ставить
read [ri:d]	read [red]	read [red]	читать
ring	rang	rung	звонить
rise	rose	risen	подниматься
run	ran	run	бежать
say	said [sed]	said [sed]	сказать
see	saw	seen	видеть
sell	sold	sold	продавать
send	sent	sent	отправлять, посылать
set	set	set	ставить; заходить (о солнце)
shine	shone	shone	сверкать
show	showed	shown	показывать
sing	sang	sung	петь
sit	sat	sat	сидеть
sleep	slept	slept	спать
smell	smelt	smelt	нюхать, пахнуть
speak	spoke	spoken	говорить
spend	spent	spent	проводить, тратить
stand	stood	stood	стоять
strike	struck	struck	ударять
swim	swam	swum	плавать
take	took	taken	брать
teach	taught [tƆ:t]	taught [tƆ:t]	обучать
tell	told	told	сказать
think	thought [ɵɔ:t]	thought [ɵɔ:t]	думать
understand	understood	understood	понимать
wake	woke	woken	будить, просыпаться
wear	wore	worn	носить (об одежде)
weep	wept	wept	плакать, рыдать
win	won [wʌn]	won [wʌn]	побеждать
write	wrote	written	писать

USEFUL ESSAY WORDS AND PHRASES

Introducing a viewpoint

To begin with / First of all / Outlining the main points
Firstly / Secondly / Thirdly / Finally / Eventually

Giving an alternative point of view

On the one hand..... On the other hand / Otherwise
As a matter of fact / Another possibility is …
In comparison / Comparing / Similarly
By contrast / On the contrary / Unlike
To draw/to make a comparison between ...and
Considering the advantages and disadvantages …
Giving arguments for and against … / Discussing the pros and cons …
Not only ... but also / Anyway / In this/that case
However / Though / Although / Nevertheless

Adding more to some point

In addition to / Additionally / Besides / Moreover / Furthermore
Above all / In the same way / In fact / Really / It is found that
Regarding / With respect to / As to / As for / Referring to …
Apart from / According to … / I'd like to point out that …

Introducing examples

For example / For instance / An example of this is …/ Giving an example of what I mean …
Namely / Including / Such as /
In particular / Particularly / Especially / Mainly / Notably / Mostly

Generalizing

On the whole / As a rule / Generally speaking / In general / To some extent
In some/many ways / In some/many respects / In some/many cases

Sharing personal points of view

I think that / In my opinion / To my mind / In my experience
As far as I know / As far as I am concerned
Being aware/unaware of a problem
To tell the truth / The fact is that
I am convinced that / I firmly believe that

Agreeing	**Disagreeing**
I entirely/absolutely agree with	I partly disagree with … / I don't entirely agree with
That's exactly my own view	I agree in principle, but … / That's not the way I see it
I'm of exactly the same opinion	I see things rather differently myself
That's perfectly true	I'm not at all convinced that / I'm not absolutely sure
I'd like to support this view	

Summing up

Finally / In conclusion / To conclude / To summarize it all / To sum up briefly / In short / In brief
We can draw the conclusion… / Therefore / Thus / Thus we can see that …
All things considered… / On the whole /

USEFUL PHRASES FOR WRITING ANNOTATIONS

The title of the article.
The article is headlined…
The headline of the article is…
As the title implies the article describes ...

The author of the article, where and when the article was published.
The author of the article is…
The author's name is ...
The author's name is not mentioned ...
The article is written by…
It was published in … (***on the Internet***).
It is a newspaper article (published in 2016).

