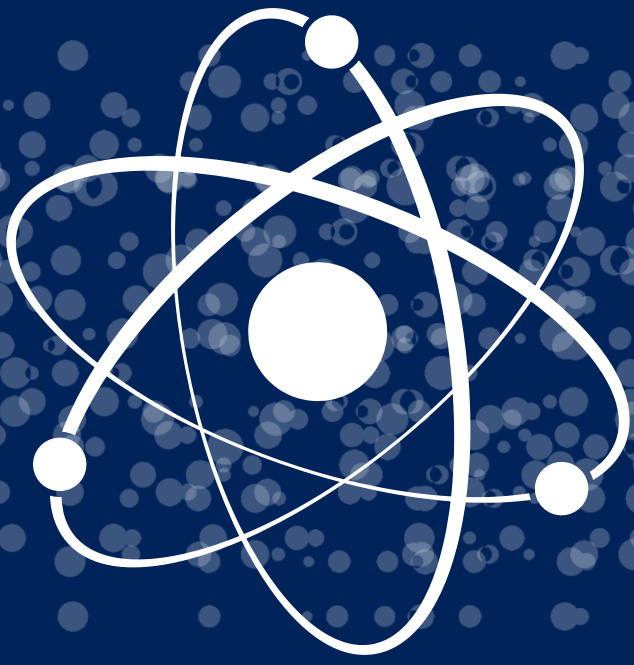
ENERGY ISSUES IN POLAND

A HANDBOOK FOR LEARNERS OF ENGLISH AS A FOREIGN LANGUAGE

ANIELA STASZEWSKA



Politechnika Białostocka

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Bialystok University of Technology

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Contents

Introduction

Today, we are facing many challenges as a university and as a country. Education is unimaginable without the computers, smart phones, and internet connections we have come to rely on to communicate and collaborate with colleagues. There is a global push for the electrification of our lives. Yet, the electricity that is required to run this new digital world is increasing in cost, not only in financial terms but also when looking at the environmental and social costs of turning everything electric.

We are living in a time of rapid human-induced climate change as humans continue to burn and release gases into the atmosphere that have been stored in the ground for millions of years. We also cannot ignore the geopolitics of our region. The war in Ukraine has disrupted traditional supplies of coal, oil and natural gas that has kept electricity production relatively cheap in Poland in the past. As a member of the European Union, Poland must quickly decarbonize its economy.

This handbook is an attempt to systemize knowledge about the current energy situation in Poland from the point of view of sustainable development (S.D.). How can we build a resilient energy system that will allow Poles to be less dependent on our neighbors to meet our energy needs? How can Poland better align with European Union norms?

Sustainable Development can be defined as **development that meets the needs of the present without compromising the ability of future generations to meet their own needs** (United Nations General Assembly, 1987, p. 43)[1]. Education for Sustainable Development (ESD) means including key S.D. issues into teaching and learning; e.g., climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. It also requires participatory teaching and learning methods that motivate and empower learners to change their behavior and take action. ESD consequently promotes competencies like *critical thinking*, *imagining future scenarios* and making decisions in a *collaborative* way.

[1] https://sustainabledevelopment.un.org/content/documents/5839GSDR%202015_SD_concept_definiton_rev.pdf [Retrieved 02.02.2023]

Pedagogical approaches in ESD[2]

There is no 'correct' pedagogy for sustainability education, but it does require a shift towards active, participative, and experiential learning methods that engage the learner.

Five pedagogic methods to bring these elements into the learning environment include:

1. ***Critical reflection*** – including the more traditional lecture, but also newer approaches such as reflexive accounts, learning journals, and discussion groups.
2. ***Systemic thinking and analysis*** – the use of real-world case studies and critical incidents, project-based learning, stimulus activities, and the use of the campus as a learning resource.
3. ***Participatory learning*** – with emphasis on group or peer learning, developing dialogue, experiential learning, action research/learning to act, and developing case studies with local community groups and business
4. ***Thinking creatively for future scenarios*** – by using role play, real-world inquiry, futures visioning, problem-based learning, and providing space for emergence.
5. ***Collaborative learning*** – including contributions from guest speakers, work-based learning, interdisciplinary/multidisciplinary working, and collaborative learning and co-inquiry.

Of the 17 S.D. Goals established by the United Nations, this handbook aims to address:

- S.D. Goal # 4 – Ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all
- S.D. Goal # 7 – Ensuring access to affordable, reliable, sustainable and modern energy for all
- S.D. Goal # 9 – Building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation
- S.D. Goal # 12 – Ensuring sustainable consumption and production patterns

The handbook is divided into four parts:

1. Basics of Energy and Power
2. Current Energy Issues in Poland
3. Electrification
4. Future Opportunities

I hope this handbook helps you become more aware of the challenges and opportunities Poland faces in terms of creating a resilient energy system as we continue our mission as a university of internationalization with a focus on sustainable development, building a future the next generations can thrive in.

Aniela Staszewska

[2] https://www.plymouth.ac.uk/students-and-family/sustainability/sustainability-education/esd [Retrieved 02.02.2023]

Clean Energy Studies at Bialystok University of Technology

1. **Take the quiz**: https://www.thoughtco.com/energy-science-quiz-4083666
2. **Watch the video** from the *European Environmental Agency* and summarize the problems and the solutions connected with shaping the future of energy in Europe, which should be clean, smart and renewable. (https://www.youtube.com/watch?v=nYTgVWkVgtY)
3. **Please read the interview** about a new course of study at the Bialystok University of Technology and place the words in the box in the correct place in the text.

a) radiation, **b)** generators, **c)** turbines, **d)** lungs,
e) geopolitical, **f)** broad, **g)** Civil, **h)** mathematics,
i) international, **j)** panels, **k)** employees, **l)** versatile

"The labor market is looking for graduates of Clean Energy Studies. We educate them at the Bialystok University of Technology"

17.01.2023

Dr. Zbigniew Skibko and Przemysław Szotko were interviewed by Jędrzej Pogorzelski on Radio Akadera, text prepared by Magdalena Grzęda-Zajkowska, translated from Polish by A. Staszewska.

The current (1) _____ situation has proven to us that it is worth investing in alternative energy sources, although the demand on the labor market for specialists in renewable energy has been noticeable for a long time. Our region abounds in companies that will welcome graduates of renewable energy on board with open arms. Studies in this field are conducted at the Faculty of Electrical Engineering, the Faculty of Mechanical Engineering and the Faculty of (2)_____and Environmental Sciences. We talk about these fields of studies with Dr. Zbigniew Skibko from the Faculty of Electrical Engineering at Białystok University of Technology and a fourth-year student of Clean Energy Studies – Przemysław Szotko.

What does Clean Energy Studies deal with?

ZS: As the name suggests, it's a very (3)_____ concept… The current situation on the national and (4)_____ arena shows that the spectrum of an energy crisis is very real. Companies are increasingly protecting themselves by buying power (5) _____. And all this for fear of a lack of electricity. And it is here that energy will play a key role, providing us with security in everyday life, both for ordinary citizens and large companies that need a lot of electricity. The whole world is currently betting on renewable energy sources. And that's where this idea came from.

Clean Energy Studies aims to educate students to work as new employees for companies dealing with the design, construction and operation of installations using clean energy sources. We are not just talking about wind (6) _____. Photovoltaic energy is currently developing very dynamically. In our homes there are solar (7) _____ that produce hot water. We are increasingly using heat pumps. In Poland, they may not be so widespread, but in the West, heat pumps are highly subsidized and will soon become the basic source of heat supply…

What does the energy market look like in Podlasie? How resilient is it and is it easy to find employment?

ZS: Podlasie is known as the green (8) _____ of Poland... maybe we do not have factories that produce devices such as photovoltaic panels or wind farms, but we have a very dynamically developing design department. A lot of photovoltaic farms, as well as wind farms, have been built in our region. If any power plant was built, obviously someone had to design it, build it and will have to service it later. Therefore, there is no problem finding a job in this area. This is confirmed by our graduates who can choose from many job offers. Local companies are looking for (9)_____ at every stage of the production process, from designing, building and servicing installations…

What renewable energy sources are mainly used in our province?

ZS: This question should be answered by sticking to the time frame. If we go back a few years, wind power was quite popular. Looking at the power dimension, wind energy is still at the forefront, but photovoltaic energy, i.e. sources that use solar (10) _____, is developing more and more dynamically. I think that in a year or two, we will be able to confidently say that there is much more energy from photovoltaics in our area than energy from wind.

What do practical classes in the field of Clean Energy look like?

ZS: Laboratories are very (11) _____ where you can measure basic electrical quantities through the execution of basic electrical installations, and ending with advanced systems of renewable energy sources. Students have classes on the study of wind turbines and photovoltaic installations. They receive a comprehensive education in practical terms in order to be able to take up professional work in the future.

Question to Przemek… – Is studying about Clean Energy a good idea?

PS: Of course, I recommend this course of study. I think that this is a really forward-looking direction that provides a good job and attractive earnings. If someone likes physics or (12)_____, because it is also needed, I invite you to the Bialystok University of Technology.

SOURCE: https://pb.edu.pl/studiujnapb/2023/01/17/rynek-pracy-szuka-absolwentow-kierunku-ekoenergetyka-ksztalcimy-ich-w-politechnice-bialostockiej/ [Retrieved 18.01.2023]

4. **Discussion**:

1. Would you like to work in the field of energy production and design? If so, which part of the process interests you? Design, production, installation, maintenance, or another area in this field?
2. What kind of energy specialists do we need to train in Poland to face future needs?

I. Basic Concepts of Energy and Power

Unit 1. Energy, Power, Work

1. **Introduction**[3]:

- What is energy?
- How do we measure it?

Energy is the lifeblood of any modern society. Energy is used in every walk of life. Without it, modern life would almost come to a standstill. From the moment of waking up in the morning with an alarm clock, we use energy for almost everything we do. Energy is a property of matter that can be converted to work, heat, or radiation. It can move things or do work, produce heat even if it does not move anything, and be converted to light (or more accurately, radiation).

2. **Match the words on the right to their definitions:**

1. Power	a) the amount done
2. Energy	b) rate at which we do work
3. Work	c) the capacity to do work

3. **Discussion Questions:**

1. What is the difference between potential and kinetic energy?
2. What is the difference between nuclear fusion and nuclear fission?
3. What are some examples of radiation?

Explore the following websites to find out and write up your answers:
https://www.e-education.psu.edu/egee102/node/1903
https://www.e-education.psu.edu/egee102/node/1904

[3] https://www.e-education.psu.edu/egee102/node/2154 [Retrieved 23.02.2023]

Unit 2. Various Forms of Energy

1. In your own words, please describe the different forms of energy and give some examples:

a) mechanical energy,
b) chemical energy,
c) thermal (heat) energy,
d) electromagnetic energy,
e) nuclear energy.