The main idea of the article.
The main idea of the article is…
The article is about…
The article is devoted to…
The article deals with…
The purpose of the article is to give some information on…

The contents of the article.
The author starts by telling (the reader) that…
The author writes (*reports, states, stresses, thinks, notes, considers, believes, analyses, points out, says, describes*) that…
The author draws the reader's attention to...
Much attention is given to…
According to the article…
It is reported that …
It is spoken in detail about…
The article gives a detailed analysis of…
Further the author reports (writes, states, stresses, thinks, notes, considers, believes, analyses, points out, says, describes) that…
In conclusion the author says that …
The following conclusions are drawn: …

Your opinion.
I found the article interesting (important, useful) because…
I think …
In my opinion, the article is useful because…
I found the article difficult to understand as …

VOCABULARY

A

absorb (v)	[əb'zɔːb]	впитывать; абсорбировать; поглощать
abundant (adj)	[ə'bʌnd(ə)nt]	обильный, изобилующий, богатый
access (v)	['ækses]	иметь доступ, получить доступ (к чему-л.)
account for (ph.v)	[ə'kauntfɔː]	объяснять
acid (n)	['æsɪd]	кислота, кислотный, кислый, едкий, язвительный
acidification (n)	[əˌsɪdɪfɪ'keɪʃən]	подкисление, окисление
advancement (n)	[əd'vɑːn(t)smənt]	продвижение; прогресс; успех, улучшение
advancement (n)	[əd'vɑːnsm(ə)nt]	продвижение, прогресс, успех, распространение
adversely (adv)	['ædvɜːsli]	неблагоприятно
affordable (adj)	[ə'fɔːdəbəl]	возможный; допустимый; по средствам, приемлемый
along with	[ə'lɒŋ wɪð]	одновременно с; так же, как и
ambiguous (adj)	[æm'bɪgjuəs]	неопределённый, неясный; неоднозначный
ampere	['æmpeə]	ампер
ancient (adj)	['eɪn(t)ʃ(ə)nt]	древний; старинный, старый
appliance (n)	[ə'plaɪən(t)s]	аппарат, прибор; приспособление, устройство
domestic electric appliances		*бытовые электроприборы*
application (n)	[ˌæplɪ'keɪʃ(ə)n]	применение, использование, приложение; заявление
apply (v)	[ə'plaɪ]	применять; использовать, употреблять, обращаться с

		просьбой, заявлением
as though (cj)	[ˌəz'ðəʊ]	как будто бы, словно, как если бы, похоже
associate (v)	[ə'səusɪeɪt, -ʃɪeɪt]	связывать; ассоциировать; объединять, соединять
assure (v)	[ə'ʃuə]	уверять; заверять кого-л.; убеждать; гарантировать, обеспечивать
atmospheric	[ˌætməs'ferɪk]	атмосферный, создающий определённую атмосферу
attain (v)	[ə'teɪn]	достигать, добиваться, приобретать, добираться
attract (v)	[ə'trækt]	привлекать, притягивать
available (adj)	[ə'veɪləbl]	доступный; имеющийся; имеющийся в наличии/в распоряжении

B

backbone (n)	[bakbəʊn]	основа; суть; сущность
barrage (n)	['bærɑːʒ]	заграждение; плотина, дамба, барраж
Basic Electricity		курс основ электротехники
be nothing but		не что иное, как
benefit (n)	['benɪfɪt]	выгода; польза; преимущество
breakthrough (n)	['breɪkˌθruː]	прорыв, достижение, открытие, крупное достижение
byproducts (n)	['baɪprɒdʌkt]	побочный продукт

C

carpool (v)	['kɑːpuːl]	совместно эксплуатировать автомобиль (для поездок на работу, в магазин, в школу…), по очереди подвозить друг друга на автомобиле