2. **Vocabulary** – Write the form of energy being described in the examples below:

1. A cup of hot coffee has _____ energy. You generate heat and have thermal energy with respect to your environment.
2. An atomic detonation or power from a nuclear plant are specific examples of _____ energy.
3. A form of potential energy that you won't observe until a reaction occurs. It can be changed into other forms of energy through chemical reactions or chemical changes, e.g. coal: combustion reaction converts _____ energy into light and heat.
4. An object possessing _____ energy has both kinetic and potential energy, although the energy of one of the forms may be equal to zero. A moving car has kinetic energy. If you move the car up a mountain, it has kinetic and potential energy. A book sitting on a table has potential energy.
5. _____ energy or radiation is light. It's any self-propagating energy that has an electric and magnetic field. You can draw examples of it from any part of the spectrum.

Check your answers by going to the website:
https://www.thoughtco.com/main-energy-forms-and-examples-609254

Click on the links to check your understanding of the different forms of energy:
https://www.e-education.psu.edu/egee102/node/1905
https://www.e-education.psu.edu/egee102/node/1907

3. **Reading:**

Use the words from the box above to fill in the blanks in the text below about mechanical energy.

a) wind energy, **b)** work, **c)** energy of an object, **d)** gravitational potential energy, **e)** energy of motion, **f)** kinetic energy, **g)** frictional force, **h)** hydropower

What Is Mechanical Energy and How Does It Work?

Mechanical energy is a matter of physical science. It's the energy of motion, or the (1)_____ that moves. All life forms and many systems use mechanical energy to function, and the energy of motion can be seen in everyday life, for example:

- A child holds a ball up in the air as they scan the field to throw it. They are applying force (holding the ball up) but have not yet exercised any amount of (2)_____ (force causes displacement of an object).
- A child kicks a ball (external force) – the force acts upon it, propelling it forward.
- A ball flies through the air ((3)_____), descends (gravitational force), bounces off the ground to go up again to a point ((4)_____ _____), then comes back down and rolls to a stop.
- A plane speeding down the runway represents the energy of motion.
- A speeding airplane slamming into a helicopter transfers (5) _____ to the other aircraft.
- A private jet slows to stop when the pilot applies brakes ((6) _____).

Mechanical energy (kinetic energy or potential energy) is the energy of either an object in motion or the energy that is stored in objects by their position.

Mechanical energy is also a driver of renewable energy. Many forms of renewable energy rely on mechanical energy to adequately produce power or convert energy.

Two examples of renewable energy that depend on mechanical energy are (7) _____ and (8) _____.

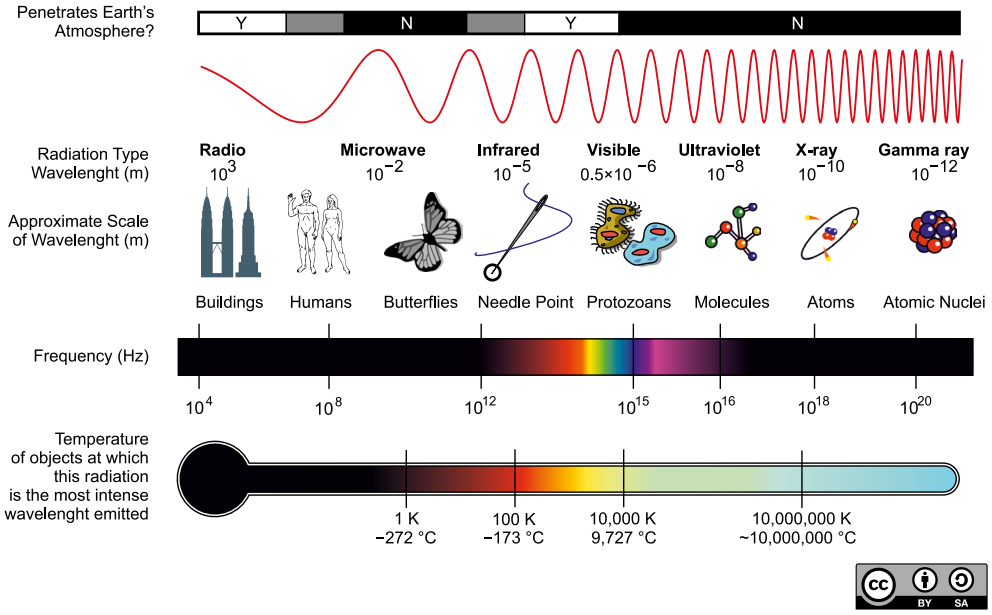
SOURCE: https://justenergy.com/blog/mechanical-energy-beginners-guide/ [Retrieved 15.01.2023]

Do the quiz at the link below about different forms of energy:

https://www.liveworksheets.com/worksheets/en/Natural_Science/Energy/Forms_of_energy_xn429867bl

Unit 3. The Electromagnetic Spectrum

1. **Describe the image below to your partner. Write 3 sentences about the image.**



SOURCE: https://commons.wikimedia.org/wiki/File:EM_Spectrum_Properties_edit.svg#/media/File:EM_Spectrum_Properties_edit.svg. This work is licensed under a Creative Commons Attribution-ShareAlike 3.0 Unported License. No changes were made [Retrieved 06.05.2023]

2. **What do you know about:**

1. radio waves,
2. microwaves,
3. infrared waves,
4. visible light,
5. ultraviolet,
6. x-rays,
7. gamma waves.

3. Take a look at the videos prepared by NASA: (105) Tour of the Electromagnetic Spectrum – YouTube. Watch the introduction video.

4. **Groupwork:** Break the class into groups of seven people. Each member of the group can research one of the seven waves of the electromagnetic spectrum, write a short summary and tell the other group members about it.

5. **Take this quiz to assess your understanding of the Electromagnetic Spectrum:**

The Electromagnetic Spectrum Quiz Questions! Trivia – ProProfs Quiz
Send the certificate you receive at the end of the quiz to your teacher.

Unit 4. Measuring Energy

1. **Answer** the following questions**:**

a) Does a **thermometer** measure **kinetic** energy or **potential** energy?[4]

b) How can you measure **energy** consumption? What about **power** consumption?[5]

2. **Read** about the different units of measurement:

Units of Measurement

How is energy measured? It is measured in various units by various industries or countries, in much the same way as the value of goods is expressed in dollars in the USA and yen in Japan or pounds in the UK.

The table below identifies different units for measuring energy. A lot of it also has some historical context. Our early studies of energy involved heating things up, so we name units based on how hard it was to heat things. Makes sense, right? Now we pass electrical energy to operate many devices, so now we use units that "better" capture this process.

Different Units for Measuring Energy

Unit	Definition	Used in	Equivalent to
British Thermal Unit (BTU)	A unit of energy equal to the amount of energy needed to raise the temperature of one pound of water by one degree Fahrenheit. Equivalent to energy found in the tip of a match stick.	Heating and Cooling industries	1 BTU = 1055 Joules (J)
Calorie or small calorie (cal)	The amount of energy needed to raise the temperature of one gram of water by one degree Celsius.	Science and Engineering	1 calorie = 0.003969 BTUs
Food Calorie, Kilocalorie or large calorie (Cal, kcal, Calorie)	The amount of energy needed to raise the temperature of one kilogram of water one degree Celsius. The food calorie is often used when measuring the energy content of food.	Nutrition	1 Cal = 1000 cal, 4,187 J or 3.969 BTUs
Joule (J)	It is a smaller quantity of energy than calorie and much smaller than a BTU.	Science and Engineering	1 Joule = 0.2388 calories and 0.0009481 BTUs
Kilowatt Hour (kWh)	An amount of energy from the steady production or consumption of one kilowatt of power for a period of one hour.	Electrical fields	1 kWh = 3,413 BTUs or 3,600,000 J
Therm	A unit describing the energy contained in natural gas.	Home heating appliances	1 therm = 100,000 BTUs

[4] https://www.dummies.com/article/academics-the-arts/science/chemistry/how-is-energy-measured-194416/

[5] Kilowatt hours (kWh) – e.g. utility bills; in Watts

3. **Answer** the following questions**:**

1. Which particles are moving fastest?
   a) Particles in boiling water.
   b) Particles in water from the sink.
   c) Particles in steam.
   d) Particles in ice.
2. _____ is a type of heat transfer that occurs only in fluids, such as water and air.
   a) Conduction
   b) Radiation
   c) Convection
   d) Heat
3. _____ is the transfer of energy by electromagnetic waves.
   a) Convection
   b) Radiation
   c) Conduction
   d) Heat
4. _____ transfers heat from one particle of matter to another within an object or between two objects.
   a) Heat
   b) Radiation
   c) Conduction
   d) Convection
5. _____ current creates a circular motion, and also causes wind and weather changes.
   a) Radiation
   b) Heat
   c) Convection
   d) Conduction
6. A material that conducts heat well is called a _____.
   a) insulator
   b) convection
   c) radiation
   d) conductor

4. **Take the quiz to check your answers:**

https://quizizz.com/admin/quiz/5df0729d0d4fcc001c55195f/heat-thermal-energy-and-temperature

Unit 5. Energy Resources – Production and Consumption

1. **Introduction:**

Every person, animal and device transfers energy. Much of that energy is supplied by electricity, which must be generated from other energy stores. Some of these are renewable but most are non-renewable. There are different energy resources in the world and the amount of energy stored by them varies greatly. For example, the nuclear energy within 1 kg of uranium contains a very large amount of energy, but the gravitational potential energy stored by many thousands of tons of water held back by a dam contains less.

2. **Explore –** Go to the website to review various types of energy resources and do the exercises: https://www.bbc.co.uk/bitesize/guides/z8k9v9q/revision/1

3. **Group work:**

Break up into groups. Pick one category of energy resources. List the advantages and disadvantages of one of the following energy resources:

- fossil fuels (chemical energy store) – oil, gas, shale gas,
- nuclear fuels,
- energy from plants (biofuel – chemical energy store),
- energy from the wind,
- geothermal,
- energy from falling water:
  - tidal (kinetic energy),
  - hydroelectric (gravitational potential),
- energy from the Sun (nuclear):
  - solar panels,
  - photovoltaic panel.

Energy can be transferred usefully, stored or dissipated, but it cannot be created or destroyed. No system is perfect. Whenever there is a change in a system, energy is transferred and some of that energy is dissipated. Devices waste energy for various reasons including **friction** between their moving parts, electrical resistance, and unwanted **sound energy**.