cause (v, n)	[kɔːz]	послужить причиной; заставлять; причина, основание
challenge (n)	['ʧælɪnʤ]	сложная задача, проблема
challenge (n)	['tʃalɪn(d)ʒ]	сложная задача; проблема
circuit (n)	['sɜː.kɪt]	цепь, схема; контур; электрическая цепь
clearly (adv)	['klɪəli]	очевидно, несомненно, конечно, по-видимому
closed loop	['kləʊzd'luːp]	замкнутый цикл; контур; простой цикл
combustion (n)	[kəm'bʌsʧ(ə)n]	сгорание; горение; сжигание
combustion (n)	[kəm'bʌsʧ(ə)n]	горение, возгорание, сжигание
commodity (n)	[kə'mɒdɪti]	товар, продукт, предмет потребления, удобство
common sense	['kɒmən'sens]	здравый смысл
comparable (adj)	['kɔmp(ə)rəbl, kəm'pærəbl]	сравнимый; сопоставимый; соизмеримый
compound (n)	['kɔmpaund]	строение, структура, целостное образование; смесь; соединение
comprehensible (adj)	[kɒmprɪ'hɛnsɪbl]	понятный, постижимый, вразумительный
comprehensive (adj)	[kɒmprɪ'hɛnsɪv]	всесторонний, обширный, тщательный; подробный
comprise (v)	[kəm'praɪz]	включать; заключать в себе, содержать
confuse (v)	[kən'fjuːz]	смущать, смешивать, сбивать с толку, спутывать
conservation (n)	[ˌkɔn(t)sə'veɪʃ(ə)n]	охрана, сохранение; защита
consumption (n)	[kən'sʌm(p)ʃ(ə)n]	потребление; расход
contaminant (adj)	[kən'tamɪnənt]	загрязняющее вещество; загрязнитель, контаминант

contaminate (v)	[kən'tamɪneɪt]	загрязнять, заражать, портить
contemporary (adj)	[kən'temp(ə)r(ə)rɪ]	новый, современный
continuously (adv)	[kən'tɪnjuəslɪ]	постоянно, непрерывно, неизменно
contradictory (adj)	[kɒntrə'dɪkt(ə)rɪ]	противоречивый, противоречащий, несовместимый
contribute (v)	[kən'trɪbjuːt, 'kɔntrɪbjuːt]	вносить; способствовать; содействовать; вносить вклад; сотрудничать
contributor (n)	[kən'trɪbjʊtə]	жертвователь, помощник, содействующий, содействующий
controversy (n)	['kɒntrəvəːsi]	спор, дискуссия, полемика, расхождение во мнениях
conversion (n)	[kən'vɜːʃ(ə)n]	преобразование; конверсия; превращение; переход
convert (v)	['kɔnvɜːt]	преобразовывать; превращать; трансформировать
convert (v)	[kən'vɜːt]	преобразовывать; превращать; конвертировать; трансформировать
cost-effective (adj)	[ˌkɔstɪ'fektɪv]	доходный, прибыльный, рентабельный
costly (adj)	['kɔstlɪ]	дорогой, дорогостоящий
coulomb (n)	['kuːlɒm]	кулон, Кл в системе СИ; единица измерения величины эл.заряда, (названа в честь франц.инженера, физика Чарльза Кулона)
crude (adj)	[kruːd]	необработанный, неочищенный; незрелый, непродуманный
currently (adv)	['kʌr(ə)ntlɪ]	теперь, в настоящее время

cut down (ph.v))	[kʌtdaun]	срубать, вырубать, сокращать

D

dam (v)	[dæm]	перегораживать плотиной; подпирать плотиной; преграждать; сдерживать
decay (v)	[dɪ'keɪ]	разрушать, надрывать
define (v)	[dɪ'faɪn]	определять, устанавливать, обозначать, характеризовать
degradation (n)	[ˌdɛgrə'deɪʃ(ə)n]	деградация, ухудшение; уменьшение, понижение
dependent (adj)	[dɪ'pendənt]	зависящий; зависимый; зависящий от
deplete (adj)	[dɪ'pliːt]	истощать, исчерпывать (запасы, финансовые ресурсы)
determine (v)	[dɪ'təːmɪn]	определять, устанавливать, разрешать, решать, принимать решение
dig out (ph.v)	[dɪgaut]	откапывать, находить, изыскивать
dioxide (n)	[daɪ'ɔksaɪd]	двуокись; диоксид
carbon dioxide sulphur dioxide	['kɑːb(ə)n] ['sʌlfə]	углекислый газ диоксид серы
discard (v)	[dɪs'kɑːd]	отбрасывать, выбрасывать, отказываться
disperse (v)	[dɪ'spɜːs]	рассеиваться; рассеивать; рассредоточивать; рассыпать
displace (v)	[dɪs'pleɪs]	перемещать; двигать, перекладывать, переставлять, заменять, замещать
disposal (n)	[dɪ'spəʊz(ə)l]	распоряжение, право распоряжаться,-управление, расположение, размещение, устройство