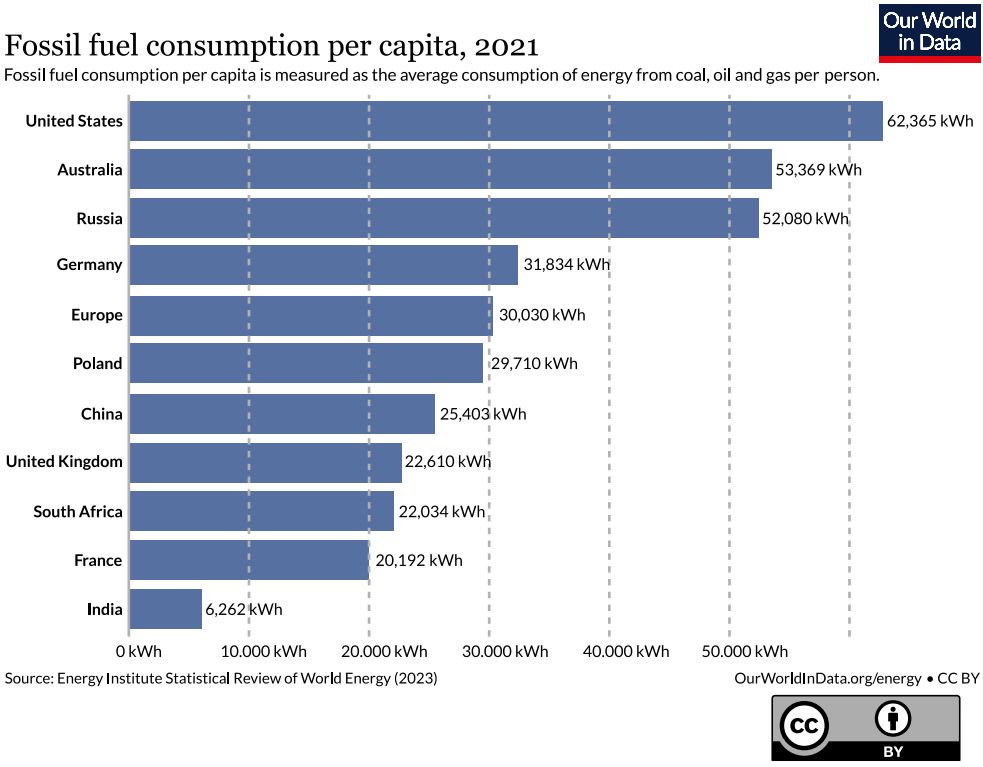
Preventing unwanted energy transfers can be avoided through:

- lubrication,
- thermal insulation.

Take the quiz: (https://www.bbc.co.uk/bitesize/guides/z8k9v9q/test)

4. **Discussion Questions:**

1. What types of energy do you use every day?
2. What changes in the way Poland produces, distributes, and consumes energy are you personally interested in?
3. What challenges is Poland facing in terms of the transformation of its energy systems?
4. Take a look at the graph on the next page about fossil fuel consumption per capita in 2021. Where does Poland fit in compared to other countries in Europe and the world? Does this surprise you?
5. What would you like to change about the energy policy in your country?



SOURCE: https://ourworldindata.org/fossil-fuels. No changes were made [Retrieved 05.05.2023]

6. **Writing:**

Go to the website https://ourworldindata.org/fossil-fuels

Select a category you are interested in. Create a chart comparing 2-3 countries. Describe the chart in your own words. Send a copy of the graph and your description to your teacher.

II. Current Energy Issues in Poland

Unit 6. Volcanoes or Humans?

1. **Introduction:**

a) Which events emit more carbon dioxide into the atmosphere, volcano eruptions or human activity?
b) Why is the issue of carbon dioxide emissions in the news recently? What do you think about all this hype?
c) Can Poland keep producing and consuming energy resources in the same way it has for the last several decades? What needs to change?

2. **Read the article below. Answer the comprehension questions.**

Which emits more carbon dioxide: volcanoes or human activities?

Human activities **emit** 60 or more times the amount of carbon dioxide released by volcanoes each year. Large, violent eruptions may match the rate of human **emissions** for the few hours that they last, but they are too rare and fleeting to rival humanity's annual emissions.

Human activities

Human activities – mostly burning of coal and other fossil fuels, but also cement production, **deforestation** and other landscape changes – emitted roughly 40 billion metric tons of carbon dioxide in 2015. Since the start of the Industrial Revolution, more than 2,000 billion metric tons of carbon dioxide have been added to the **atmosphere** by human activities.

Volcanoes

Volcanoes emit carbon dioxide in two ways: during eruptions and through **underground** magma. Carbon dioxide from underground magma is released through vents, porous rocks and soils, and water that feeds volcanic lakes and hot springs. Estimates

of global carbon dioxide emissions from volcanoes have to take both erupted and non-erupted sources into account.

Today versus the past

Volcanic activity today may pale in comparison to the carbon dioxide emissions we are generating by burning fossil fuels for energy, but over the course of geologic time, volcanoes have occasionally contributed to global warming by producing significant amounts of carbon dioxide and other greenhouse gases.

For example, some geologists hypothesize that 250 million years ago, an **extensive flood** of lava **poured continually** from the ground in Siberia perhaps hundreds of thousands of years. This large-scale, long-lasting eruption likely raised global temperatures enough to cause one of the worst **extinction** events in our planet's history. Current volcanic activity doesn't occur on the same massive scale.

Read the whole article here: https://www.climate.gov/news-features/climate-qa/which-emits-more-carbon-dioxide-volcanoes-or-human-activities
[Retrieved 06.05.2023]

Comprehension Questions:

1. On a yearly basis, how much more carbon dioxide is emitted into the atmosphere through human activity than by volcano eruptions?
2. What human activities emit the most carbon dioxide into the atmosphere?
3. In the past, did volcanic eruptions contribute to global warming?

3. **Translate these words into Polish:**

English	Polish	English	Polish
1. emission		2. to emit	
3. deforestation		4. underground	
5. atmosphere		6. extensive flood	
7. to pour 8. continuously		9. extinction	

4. **Writing**

1. What does the term 'decarbonization' mean to you?

2. How can we 'decarbonize' our economy[6]:

– in power generation?

_____
_____
_____

– in industry?

_____
_____
_____

– in transport?

_____
_____
_____

– in buildings?

_____
_____
_____

– in agriculture?

_____
_____
_____

5. **Listening**

Listen to the suggestions given in the film about how Poland can achieve carbon neutrality. What do you think of these solutions? Fill in the exercise above from the suggestions you hear.

https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/carbon-neutral-poland-2050-turning-a-challenge-into-an-opportunity

[6] https://news.climate.columbia.edu/2022/04/22/what-is-decarbonization-and-how-do-we-make-it-happen/ [Retrieved 05.05.2023]

Unit 7. Air Quality

1. **Introduction:**

a) What can you say about air quality in Poland? In your region?
b) Has air quality gotten better or worse over the past couple of years? What is causing the change?
c) Which region of Poland has notoriously poor air quality? What changes are being implemented to improve the situation?

2. **Read** about the air quality in Poland. Should we do something to change the situation?

Air Quality in Poland

Poland has some the most polluted air in all of the European Union. These pollutants are mainly emitted from household and transport sectors. The pollutants emitted close to the ground level are relatively poorly transported in the atmosphere, which means that they have a significant impact on local air quality and human health. In Poland, most houses are heated with coal in low-efficiency stoves and boilers. The **World Health Organization's (WHO)** statistics show that the mortality rate due to poor air quality in Poland was 36.3 (36.3 deaths per 100,000 inhabitants) in 2018.

During the **United Nations** Conference on Climate Change, which took place in Paris in 2015, it was decided to take measures to prevent the global temperature rising by 2 °C compared to pre-industrial levels. Therefore, greenhouse gas emissions, including carbon dioxide, should be significantly reduced. **The European Green Deal** has provided a roadmap revealing intended actions to achieve its climate neutrality by 2050.

SOURCE: Zyśk, J.; Wyrwa, A.; Suwała, W.; Pluta, M.; Olkuski, T.; Raczyński, M. *The Impact of Decarbonization Scenarios on Air Quality and Human Health in Poland—Analysis of Scenarios up to 2050*. Atmosphere 2020, *11*, 1222. https://doi.org/10.3390/atmos11111222 [Retrieved 23.03.2023]

3. **Comprehension Questions:**

a) According to the article, where does most of the air pollution found in Poland come from?
b) How does air pollution affect human health?
c) What was decided during the United Nations meeting in Paris in 2015?

4. **Discussion Questions:**

a) What do you know about the World Health Organization (WHO)?
b) What do you know about The United Nations?
c) What do you know about the European Green Deal?

5. **Vocabulary:**

Match the words with their definitions (a-g).

1. Air quality		a) a poisonous gas with a strong smell that is used in industry and causes air pollution
2. Smog		b) Fuel, such as coal or oil, that was formed over millions of years from the remains of animals or plants and is combusted in engines and furnaces
3. Exhaust fumes		c) smoke, gas, or something similar that smells strongly or is dangerous to breathe in
4. Greenhouse gases		d) The cleanliness of the air that we breathe
5. Burning Fossil Fuels		e) a layer of ozone high above the Earth's surface that helps to protect the Earth from harmful radiation from the Sun
6. Earth's ozone layer		f) any of the gases that are thought to cause the greenhouse effect, especially carbon dioxide
7. Sulphur dioxide		g) a form of air pollution that is or looks like a mixture of smoke and fog, especially in cities

SOURCE: https://ieltsmatt.com/ielts-environment-air-pollution-vocabulary/ [Retrieved 06.05.2023]

Unit 8. Conflict among Poland's Neighbours over Decarbonisation

1. **Introduction** – Answer the following questions:

a) What happened in Ukraine in February 2022?
b) What is the role of Russia in supplying Europe with coal, gas and oil?
c) Why is Ukraine important for Russia?

2. **Vocabulary** – Match the words with their definitions:

a) collapse, **b)** to stagnate, **c)** budget deficit, **d)** abundant, **e)** vital, **f)** wealth, **g)** decarbonization, **h)** electrification, **i)** economic deceleration, **j)** to plummet

1.	a large amount of something good
2.	more than enough
3.	to stay the same and not grow or develop
4.	to fall very quickly and suddenly (two words)
5. 6.	the process of stopping or reducing carbon gases, especially carbon dioxide, which are released into the atmosphere
7.	decrease in the growth rate of an economy
8.	the process of making a machine or system operate using electricity when it did not before
9.	the difference between a government's income and how much it spends
10.	necessary for the success or continued existence of something; extremely important

3. **Reading**

Read an excerpt of an article about the situation in Ukraine concerning its energy resources:

The Role of Decarbonisation In Shaping the Russian Invasion of Ukraine

By Man Lok Kwok, 16.12.2022

While the actual motivation behind Russian invasion of Ukraine is still being debated, the global responses to climate change and the natural resources in Ukraine might act as the underlying factors that reinforce the decision-making of the Russian officials. The ongoing trend of **decarbonisation** and **electrification** of the energy

and transportation sector will decrease the importance of fossil fuels in Europe and the world, weakening Russian economic and political power globally in the long term…

Contributed by the economic **deceleration** in China and the US, and the oversupply of oil in the market, oil prices **plummeted** by 44% between June and December 2014, and the oil price dropped by 70% between 2014 to 2016. The collapsed oil price was regarded as the biggest **collapse** in modern history, at least before the pandemic.

The European Union has long been **a net energy importer** and Russia's largest trading partner. Imports from Russia contributed to 24.4% of Europe's total energy consumption in 2020. In 2021, the EU, the UK, and Norway imported about 49% of their oil and natural gas, equivalent to 33% of Russia's total oil and gas exports.

Since the **ratification of the Paris Agreement** in 2016, Europe has sped up the process of decarbonising its energy sector and established the timeframe for phase-out fossil fuels. Prior to the Russian invasion, the EU aimed to significantly increase the share of renewable energy to 40% by 2030, but later revised it to 45% in 2022.

Major European economies are rushing to increase their renewable portfolio; Germany aims to achieve 80% of renewable energy in the energy mix by 2030, and the UK targets to decarbonise the electricity system by 2035. Additionally, other decarbonising measures in Europe, like the **electrification of the transportation system and heating system**, the development of **hydrogen-based fuel** and technology, and other energy efficiency targets, are going to further decrease the demand for fossil fuels…

…given that Russia has long been utilising its energy sector to maintain its influence over **Europe, the Middle East, and North Africa region (MENA region),** the annexation of Ukraine could allow Russia to assert a certain influence in Europe in a post-fossil-fuel economy by controlling the abundant mineral and agricultural resources in Ukraine.

Ukraine is rich in mineral resources, including strategically important minerals for a green transition, such as nickel, graphite, manganese, and lithium. These mineral resources will be vital for Europe's decarbonisation process. For instance, the EU is set to satisfy 69% and 89% of its growing battery demand by 2025 and 2030, respectively. The Russian invasion of Ukraine could allow Russia to obtain Ukraine's mineral wealth and increase Russia's economic importance in a green economy.…

SOURCE: https://earth.org/decarbonisation-russian-invasion/ [Retrieved 05.01.2023]

4. **Comprehension Questions:**

1. How much of Russia's energy exports were imported by the EU, UK and Norway before the 2022 conflict?
2. What was the aim of the Paris Agreement of 2016?
3. Which important minerals can be found in Ukraine?

5. **Grammar Reference – Conjunctions**

Because of conjunctions, we are able to connect several words or concepts together – allowing us to build complex sentences that can convey interesting and compelling messages.

Click on the link to learn more about conjunctions:
https://www.hurrayedutech.com/post/
the-importance-of-conjunctions-in-sentences

Click on the links to practice conjunctions:
https://www.internationalschooltutors.de/English/activities/grammar/match2/
conjunct.html; https://www.usingenglish.com/quizzes/96.html#quiz

6. **Discussion:**

1. Can you think of any other conflicts over resources (e.g. water, minerals, sand) around the world?
2. What resources do we need to make our lives possible at the standard it is now?
3. Can space exploration help in retrieving these limited resources for the consumption of more people? What other creative ways of extracting resources can you think of?

7. **Word Formation** – Complete the chart with the right verbs and noun forms of the words:

Verb	Noun
	deceleration
to stagnate	
	invasion
	contribution
to motivate	

Unit 9. Insulation of Houses and Energy Poverty

Prepared by: Michał Barszczewski, Artur Dracewicz, Ida Fiodorow, Jakub Pikuła, 2022.

1. **Introduction questions:**

1. Are houses in Poland well insulated?
2. How do people heat their homes in the city? How about in the countryside?
3. What is energy poverty?

2. **Watch the following video and do the exercises:**

https://www.youtube.com/watch?v=ZXPvaroR2AI&t=8s

1.	Electricity is a cheap resource in Poland.	T	F
2.	There are many people in Europe that are unable to keep their homes warm.	T	F
3.	Four types of insulation are mentioned.	T	F
4.	Producing mineral wool insulation is ecological.	T	F
5.	Bio-source insulation is expensive.	T	F
6.	There is no difference what type of insulation you will choose for your house.	T	F
7.	Energy poverty results from a combination of low income, a high share of disposable income spent on energy and from poor energy efficiency, esp. in buildings.	T	F
8.	Current geopolitical situation had no impact on energy costs.	T	F
9.	Off-grid comes from renewable sources, which makes it the perfect alternative to obtain a reliable and sustainable energy service.	T	F
10.	Currently there are none off-grid renewable power projects.	T	F

3. **Discussion:**

1. What can we do to make our situation better in terms of energy poverty?
2. Do you think the energy situation will improve? Why/Why not?
3. Do you think off-grid renewables is the future for energy market? Why/Why not?

4. **Match the vocabulary phrases to their definitions:**

1. Energy poverty		a) situation when demand for a specific resource is greater than the supply of that resource, as resources are limited
2. Resource scarcity		b) the process of renovating a building in order to minimize losses related to heat and energy loss
3. Thermal insulation		c) lack of affordability or of access to basic energy services to meet one's most common needs, such as lighting, cooking, heating and cooling
4. Energy transition		d) energy from a source that is not depleted when used, such as wind or solar power
5. Central heating		e) inflammation or other discomfort in a body part caused by reaction to substance
6. Thermo-modernization		f) ongoing process of replacing fossil fuels with low carbon energy sources
7. Energy market		g) procedures related to the cost of electricity, fuel oil, gasoline, heating oil, natural gas, or other source of energy
8. Renewable Energy		h) Reduction of heat transfer between objects in thermal contact or in range of radiative influence. It can be achieved with specially engineered methods or processes, as well as with suitable object shapes and materials.
9. Energy cost procedures		i) system that provides warmth to a number of spaces within a building from one main source of heat
10. Irritation		j) national and international regulated market that deal specifically with the trade and supply of energy

Unit 10. Transport

1. **Introduction Questions:**
    1. In pairs, tell each other how you got here today.
    2. What do you think of the public transport system in your city?
    3. How can the public transport system be improved?
    4. Do we have the technology to achieve zero emission transport?

2. **Please read the following text. What other changes do we need to think about?**

Where do we want to go in terms of building a sustainable public transport system?

- fast/reliable public transport (city/region),
- sustainable power sources (global/city/region),
- zero emission transport (global/city/region).

What's the current situation? What's working, what's not?

What's working:
Locally:

In Białystok there are a lot of bicycles and electric scooters for people to use, there's also good public transportation such as trains and buses – although they are not working at night, something that should change in the future.

Nationally:

In Poland, public transportation is on a good level. We have trains, trams, buses and in some cities we also have metro stations. People use a lot of bikers and electric scooters. To make it even better we can expand railways and upgrade some of them because they can get old and rusty. We can also expand buses to places where there is no good public transportation, such as to small villages and small cities.

Regionally:

There is good connection by rail to some countries in Europe – for example if you're from the UK there's no need to fly within Europe. It's surprisingly easy, quick and comfortable to travel by train from London to almost anywhere: Spain, Italy, Switzerland, Greece, Prague, Helsinki etc. Via Baltica, which connects Estonia, Latvia, Lithuania and Poland by road, is very helpful for drivers in the region. Via Carpatia, which connects Lithuania, Poland, Slovakia, Hungary, Romania, Bulgaria and Greece by road will also let travelers get from the north of Europe to the south much faster.

Internationally:

Japan has an efficient public transportation network, especially within metropolitan areas and between the large cities. Japanese public transportation is characterized by its punctuality, its superb service, and the large crowds of people using it. Japan's transport sector stands out for its energy efficiency: it uses less energy per person compared to other countries, thanks to a high share of rail transport and low overall travel distances.

The Shinkansen, or "bullet trains", as they are often known, are the high-speed rail trains that run across Japan. The 2,387 km (1,485 mi) of 8 Shinkansen lines run on completely separate lines from their commuting train counterparts, with a few exceptions. Shinkansen takes up a large portion of the long-distance travel in Japan, with the whole system carrying over 10 billion passengers in its lifetime. Shinkansen trains are also known to be very punctual, following suit with all other Japanese transport; in 2003, the average delay per train on the Tokaido Shinkansen was a mere 6 seconds. Japan has been trying to sell its Shinkansen technology overseas, and has struck deals to help build systems in India, Thailand, and the United States.

What's not working?

Locally:

- Lack of public transportation at night, except for taxis with high prices.
- Intercity transport in Podlasie has probably the oldest fleet in Poland and is severely underfunded

Nationally:

Tram tracks aren't in the greatest condition in many major Polish cities. That creates a major chance for communication problems and can be very unsafe to use.

Regionally:

Regional connections are lacking in some places. Trains can be delayed by a few hours and that happens quite often. Buses can also be a bit off, but the main reason for that are traffic jams caused by the increasing number of cars and poor infrastructure.

Internationally:

In India, road transit is the most common means of transport. Despite this, problems of road transport in India are increasing drastically day by day, due to inadequate road infrastructure, multiple checkpoints, and congestion. Whether transporting big cargo or fragile items, a well-maintained road infrastructure is essential to ensure that commodities arrive safely at their final destination. According to traffic reports generated by the world's top countries, India is also the most populated country and has a plethora of traffic problems and solutions. Due to the growing population of cities, freight vehicles and travelers alike must spend a significant amount of time stuck in traffic.

Some of the biggest issues surrounding transportation systems include:

- traffic management measures,
- long commutes,
- parking issues,
- large fleet costs,
- sprawling cities.

Many neighborhoods are not connected to train stations, requiring some other form of transportation (mainly a car) to gain access. This defeats the purpose of reducing congestions, as a majority of residents would rather continue their commute by car than to find a parking spot for their car, buy tickets to a train, and walk to the platform. To boost the use of new and existing train stations, shuttle services and buses should connect neighborhoods to the stations. These stations can also accommodate amenities, such as food carts, shops, and internet services, increasing use and attractiveness.

What actions can be taken to get to where we want to go?

- Globally we should walk away from fossil fuels to generate electricity from nuclear power.
- On the city scale, there should be more bus connections, because it's a little tricky to get around far from the city center. There should also be more train connections because even if you can get to a lot of places by train in our region, there still are a few important places that you can't get to by train.
- To further reduce emissions of vehicles we need better methods of productions of batteries (maybe new kinds of batteries, not lithium) and better methods of getting hydrogen (by renewable sources of energy).
- We shouldn't give up on cars with combustion engines because classic engines still can be upgraded in terms of efficiency and emissions.

Extend existing bike lanes:

- Identify streets that would benefit from extending existing bike lanes. Neighborhoods within a city can benefit from having added bike infrastructure that connects them to roads leading to commercial centers. Also, consider designing protected bike lanes by adding a physical buffer between car lanes and bike lanes.

Provide Bike Racks at Park Entrances:

- This makes parks and open spaces more accessible to cyclists when connecting bike networks from neighborhoods. It also increases city equity by allowing far away neighborhoods to enjoy open spaces.