drill (v)	[drɪl]	сверлить, бурить, добывать; тренировать, натаскивать (вучёбе, спорте)
drive (v)	[draɪv]	управлять, манипулировать; побуждать, стимулировать; заставлять
due to	[djuː tuː]	из-за, по причине

E

embrace (v)	[ɪm'breɪs]	включать; заключать в себе, охватывать использовать, воспользоваться
emission (n)	[ɪ'mɪʃ(ə)n]	выброс; распространение; эмиссия; выделение
emit (v)	[ɪ'mɪt]	испускать; выделять; выбрасывать
eventually (adv)	[ɪ'venʧuəlɪ, -tju-]	в конечном счёте, в итоге, в конце концов; со временем
excessive (adj)	[ɪk'sɛsɪv]	чрезмерный; излишний; избыточный
exhaust (v)	[ɪg'zɔːst]	исчерпывать, израсходовать, использовать полностью
explore (v)	[ɪk'splɔː]	исследовать, рассматривать, изучать, анализировать
exposure (n)	[ɪk'spəʊʒə]	воздействие, демонстрация, расположение, местоположение

F

face (v)	[feɪs]	встречать смело; смотреть в лицо (чему-л.) без страха, сталкиваться лицом к лицу
fathom (v)	['fað(ə)m]	постигать, понимать, соображать; догадываться
feature (n)	['fiːtʃə]	особенность, характерная черта; признак, свойство

filament (n)	['fɪləmənt]	нить; нить накала, волокно, волосок; крупица, малая толика
finite (adj)	['fʌɪnʌɪt]	конечный, ограниченный, личный, имеющий предел
fission (n)	['fɪʃ(ə)n]	расщепление, распадение
flourish (v)	['flʌrɪʃ]	процветать, расцветать, преуспевать, жить
foresee (v)	[fɔː'siː]	предвидеть, провидеть, знать заранее
foreseeable (adj)	[fɔː'siːəbl]	предсказуемый, предвидимый
fossil fuel	['fɔs(ə)l fjuːəl]	ископаемое топливо
fossil fuel	['fɔs(ə)l 'fjuəl]	ископаемое топливо
foster (v)	['fɒstə]	благоприятствовать, способствовать; поощрять
free (v)	[friː]	освобождать, высвобождать; отсоединять, отвязывать
freezer (n)	['friːzə]	холодильник; холодильная установка, морозильная камера
furthermore (adv)	[ˌfɜːðə'mɔː]	к тому же, кроме того; более того
fusion (n)	['fjuːʒ(ə)n]	слияние, сплав, объединение

G

gasifier (n)	['gæsifaɪə]	газификатор; газогенератор; газообразователь
gasoline (n)	['gæs(ə)liːn]	бензин; газолин
give off (ph.v)	[gɪvɔf]	выделять, испускать
grasp the concept		понятьсуть
greenhouse effect	['griːnhaʊs ɪ'fɛkt]	парниковый эффект
grind (v)	[graɪnd]	шлифовать; перемалывать; растирать; измельчать; дробить