PREPARED BY: Karolina Szczerbińska, Kornel Grabowski, Patrycja Raś, Karol Dziubek, 2022.

3. **Comprehension Questions:**

1. What are some issues with public transport on a local level?
2. What are some issues with public transport on a national level?
3. What do the authors suggest would make public transport more accessible?

4. **Grammar Reference** – Cause and effect relationships

It often happens that something causes something else to happen. For example, if public transportation is more convenient than using private transport, more people will begin to use it. Review cause and effect relationships by clicking the link below:

https://www.bbc.co.uk/learningenglish/english/course/intermediate/unit-10/session-2

5. **Use of English** – Complete the text with ONE word that fits into each gap:

Without (1) _____ doubt, traffic is one of the main causes (2) _____ pollution. The increased use of public transport would be a good solution to the problem (3) _____ many people could be transported in few vehicles. In order to achieve this the government must (4) _____ appropriate action to get people to use buses, trains and the underground.

One of the most important measures is to make public transport affordable. Some cities have already experimented (5) _____ free access to public transport for all citizens. If it (6) _____ free most people would choose to leave their cars at (7) _____, since petrol and the maintenance of a car costs a lot of money. Authorities could finance free transport (8) _____ raising taxes or charging a small fee.

Cities must provide public transport (9) _____ is comfortable and convenient. Commuters must rely on precise schedules to get to work in time. Buses and trains should have WiFi access so that people can do work (10) _____ travelling to the office.

It is safe to say that if the government (11) _____ more money on improving public transport services the majority of citizens (12) _____ change their attitude. That would (13) _____ only help combat pollution but also lead to fewer accidents on our streets.

SOURCE: https://www.english-practice.at/b2/vocabulary/language-in-use/liu034-public-transport.pdf [Retrieved 23.05.2023]

Do you have any other suggestions on how to improve public transport?

6. Watch the following presentation about a clean energy future:

https://www.ted.com/talks/shivachi_muleji_the_future_of_transportation

What do you think about what the speaker says?

Unit 11. Electric Vehicles and Batteries

1. **Introduction:**

1. What do you know about the company "Tesla"? What other car companies produce electric vehicles?
2. Have you used an electric scooter? How was your experience? Are these used safely by people you have observed in the street?
3. What new issues has the solution of electric vehicles raised in Poland?

2. **Vocabulary** – Match the words with their definitions[7]

1. exhaust fumes		a) formed or developed from something else; not original
2. derived from		b) changing position or direction
3. eager		c) one trouble leads to another that aggravates the first
4. shifting		d) gases ejected from an engine as waste products
5. to opt for		e) having or showing keen interest or intense desire or impatient expectancy
6. vicious cycle		f) oppose and mitigate the effects of by contrary actions
7. to counteract		g) select as an alternative over another

3. **Gap Fill** – Fill in the blanks below using the vocabulary words from the exercise above[8]. Change the form of the words if necessary.

1. Then, gradually, the glow fades, and I find myself suspended in midair, overlooking a vast expanse of blue ice and snow-covered glaciers, all _____ and cracking under their own weight.
2. The roar of wheels turning into the station, the stench of _____ _____, the sudden bustles of people unloading told me it was time to go.
3. She _____ the job on the East coast.
4. There seems to be a _____ _____ at work here, making ours not just an economy but a culture of extreme inequality.
5. As we have seen, the first mechanical clocks date to the late thirteenth century, and their geared machinery _____ _____ water-wheels and windmills.
6. At restaurants he always carried with him a virtual pharmacy of remedies and potions to immediately _____ any poisons that they might slip into his food or drink.
7. Although they were _____ to get to Japan, a lot of our military leaders also dreaded that thought.

[7] https://www.vocabulary.com/

[8] https://www.vocabulary.com/

4. **Reading** – Electric Vehicles:
    1. What do you think of electric cars and buses? Are they the solution to decarbonise transport in Polish cities?
    2. What kind of batteries do electric vehicles use? Are they easy to recycle?

Introduction

The problem is the increasing number of cars resulting in the amount of **exhaust fumes** and pollution. Everyone thinks that changing from combustion cars to electric cars is the solution. Unfortunately, as long as energy in Poland continues **to be derived** mostly from coal, electric cars will not result in an improvement; on the contrary, they will increase the amount of pollution. Reducing the number of vehicles by using public transport and alternative means of transport can help us.

Where do we want to go?

The future of transportation in general, but specifically in our beautiful city Białystok, should be based on eco-friendly cars and buses and electric vehicles such as scooters and bikes. Since there are a lot of **residents** in the area, the government should bet on popularizing mass transportation. If people traveled by buses instead of private cars, there would be less pollution in the city. In that case, the air would be clearer and people would be healthier.

It is also a good idea to build more bicycle paths. During summer, spring and early autumn, a large number of people are **eager** to choose bicycles, rollerblades, skateboards etc. over the car. Providing new paths would not only make it easier for everyone to get around, but also make it safer on the roads. Giving up driving a car contributes to reducing the amount of carbon dioxide in the air.

If we want to **shift** to electric cars in the future, Poland should invest in nuclear energy. Producing electricity through nuclear power stations, energy prices will be lower, and consequently, more people will **opt for** electric cars which wouldn't be powered by the burning of fossil fuels like coal.

What is the current situation? What is working? What isn't?

Currently, the situation is not the best, but it seems to be on the way to improvement. The downside is still that there is a lot of carbon dioxide air pollution in the city from too many cars running on combustion engines. On the other hand, there are more and more electric cars and electric public buses, but unfortunately they are powered by coal-sourced energy, which makes a **vicious cycle**. However, the city, aiming for a better future, has built more bike paths and lowered bus fares, so more people are choosing to ride them instead of cars, due to high fuel prices.

What actions need to be taken to get to the future we want?

To get us to the future we want, we need to take some important steps, without them change will not be possible. The first is to make people aware of the problem, without

this further action will be **pointless**. The public needs to know where the huge amounts of pollution and exhaust fumes come from every day, and how to **counteract** it. Once this is done, it is time to improve the existing solutions. We need to focus on public transport and make it more intelligent and **accessible**. We can do this by **designing and designating** more bus lanes, building stops like metro gates. Another major improvement and change would be to install ticket machines at bus stops, which would encourage people to use public transport. Once the current solutions are in place and have the support of the public, only then will it be possible to look for further ways to improve transport for the better.

Conclusion

To sum up, if we want to make progress towards being eco-friendly, the government needs to make some big steps towards building nuclear reactors. This would allow more people to drive electric cars without "dirty energy", by that time hydrogen cars would be a great improvement to the life of regular people. Public transport is the key to reduce cars on the street right now, which means less pollution. For people to be willing to travel by bus, it would be good to build terminals on bus stops to allow faster transfers. It's important for people to be aware of the problems concerning air pollution in our city, and it would be a great idea to make campaigns about the importance of transferring to a green economy.

PREPARED BY: Angelika Paszkiewicz, Przemysław Wyrobek, Jakub Januszko, 2022.

5. **Discussion Questions:**

1. What do you think about what you have read?
2. What are some problems you encounter while commuting in the city?
3. What is your favorite way of travelling?
4. How can we improve public transport in Bialystok?
5. For travelling beyond the city, should Bialystok invest in better railways or an airport?

6. **Lithium Ion Batteries:** To learn more about the technology behind electric vehicle batteries, go to the link below, read the text, listen to the videos, and do the **quiz.**

https://learningenglish.voanews.com/a/exploring-the-technology-behind-electric-vehicle-batteries/6517718.html

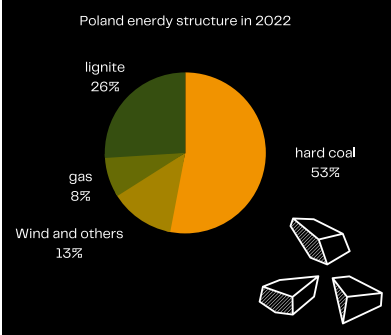
7. Complete the worksheet on **car batteries**:

https://en.islcollective.com/english-esl-worksheets/grammar-topic/word-order/car-battery/20650

8. Have a discussion about **cars**:

https://esldiscussions.com/c/cars.html

STATE AND FURTHER DEVELOPMENT OF POLAND'S ENERGY SECTOR

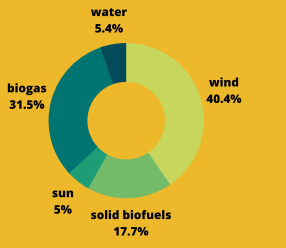


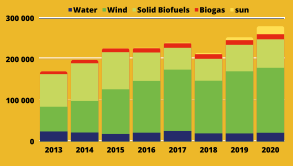
Coal Mining

- The Polish energy industry is largely based on coal, the resources of which will run out sooner or later
- Hard coal mining, along with deeper and deeper resources and growing salaries and benefits for miners, slowly ceases to be profitable
- Shallow lignite is still very profitable, due to the easy nature of its extraction
- Mines should be shut down. Nevertheless, it should be done in a slow, gradual way
- The decommissioning of coal mines should be accompanied by an increase in the share of alternative energy sources

OZE in Poland

- Changing weather conditions and rivers with irregular water level fluctuations do not allow the full use of solar and hydro energy
- The only reliable "green" source of Energy, that can exists in our country is wind energy and biofuels
- The best conditions for building wind turbines are in the northern belt of Poland
- Wind energy developed dynamically in our country in 2010–2015
- its development significantly slowed down, because there were many laws impeding the construction of new wind turbines





Atom energy

- The only viable solution is an atom
- Fears of a nuclear disaster are unfounded. Today's reactors are very safe
- Two nuclear power plants will be built in Poland

PREPARED by Kamil Kulenko, III year Logistics Student, 2022

III. Electrification

Unit 12. Poland's Energy Mix

1. **Reading:**

Nowadays, being on the verge of an energy crisis, we should reflect on the energy policy of our country. Currently, the Polish energy industry is largely based on coal. Hard coal has gotten increasingly more expensive to extract from the depths of the earth. Nevertheless, mining shallow lignite is still very profitable, due to the easy nature of its extraction. The Bełchatów lignite power plant currently produces 20% of electricity in Poland, and the resources in the mine located next to it are estimated at several dozen years. Unprofitable mines should be shut down, however, it should be done in a slow, gradual way because, as the current situation has shown, where we are dealing with a scarcity economy and broken chains, we cannot base our energy on imports.

The decommissioning of coal mines should be accompanied by an increase in the share of alternative energy sources. The only reliable "green" source of energy that can exists in our country is wind energy, because changing weather conditions and rivers with irregular water level fluctuations do not allow the full use of solar and hydro energy.

The best conditions for building wind turbines are in the northern belt of Poland. Wind energy developed dynamically in our country in 2010-2015. Its share in the energy structure increased during this period from 1% to 5%. Unfortunately, after the election of the new government, its development significantly slowed down, because there were many laws impeding the construction of new wind turbines.

Ultimately, wind energy cannot meet Poland's demand. The only viable solution is atomic energy. Fears of a nuclear disaster are unfounded. Today's reactors are very safe. We as a society must overcome the trauma of the Chernobyl disaster and move towards the future with nuclear energy.

PREPARED BY: Kamil Kulenko III year logistics student, 2022.

Further Reading: https://euracoal.eu/info/country-profiles/poland/

Take a look at the link above to learn more about coal mining in Poland. What surprises you about the realities of coal mining in Poland and its importance for Poland's energy mix?

2. **Discussion Questions:**

- Why is the Bełchatów lignite power plant important for Poland?
- Do you agree that wind power is the best source of renewable energy for Poland?
- What do you think about nuclear energy? What are the benefits and challenges of using this technology?

3. **Listening**

BBC 6 minute podcast – Shocking facts about electricity (EPISODE 200514 / 14 MAY 2020) https://www.bbc.co.uk/learningenglish/english/features/6-minute-english/ep-200514

4. **Vocabulary** – Match the vocabulary words with their definitions

1. frequency		a) informal expression meaning a difficult situation with no obvious answer
2. synchronous		b) differences from what is usual or expected
3. a bit of a pickle		c) get the power needed to work; recharge
4. charge up		d) how often something repeats; electrical current frequency is the number of times a wave repeats a positive-to-negative cycle
5. anomalies		e) electronics using semiconductors which have no moving parts and can automatically convert different electrical currents
6. solid state		f) occurring together at the same time, place or rate

5. **Group Work**

Divide into small groups.

Take a look at a list of the largest power plants around the world:
https://en.wikipedia.org/wiki/List_of_largest_power_stations

Non-renewable power stations are those that run on coal, fuel oils, nuclear fuel, natural gas, oil shale and peat, while renewable power stations run on fuel sources such as biomass, geothermal heat, hydro, solar energy, solar heat, tides and the wind.

Here is an overview of electricity production in Poland:
https://en.wikipedia.org/wiki/Energy_in_Poland

Choose a power plant to research. Prepare a short presentation about its past, present and future role in power generation and its importance to energy security of the region it is in.

6. **Grammar Reference – Conditionals**

To review your understanding of conditionals, click on the link and do the exercises:
https://learnenglishteens.britishcouncil.org/grammar/b1-b2-grammar/conditionals

Complete the following sentences using the words "if"' or ''unless"'.

1. I will take the job _____ the pay is too low.
2. I will be back tomorrow _____ there is a plane strike.
3. Let's go for a walk – _____ you are too tired.
4. I am going to work in the garden this afternoon, _____ it rains.
5. I will be surprised _____ he doesn't have an accident soon.
6. I think she would look prettier _____ she didn't wear so much make-up.
7. _____ you don't stop smoking, you will fall seriously ill.

Check your answers by going to the following link: If and Unless Exercise (english-grammar.org)

Unit 13. Coal

1. **Introduction:**

1. Is coal an important industry in Poland?
2. Is it a growing industry or one that is ending?
3. What is carbon leakage?

2. **Listening:**

Watch the film about coal use in Poland in 2020. What do you think about this situation?

https://www.youtube.com/watch?v=RNcv5EbePjI

Comprehension questions. Answer true (T) or false (F):

1. Using coal to heat houses in Poland is much cheaper than using electricity to heat homes.
2. Poland depends on coal for 50% of its electricity production.
3. Because most of Poland's power plants are old and use only one source of energy, it will be easier for them to 'leap frog' and invest in new modern technology using renewable energy.

3. **Vocabulary –** Translate the following phrases into Polish:

The Polish Perspective	
heavily dependent on	
to abide	
subsidies	
externalities	

4. **Read** the article and answer the comprehension questions.

The Polish Perspective On The Coal And Climate Nexus

Poland, a Member State of the European Union since 1st May 2004, is quite special, where climate and energy issues are concerned. It is a large country (ca 38.5 million inhabitants over an area of 312 000 km2), with an economy in transition that is **heavily dependent on** coal, the prime national mineral resource. The country virtually "sits on" coal, and its energy supply is strongly coal-dominated: 86% of electricity is produced from hard coal and lignite (KOBIZE 2013). There are still abundant reserves of coal in Poland, though coal reserves in working coal mines are assessed as much smaller (enough for only 40–50 years). The coal lobby has always been very strong in Poland and remains so today. Indeed, hundreds of thousands of jobs depend on coal.

The need **to abide** by European Union climate policy is perceived as an exceedingly heavy burden by much of Polish society (Kundzewicz and Matczak 2012)…Poland is also one of the European countries in which the perception of climate change as a serious problem is weakest (see: http://ec.europa.eu/clima/citizens/support/docs/report_2014_en.pdf).

A considerable part of Polish society thus believes that coal is the nation´s cheapest fuel and that an energy transition towards a low-carbon-economy would be very costly. In fact, from a macroeconomic point of view, coal is not especially cheap, if **subsidies** and **externalities** are taken into account. In Poland, several sectors are identified as potentially vulnerable to climate change: **water management**, associated with changes in extreme precipitation and floods, and an increased risk of summer droughts; **coastal management**, due to sea level rise; agriculture, forestry, and health. In some areas, there could be benefits associated with a longer growing season, but a summer water deficit is expected to reduce yields of wheat or potatoes, if no adaptation actions are taken. While Poland is perceived to be less vulnerable to climate change than southern European countries, hotter summers may cause discomfort for an aging population, and worsen atmospheric pollution during heatwaves (Szwed et al. 2010).

There is no doubt that Poland has to gradually improve its energy efficiency, and decarbonise its energy sector. There is also a requirement to **improve air quality**, and specifically the concentration of fine particles emitted from coal powered heating systems in individual houses and apartments. However, there are risks of introducing a high carbon tax abruptly, as well as a threat of **"carbon leakage"** in some branches of industry (i.e. a shift of production and carbon dioxide emissions to the east, to countries that do not partake in the global climate change mitigation and are not obliged to reduce emissions), and in consequence, a loss of jobs in Poland. This is a reason for considerable concern throughout Poland. It would be unfortunate if the **cure** (climate change mitigation) were perceived to be worse for Poland than the **disease** (climate change) – yet this is something that many Poles do indeed believe already.

SOURCE: Kundzewicz Z. W., 2015. *Climate Change – Is it worse than expected?* Institute for the Agricultural and Forest Environment, Polish Academy of Sciences, Poznan, Poland, p. 4 https://bibliotekanauki.pl/articles/11954.pdf [Retrieved 24.01.2023]

5. **Comprehension Questions**: Answer True (T) or False (F) based on the text.

1. Poland has abundant reserves of coal, although it's difficult to get access.
2. The coal lobby has always been very strong in Poland and remains so today.
3. An energy transition towards a low-carbon-economy is quite cheap to execute
4. Two sectors in Poland vulnerable to climate change include water management and coastal management.
5. Poland does not have a problem with air quality.
6. Carbon leakage is when carbon intensive industries move to places with less strict laws about carbon emissions.

7. People in Poland are enthusiastic about the mitigation of climate change because these solutions are cheap and easy to carry through.

6. **Translate** these words into English[9]:

1. paliwa kopalne	
2. węgiel kamienny	
3. węgiel brunatny	

7. **Discussion Questions:**

1. What are some challenges facing **the coal mining industry** in Poland?
2. What issues concerning **water management** is Poland facing?
3. What issues concerning **coastal management** is Poland facing?
4. What do you know about **the current state of climate change** happening today?

Write a 100-150 word response.

[9] 1. Fossil fuels, 2. Hard coal/bituminous coal, 3. Lignite (coal)

Unit 14. Hydropower in Poland

1. **Introduction:**

a) What is the difference between a *hydroelectric power plant* (e.g. in Włocławek)[10] and a *pump-storage hydropower plant* (e.g. Solina)[11]?
b) What are the benefits of producing electricity from hydropower? What are the drawbacks?
c) Are reservoirs a good way to store potential energy and act as batteries?

2. **Reading:**

Read about the pump-storage power plant in Żarnowiec and choose the correct alternative.

The pump-storage power plant in Żarnowiec

In Poland, there are six pump-storage hydropower plants, of which the largest one is the hydropower plant Żarnowiec of power 716 MW. The location for the construction of the pump-storage hydropower plant Żarnowiec at the Żarnowieckie Lake was due to **(1) favourable/rugged** topographic conditions. (*The nuclear power plant Żarnowiec was supposed to be built in the vicinity, but construction was stopped in 1989).* Thus, the hydropower plant would function as an energy "accumulator." The power plant Żarnowiec is equipped with four reversible, diagonally positioned hydro turbines with a wide range of power for regulation purposes of value 1516 MW:800 MW absorbed from the system and 716 MW of generated power.

Individual turbine systems operate in a block, creating four **(2) connected/independent** process lines and power outlets, with autonomous control for each block. The individual work of these turbines establishes the global character of the power plant's operation determining its regulation and intervention functions in the National Grid System. These functions include:

- Balancing the daily load curve,
- Covering sudden losses and peaks in power consumption that occur in the system,
- Optimising the operation of the national grid system by quick and continuous regulation of active power supplied to the system,
- Regulating reactive power flow in the system.

The top reservoir of the power plant is a man-made body of water, ***(3) constructed/equipped*** on one of the highest plateaus located around Lake Żarnowieckie. With the total area of 135 ha and storage volume of 13.8 million m^3 of water, the reservoir acts as an electric power ***(4) turbine/accumulator*** in the amount of 3600 MWh. This amount of water is enough to supply the maximum power to the power grid system

[10] https://en.wikipedia.org/wiki/Hydroelectric_power_plant_in_W%C5%82oc%C5%82awek

[11] https://en.wikipedia.org/wiki/Solina_Dam

for about 5.5 hours. To be **(5)** ***emptied/ refilled*** with water, the top reservoir requires four hydro turbines to operate in a pumping mode for about 6.5 hours. Daily variations in the water level in the top reservoir are 16 m.

SOURCE: Igliński, B. *Hydro energy in Poland: the history, current state, potential, SWOT analysis, environmental aspects*. Int J Energ Water Res 3, 61–72 (2019). https://link.springer.com/article/10.1007/s42108-019-00008-w [Retrieved 21.02.2023]

3. **Vocabulary:**

Complete the live worksheet on hydropower: https://www.liveworksheets.com/ne880687cg

4. **Read the article:**

https://notesfrompoland.com/2022/01/18/poland-set-to-resume-work-on-largest-hydroelectric-plant-after-33-years/

5. **Translate the text below from Polish into English.**

Elektrownia Szczytowo Pompowa, Młoty

W latach 60. pojawił się pomysł na zbudowanie we wsi Młoty elektrowni szczytowo pompowej, której moc miała wynosić około 750 megawatów, byłaby to największą tego typu elektrownia w Polsce. W Dolinie Bystrzycy miała powstać tama o wysokości 80 i rozpiętości 240 metrów. Przygotowania do budowy rozpoczęto w 1972 roku, a na przełomie lat 70. i 80. budowa rozpoczęła się na dobre. Ale po dwóch latach budowy w 1981 roku w wyniku załamania się gospodarki prace na budowie elektrowni stanęły.