H

habitat (n)	['hæbɪtæt]	родина, место распространения, ареал (животного, растения)
harmful (adj)	['hɑːmfʊl]	вредный, пагубный, губительный, тлетворный, разлагающий
harness (v)	['hɑːnɪs, -nəs]	использовать (в определенных целях); приспосабливать,
harness (v)	['hɑː.nəs]	использовать; обуздывать, покорять, укрощать
harness (v)	['hɑːnɪs]	использовать (природные ресурсы); приспосабливать
hazard (n)	['hæzəd]	опасность; риск; угроза
hence (adv)	[hɛns]	следовательно, отсюда, с этих пор
hub (n)	[hʌb]	ступица (колеса), втулка; центр (событий, внимания)

I

imbalance (n)	[ɪm'bæləns]	отсутствие равновесия; неустойчивость; дисбаланс
impact (n)	['ɪmpækt]	воздействие; влияние; эффект
implication (n)	[ɪmplɪ'keɪʃ(ə)n]	смысл, вовлечение, соучастие
imply (v)	[ɪm'plʌɪ]	означать, подразумевать, предполагать, значить, заключать в себе
impose (v)	[ɪm'pəʊz]	навязать, навязаться, навязывать, налагать, облагать
incandescent (adj)	[ˌɪnkæn'des(ə)nt]	раскалённый, накалённый добела; яркий, светящийся, сияющий
incompatible (adj)	[ɪnkəm'patɪb(ə)l]	несовместимый, несочетающийся
inevitable (adj)	[ɪn'ɛvɪtəb(ə)l]	неизбежный, неминуемый, неизменный

inexhaustible (adj)	[ˌɪnɪg'zɔːstəbl]	неистощимый, нескончаемый, неисчерпаемый
inherent (adj)	[ɪn'her(ə)nt]	обязательно присущий, неотъемлемый
intermediate (adj)	[ˌɪntə'miːdɪət]	промежуточный; средний; вспомогательный; посреднический
internal (adj)	[ɪn'tɜːn(ə)l]	внутренний; душевный, сокровенный
involve (v)	[ɪn'vɒlv]	включать, вовлекать, включать в себя, предполагать, подразумевать

J

jump to it	[dʒʌmp]	энергично приступить к делу; предпринять быстрые действия

L

lack (v)	[læk]	испытывать недостаток, нуждаться, не иметь
last (v)	[lɑːst]	длиться; продолжаться
leakage (n)	['liːkɪʤ]	утечка; течь; протечка
limit (n)	['lɪmɪt]	граница, предел; рубеж, ограничение
liquid (n)	['lɪkwɪd]	жидкость

M

manifestation (n)	[ˌmænɪfes'teɪʃn]	проявление, манифестация, обнародование; обнаружение
match (v)	[mæʧ]	подходить, соответствовать, приводить в соответствие, согласовывать
mean (v)	[miːn]	означать, значить
meaningful (adj)	['miːnɪŋfʊl]	многозначительный, значительный, существенный,

		содержательный
means (n)	[mi:nz]	средство, способ
mitigation (n)	[mɪtɪˈgeɪʃ(ə)n]	смягчение, уменьшение
motion (n)	[ˈməʊʃ(ə)n]	движение, ход, перемещение
mount (v)	[maunt]	устанавливать; поднимать; монтировать; взбираться; восходить
multiple (adj)	['mʌltɪpl]	составной; неоднократный, повторяющийся; разнородный; многочисленный, различный

N

namely (adv)	['neɪmlɪ]	а именно, тоесть
nonrenewable (adj)	['nɔnrɪ'nju:əbl]	невосстановимый, невозобновляемый (о природных ресурсах и т. п.)
nourish (v)	['nʌrɪʃ]	оказывать поддержку, снабжать, поддерживать; кормить, питать
noxious (adj)	[ˈnɒkʃəs]	вредный, пагубный, гибельный; нездоровый; ядовитый

O

occur (v)	[əˈkəː]	происходить, встречаться, иметь место, случаться
opportunity (n)	[ˌɔpə'tju:nətɪ]	удобный случай, стечение обстоятельств, благоприятная возможность
oven (n)	['ʌv(ə)n]	печь; духовка
overcome (v)	[əʊvə'kʌm]	преодолевать, побороть, перебороть, побеждать