Myślano że to chwilowa przerwa, ale z budowy już nie wznowiono. W 1989 przeprowadzono tylko prace zabezpieczające, od tego czasu wszystkie wydrążone sztolnie stoją zamieszkane przez nietoperze. Obecnie wszystkie wejścia do sztolni są otoczone gęstym lasem, dużo czasu zajęło mi znalezienie chociaż jednej. Jest to sztolnia obiegowa, którą miała płynąć rzeka w czasie budowy tamy.

SOURCE: Elektrownia Szczytowo Pompowa, Młoty | Opuszczone.net | podróż do świata który zniknął [Retrieved 02.06.2023]

Unit 15. Nuclear Energy in Poland

1. **Introduction:**

a) Does Poland **produce** electricity from nuclear power?
b) Does Poland **use** electricity from nuclear power?
c) What do you know about the **MARIA** research reactor?

2. **Read** about the Maria Research reactor and tell your class about your findings:
https://www.ncbj.gov.pl/en/aktualnosci/40-years-maria-research-reactor

3. **Put the sentences in the correct order**[12]**:**

	a) Electricity is sent via pylons and cables to homes around the country.
	b) Uranium is mined from rocks.
	c) Uranium atoms inside the rods are split into two smaller atoms and energy is released.
	d) The yellowcake is taken to a factory where it is turned into nuclear fuel rods.
	e) It is then crushed and concentrated to make a powder called 'yellowcake'.
	f) As the turbines spin, they drive generators, which make electricity.
	g) This energy heats the water and makes steam, which is then used to make turbines spin.
	h) At a power station, the nuclear fuel rods are placed under water inside a chamber.

4. **Rapid drill.**

Scan an excerpt from a blog about Żarnowiec nuclear power plant (30 seconds). Try to be the first student to find all the numbers necessary to answer the questions on the next page.

The abandoned Żarnowiec nuclear power plant in Poland

Żarnowiec Nuclear Power Plant was supposed to become Poland's first nuclear power plant. Planning began in the early 1970's, with extensive research with the purpose to find the most suitable location. After several years, a site near the village of Żarnowiec, 50 km (31 miles) northwest of Gdańsk was chosen. The site was near the Baltic Sea and Lake Żarnowiec which was to be used for cooling.

Construction began in 1982 with completion of the first reactor planned for 1989 and the second for 1990. These dates were later extended by a year. The plant was planned to occupy 70 ha of land area, while the entire complex with dedicated construction facilities and supporting buildings would take 425 ha. In addition to 79 buildings of the reactor-housing compound, the complex included hundreds of supporting facilities, including housing for the staff, a meteorological station and a railway station.

[12] https://www.onestopenglish.com/download?ac=4449 [Retrieved 04.06.2023]

Any public opposition for the project was initially silenced by the introduction of martial law in 1981. After the Chernobyl disaster of 1986 though, environmental organizations started an anti-nuclear campaign which quickly gained widespread support. The protest which was also supported by political parties, included roadblocks and hunger strikes. In 1987, the government finally caved in and announced a referendum. Although 86,1% voted against completing the power plant, government chose to ignore the not legally binding referendum and continue the construction works.

The project was finally abandoned in 1990 after all the supporting buildings and 40% of the first reactor had been built, with the government citing the unclear safety status of the nuclear plant, among other reasons. By that time, 84% of the construction budget had already been spent.

After the project's abandonment, some of the equipment that had already been installed was scrapped while other was stolen. Local government tried to attract investments in the area by establishing a Special Economic Zone, but there wasn't enough success. Currently there are only 20 companies operating in the area while most of the buildings remain abandoned. The total losses resulting from mismanagement of the abandoned property over the years have been calculated as high as $2 billion.

SOURCE: https://desertedplaces.blogspot.com/2017/02/the-abandoned-zarnowiec-nuclear-power.html [Retrieved 24.02.2023]

7. **Comprehension questions:**

1. Planning for the nuclear power plant in Żarnowiec began in the early _____.
2. a site near the village of Żarnowiec, _____ northwest of Gdańsk was chosen.
3. Construction began in _____.
4. The plant was planned to occupy _____ of land.
5. Although _____ of those asked voted against completing the power plant, government chose to ignore the not legally binding referendum and continue the construction works.
6. Currently there are only companies operating in the area while most of the buildings remain abandoned.
7. The total losses resulting from mismanagement of the abandoned property over the years have been calculated as high as _____.

6. **Discuss the following questions. Check your answers by scanning the text below.**

1. What three companies offered to build nuclear power plants in Poland?
2. How much nuclear energy capacity does Poland want to have by 2040?
3. What kind of reactor technology will be built in Poland?

7. **Reading**

Read the article about plans to build three nuclear power plants in Poland.

Poland to build three nuclear power plants

Mihajlo Vujasin, 1.11.2022

Poland plans to build three nuclear power plants with a total capacity of **9 GW** by 2040. Under an agreement with the United States, **Pittsburgh-based Westinghouse** was picked for the first project, on the Baltic coast. The construction will begin in 2026, and the first reactor is expected to become operational in 2033. In parallel, ZE PAK and Polska Grupa Energetyczna (PGE) signed a letter of intent with **South Korean state-owned company Korea Hydro & Nuclear Power (KHNP)** to work on the development of another such project.

The government in Warsaw has unveiled plans to install six large pressurized water reactors by 2040 with a combined installed capacity of **6 GW to 9 GW**.

In September, Poland signed an agreement with the US on cooperation in the field of civil nuclear energy. Westinghouse has offered its **AP1000 reactor technology**. The construction of the first reactor, with a capacity of 1 GW to 1.6 GW, is scheduled to begin in 2026.

The first nuclear power plant will be built on the Baltic Sea coast, near the towns of Lubiatowo and Kopalino in the municipality of Choczewo. The plan is to begin the construction of the first, **1 GW to 1.6 GW** reactor in 2026 and get it online in 2033.

As part of Poland's plan to reduce dependence on coal, other reactors should be built every two years. Poland relies on coal to produce 70% of its electricity.

The Polish government believes that nuclear energy is important for energy security. The Prime Minister of Poland pointed out that the state needs stable energy that will replace coal. Poland received offers also from **France's EDF** and South Korean state-owned company Korea Hydro & Nuclear Power (KHNP), with which a letter of intent was signed.

SOURCE: https://balkangreenenergynews.com/poland-to-build-three-nuclear-power-plants/ [Retrieved 24.01.2023]

Unit 16. Innovation in Nuclear Technology

1. **Introduction questions:**

1. Where are most nuclear energy reactors in the world located?
2. How is nuclear safety and security guaranteed for nuclear power plants?
3. What is the service life of a nuclear power plant? How long can you extend its service life?
4. Why and how do you dismantle a nuclear power plant?
5. What do we do with nuclear waste? How is it treated?
6. What is an EPR? How does an EPR differ from a current reactor?
7. What kind of future does nuclear energy have?

Take a look at the answers to these questions on the example of France.

https://www.cea.fr/english/Pages/News/nuclear-energy-in-14-questions.aspx

2. **Group Work**

Divide into groups of 6 people. Each member quickly scan one of the topics below on the website

https://www.startus-insights.com/innovators-guide/nuclear-technology-trends/

Tell your group members about the trend you researched.

Top 6 Nuclear Technology Trends

a) Clean Energy
b) Nuclear Medicine
c) Artificial Intelligence
d) Semiconductors
e) Propulsion Technology
f) Nuclear Waste Management

3. **Describe the figure:**

Click on the link https://www.powermag.com/being-pro-nuclear-wont-be-enough-heres-why/ and take a look at the graph of nuclear projects around the world. With your partner, summarize the development of nuclear power plants up to 2022.

3. **Listening:** How Green is Nuclear Energy?

Do the vocabulary exercise before listening to the podcast.
https://www.bbc.co.uk/learningenglish/english/features/6-minute-english/ep-211125

What do you think about what the presenters said?

5. **Vocabulary:**

1. phase (something) out		a) memories that produce powerful feelings and strong, clear images in the mind
2. **vivid memories**		b) the feature of something that makes it different from and better than its competitors
3. **ingrained**		c) person or thing that suffers as a result of something else happening
4. **unique selling point (or USP)**		d) (beliefs) so strongly held that they are difficult to change
5. **Casualty**		e) gradually stop using (something)

6. **Read an excerpt of an article about innovation in nuclear energy.**
What aspect do you find the most interesting?

Nuclear's Most Forceful Engine: Innovation

Sonal Patel, 3.03.2023

While the commercial nuclear industry has championed innovation since its advent nearly 70 years ago to boost plant economics, efficiency, and flexibility, "today, we are observing a burst of innovation in the nuclear energy arena that is unlike anything seen since the 1950s," noted William D. Magwood, IV, director-general of the Nuclear Energy Agency (NEA) in October.

"**Generation IV technologies**, long explored in the laboratories of government ministries, are moving from experiment and concept to large-scale demonstration," he said. **Small Modular Reactors (SMRs)** are meanwhile incorporating lessons learnt from 60 years of commercial nuclear operational experience, and "new innovations, insights and technologies from other sectors, are approaching commercial reality far sooner than some had predicted…Innovation, however, is also thriving in other critical segments, promising to shift nuclear's long-standing paradigm.

Non-electric Nuclear Energy Applications.

"**Products beyond electricity generation** are coming into view over the longer term – heat for industry, hydrogen for transport, clean water for cities," Magwood noted. During 2021, a total of 61 operating nuclear reactors were used for non-electric applications. Of these, 48 supported **district heating**, three reactors supported industrial process heat, five supported both district and process heating, and another five, **desalination**. According to the International Atomic Energy Agency (IAEA), nuclear heating technology appears poised to flourish even more if the hydrogen economy takes off. A recent scoping investigation by the IAEA suggests nuclear energy could be the most cost-effective means of **producing clean hydrogen** if gas prices remain above $10–$15 per million British thermal units.

Fuel Cycle.

While nuclear fuel production is already mature, automation and digitalization offer continuous safety and efficiency improvements. Progress is also unfolding for fuels developed after the Fukushima disaster, including **accident-tolerant fuels**, and fuels for current and next generations of nuclear power reactors, which will use high-assay low-enriched uranium (HALEU) – uranium-235 enrichments of up to 20%. These fuels promise to improve the economics and sustainability of nuclear power by increasing fuel irradiation cycles and higher burns. In parallel, efforts are picking up to develop new fuel cycles and **recycle spent nuclear fuel**. Significant progress in technologies supporting nuclear waste disposal, a long-standing industry concern, is also starting to show gains. Finland is approaching operating its **deep geological repository (DGR)** in 2025, and Sweden, which garnered government approval, envisions its DGR will be fully developed in the 2080s.