P

partially (adv)	['pɑ:ʃ(ə)lɪ]	немного, отчасти, частично, частью

pellet (n)	['pelɪt]	гранула; шарик; таблетка; пулька; катышек; брикет
perceive (v)	[pə'siːv]	воспринимать; ощущать;понимать, осознавать
pervasive (adj)	[pəˈveɪsɪv]	распространяющийся, всеобъемлющий, глубокий, проникающий
phenomenon (n) pl. phenomena	[fɪˈnɒmɪnən]	явление, феномен мн.ч. явления
pin down (ph.v)	[ˈpinˌdaʊn]	точно определить, установить; заставить (выполнить обещание), поймать на слове
pollution (n)	[pə'luːʃ(ə)n]	загрязнение (вредными веществами)
portable (adj)	[ˈpɔːtəb(ə)l]	портативный, переносной; ручной; передвижной
pose (v)	[pəuz]	представлять собой, являться
possess (v)	[pəˈzes]	обладать, владеть, овладевать, захватывать, сохранять, удерживать
predict (v)	[prɪ'dɪkt]	предсказывать; прогнозировать; пророчить
primarily (adv)	[praɪ'mer(ə)lɪ]	главным образом; первоначально
promote (v)	[prəˈməʊt]	способствовать, поощрять, продвигать, стимулировать, поддерживать
propel (v)	[prə'pel]	двигать, побуждать, стимулировать, толкать
push (v)	[pʊʃ]	толкать, помочь пройти испытание, подталкивать

Q

quantitative (adj)	['kwɔntɪtətɪv]	количественный

R

radiant (adj)	['reɪdɪənt]	лучистый; излучающий; радиационный; светящийся, излучающий свет
rapidly (adv)	['rapɪdli]	быстро
rate (n)	[reɪt]	темп; скорость; уровень; показатель; коэффициент
reciprocate (v)	[rɪ'sɪprəkeɪt]	отвечать взаимностью, обмениваться, взаимно делиться; отплачивать (услугойзауслугуит. п.)
recognize (v)	['rekəgnaɪz]	признавать; узнавать; распознавать; осознавать
refer (v)	[rɪ'fɜː]	ссылаться; упоминать; касаться; иметь отношение
refill (v)	['riːfɪl]	доливать; пополнять
regard (v)	[rɪ'gɑːd]	рассматривать; считать, относиться; касаться, иметь отношение
regrowth (n)	[riː'grəʊθ]	вторичный рост, отрастание, возобновление
release (v)	[rɪ'liːs]	освобождать; отпускать; выпускать; выделять
reliance (n)	[rɪ'lʌɪəns]	опора, доверие, уверенность
renewable (adj)	[rɪ'njuːəbl]	восстановимый, возобновляемый (о природных ресурсах и т. п.)
replenish (v)	[rɪ'plenɪʃ]	снова наполнять(ся), пополнять(ся)
replenish (v)	[rɪ'plenɪʃ]	пополнять, снова наполняться; добавлять; обновлять
residential (adj)	[ˌrezɪ'den(t)ʃ(ə)l]	жилой; связанный с местом жительства
residential (adj)	[ˌrezɪ'den(t)ʃ(ə)l]	жилой, связанный с местом жительства

result from (ph.v)	[rɪ'zʌltfrɔm]	вытекать из … (ситуации); исходить из
result in (ph.v)	[rɪ'zʌltɪn]	приводить к
run (v)	[rʌn]	управлять, направлять
run out (ph.v.)		истощиться, кончиться (о запасах), иссякать
run out of (ph.v)		истощиться, кончиться (о запасах), иссякать

S

scale (n)	[skeɪl]	масштаб, градация, шкала, размер, протяжённость; охват
sensible (adj)	['sɛnsɪb(ə)l]	разумный, здравомыслящий, здравый, благоразумный
separate (adj)	['seprət]	отдельный; изолированный; обособленный, особый
shaft (n)	[ʃɑːft]	вал; шахта; ствол; ось
sort of	[sɔːt əv]	отчасти;какбы, вроде
spark (n)	[spɑːk]	искра, вспышка
stationary (adj)	['steɪʃ(ə)n(ə)ri]	стационарный, неподвижный, постоянный, закрепленный, неизменный
stem (v)	[stem]	происходить, возникать, запруживать, перегораживать
store (v)	[stɔː]	хранить, сохранять, запоминать
store (v)	[stɔː]	хранить; сохранять; запасать; накапливать
suitable (adj)	['s(j)uːtəbl]	годный, подходящий, соответствующий
sulfur (n)	['sʌlfə]	сера
sulfur dioxide	['sʌlfədaɪ'ɔksaɪd]	двуокись (диоксид) серы
supply (v)	[sə'plaɪ]	снабжать (чем-л.), поставлять;

		доставлять, восполнять, возмещать
surface (n)	['sɜːfɪs]	поверхность; покрытие; вид, внешность, наружность
sustainable (adj)	[sə'steɪnəbl]	устойчивый; жизнеспособный; устойчивый (не наносящий ущерба окружающей среде)
	T	
tackle (v)	['tak(ə)l]	энергично браться, заниматься, решать; работать (над чем-л.)
take into account		учитывать; приниматьвовнимание
take on (ph.v)		приобретать (форму, качествоит. п.); брать
taste (n)	[teɪst]	вкус, пристрастие, склонность, стиль
thankfully (adv)	['θaŋkfʊli]	благодарно, с благодарностью, с облегчением
tidal (adj)	['taɪd(ə)l]	приливной, приливо-отливный; подверженный действию приливов
transmit (v)	[trænz'mɪt]	передавать; отправлять; пересылать; пропускать
transverse (adj)	[trænz'vɜːs]	пересекающийся, поперечный
tremendous (adj)	[trɪ'mendəs]	огромный; громадный; потрясающий; гигантский
	U	
ultimately (adv)	['ʌltɪmətlɪ]	в конечном счёте, в конце концов
undesirable (adj)	[ˌʌndɪ'zaɪərəbl]	нежелательный,неподходящий, неудобный
undoubtedly (adv)	[ʌn'dautɪdlɪ]	несомненно, явно, бесспорно
upset (v)	[ʌp'set]	срывать; расстраивать (планы); нарушать (порядок)

V

vague (adj)	[veɪg]	смутный; неопределенный; неясный; нечеткий
valuable (adj)	['væljuəbl]	ценный; важный; дорогой; дорогостоящий
vehicle (n)	['viːɪkl]	машина; автомобиль; транспортное средство
versatility (n)	[ˌvɜːsə'tɪlɪti]	разносторонность, многосторонность
via	['vaɪə]	через; путём, посредством, с помощью
viable (adj)	['vaɪəbl]	жизнеспособный
virtually (adv)	['vəːtʃʊəli]	фактически, в действительности; по существу, на деле
visible (adj)	['vɪzəbl]	видимый; видный; заметный; очевидный; зримый; явный

W

waste (v)	[weɪst]	тратить впустую, растрачивать; неэкономно расходовать
waste disposal	[weɪst dɪs'pəuz(ə)l]	уничтожение отходов
well (n)	[wel]	колодец, источник, родник, ключ, водоём
wire (n)	['waɪə]	проволока; провод, электрический провод, телеграмма
witness (v)	['wɪtnəs]	быть свидетелем, очевидцем; видеть; свидетельствовать
witness (v)	['wɪtnəs]	быть свидетелем, очевидцем, служить доказательством
wrongly (adv)	['rɒŋli]	ошибочно, неправильно, по ошибке; по недоразумению

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