Digitalization.

Digital capabilities, including artificial intelligence and machine learning, and data analysis tools are transforming the way nuclear systems are being designed, licensed, and operated.

Fusion.

More fusion enterprises have begun cropping up, backed with private capital. While fusion still needs substantial development, ambitious demonstrations are taking shape outside ITER. In October, the UK Atomic Energy Authority picked a coal power plant site for its STEP demonstration, whose first operation is targeted for the early 2040s. In a pivotal breakthrough announced in December, researchers at the National Ignition Facility (NIF) at the U.S.-based Lawrence Livermore National Laboratory achieved **fusion ignition** – or "scientific energy breakeven," meaning it produced more energy from fusion than the laser energy used to drive it.

SOURCE: S. Patel (2023). https://www.powermag.com/being-pro-nuclear-wont-be-enough-heres-why/ [Retrieved 24.01.2023]

7. **Comprehension Questions:**

Fill the gaps in the sentences below with words from the text above.

1. Nuclear products beyond electricity generation include _____, _____, and _____.
2. Innovations in the fuel cycle of nuclear energy include _____, _____ and _____.

8. **Discussion questions:**

1. What is the difference between fission and fusion energy?
2. Is it better to have one or two large nuclear power plants or should each city have its own small modular reactor (SMR)?
3. What are the major challenges to the expanded use of nuclear energy?

9. **Radioactive Waste**

https://www.nrc.gov/reading-rm/basic-ref/students/for-educators/unit4-radioactive-waste.html

Click on the link, read about radioactive waste disposal, and answer the following questions:

1. Would a small leak of radioactive waste from a nuclear repository be detected? Why or why not?
2. How would immediate detection of even a very small leak of radioactive waste differ from leak detection of other types of industrial toxic wastes?
3. Why are there special sites for disposal of low-level wastes?
4. Why is there a controversy over the selection of a high-level nuclear waste disposal site?
5. How would it affect health care in your country if there were no low-level waste disposal sites available?
6. Are special packaging containers built to protect the contents or keep the contents from getting in contact with the environment?
7. How are liquids processed to remove radioactive impurities?

Further Reading:

Notes from Poland:

https://notesfrompoland.com/2021/03/15/poland-bets-on-nuclear-as-it-seeks-to-reduce-reliance-on-coal/

IV. Future Opportunities

Unit 17. Poland's Energy Strategy for 2040

1. **Introduction:**

a) What are some sources of non-renewable energy?
b) What are some sources of renewable energy?
c) What is the difference between energy reserves and resources?
d) Which types of energy sources do we use the most in Poland?
e) How is the Polish government trying to change Poland's energy mix?

2. Take a look at this website about the sources of energy available for human consumption around the world and do the exercises:

https://www.e-education.psu.edu/egee102/node/1909

3. **Reading:**

Read an article about Poland's Energy Policy approved in January 2020. Fill in the blanks with the words in the words in the box.Bold letters (a-e) go with task 6 below.

a) introduction, **b)** dominant, **c)** diversify, **d)** sector, **e)** decrease, **f)** reactor, **g)** consumption, **h)** production, **i)** phased out, **j)** emission

Poland's Energy Strategy For 2040

Poland's Energy Policy (PEP2040) lays out a plan for meeting Poland's increasing electricity (1) _____, which amounts to almost 170TWh and is expected to increase.

Plans include a significant (2)_____ of the share of coal in the national **power generation mix** from current levels of 80% to 60% by 2030 and to 22% by 2040; substantial increase of the share of renewable generation in solar capacity and offshore wind; decrease of onshore wind capacity after 2030; and (3) _____of nuclear power in 2033. The Ministry of Energy is also planning to **(a)** expand transmission

and distribution grids, **(b)** trans-border connections, **(c)** develop high-efficient cogeneration, **(d)**(4)_____ gas and crude oil supplies and **(e)** develop a national gas transmission system.

Hard coal and lignite

Significant withdrawal of coal capacity is expected in the next several years due to international energy efficiency and environmental obligations. Between 2018 and 2035, approximately 16.7 GW of existing coal-fired power generation is expected to be (5) _____ of the system. At the same time, **5.9 GW new coal capacity is expected to be built**. Apart from Ostroleka C power plant, new coal-fired capacity can only be created in cogeneration. After 2030, the Ministry of Energy plans to replace lignite with nuclear. Coal will remain the (6) _____ source of power supply, with around 60% of generation coming from hard coal and lignite in 2030.

Nuclear power

The Ministry of Energy plans to launch operations of the first 1-1.5GW nuclear power (7)_____ in 2033. The remaining five are expected to come online by 2043 every two years. Poland plans to reach the total nuclear power plant output capacity of 6-9GW.

Renewable energy sources (RES)

The development of *photovoltaics* and *offshore wind farms* are key RES in Poland. The maximum level of annual capacity growth in the system was set at 1 GW for photovoltaic sources and 1.2 GW for offshore wind farms to reach 10 GW installed power in the Baltic wind farms in 2040. In accordance with the current legal status, no new onshore wind power plants would be built. A decrease of onshore wind is predicted – from 6.4GW in 2018 to 6GW in 2030 and 2.1GW in 2035. RES in final energy consumption will reach around 21% in 2030, translating to about 27% in net electricity (8)_____.

Based to the draft PEP2040, the average (9) _____ of power sector is planned at 394 kg CO2/MWh. According to the Minister of Energy, introduction of all PEP provisions into Polish energy (10)_____ will cost $100 billion.

SOURCE: https://www.trade.gov/market-intelligence/polands-energy-strategy-2040 [Retrieved 26.01.2023]

4. **Comprehension Questions:**

1. What will supplement coal in Poland's power generation mix by the 2030's?
2. Does Poland produce all the power it consumes itself? What systems allow Poland to access to power produced elsewhere?
3. Will Poland stop building coal power plants?

5. **Grammar Reference – Modal Verbs**

We use modals to show if we believe something is certain, possible or impossible:
*Wind energy **must be** part of the energy mix of Poland.*
*It **might** rain tomorrow.*
*That **can't be** the best solutions. There **has to be** a better way.*

We also use them to do things like talk about ability, ask permission, and make requests and offers:
*I **can't** swim.*
***May** I ask a question?*
***Would** you like some help?*

Click on the links below to practice using modal verbs:
https://learnenglish.britishcouncil.org/grammar/english-grammar-reference/modal-verbs

https://usefulenglish.ru/grammar/modal-verbs-exercise-seven

6. **Research:**

Take a look at various statistics about Poland's energy sector today:
https://www.statista.com/topics/10235/energy-sector-in-poland/#topicOverview

Talk to your classmates about what you found.

7. **Group Work**:

Divide the class into 5 groups. Each group can research how Poland is planning to:
a) expand transmission and distribution grids,
b) trans-border connections,
c) develop high-efficient cogeneration,
d) diversify gas and crude oil supplies and
e) develop a national gas transmission system.

Present your results to the class.

Unit 18. Energy Efficiency

1. **Introduction:**

a) What does it mean to be energy efficient? How energy efficient is your home? Do you have energy efficient appliances? Why does this matter in terms of energy and water use?
b) When it comes to the decarbonization of the economy, is it more important to produce energy from renewable resources or to improve energy efficiency?

2. **Read about energy efficiency in Poland and answer the questions below.**

Energy Efficiency in Poland

During the last two decades, Poland has greatly improved its energy efficiency. Energy consumption of the Polish economy decreased by 51% between 1996-2013 and the country's primary energy consumption, per capita, is 25 percent lower than the EU average. Poland plans to achieve the EU15 energy intensity level of 2005 by 2030 and is obligated to meet EU directives to improve energy efficiency by 20% in 2020, showing annual energy efficiency savings of 1.5% from 2014-2020.

The system of **white certificates** that awards energy efficiency investments and undertakings is an instrument for increasing energy efficiency in Poland. The system is obligatory for **utilities** that sell electricity to end-users. In order to receive a white certificate, a company must submit an application with an energy efficiency audit to the President of the Energy Regulatory Office. **Energy efficiency audits** are obligatory for large companies (more than 250 employees). With the availability of EU funds dedicated to improvement of energy efficiency, the energy efficiency market in Poland has been developing quickly over the past 10 years, especially in the area of **thermo-modernization** of buildings, modernization of street lighting, and improvement of industrial processes. The total amount of EU funds allocated to support the **low carbon economy** in Poland (including energy efficiency projects) was Euro 6.8 billion in 2014-2020.

Energy efficiency improvement areas that may be supported by EU funds are: *production* of electric energy (**CHP production**), electricity *transmission* and *distribution* (including **smart grid**), energy *consumption* (energy modernization of public and residential buildings, energy efficiency improvement in factories and commercial buildings, as well as the improvement of regional infrastructure).

SOURCE: https://www.trade.gov/market-intelligence/polands-energy-efficiency [Retrieved 25.01.2023]

3. **Vocabulary – Match the words with their definitions**:

1. white certificate	a) the process of inspecting and reporting the energy flows in a building for energy conservation
2. a public utility	b) economy based on energy sources that produce low levels of greenhouse gas (GHG) emissions; a.k.a. decarbonised economy
3. Energy efficiency audit	c) a planned nationwide network that uses information technology to deliver electricity efficiently, reliably, and securely. It's been called „electricity with a brain," „the energy internet," and „the electronet"
4. thermo-modernization	d) a technology that produces electricity and thermal energy at high efficiencies using a range of technologies and fuels
5. low carbon economy	e) a document confirming that a certain minimum level of reduction in annual energy consumption has been achieved as part of the modernization
6. CHP production	f) eliminating heat losses directly at the construction level by ensuring proper insulation of partitions separating the interior of the building from the outside world in new and already existing facilities, also replacement of devices working for central heating and hot utility water
7. smart grid	g) a business organization (such as an electric company) performing a public service and subject to special governmental regulation

4. **Comprehension questions**

1. Has energy efficiency improved in Poland in the recent past?
2. Per capita, do Polish citizens consume more primary energy than the
3. European Union average?
4. Is it true that companies which have over 250 employees do **not** need to prepare an energy efficiency audit?

Further reading:

U. Pawlak, M. Pawlak, 2019. "The thermomodernization of a single family house located in the Świętokrzyskie Mountains – a case study" – http://iks.pn.sggw.pl/PN85/A8/art8.pdf

Unit 19. Geothermal Energy and Heat Pumps

1. **Introduction questions:**

a) What can we heat our houses with?
b) Do you know the temperature we need to keep a room comfortable to sit in?
c) Do you know how your house is insulated?
d) What is a heat pump? How does it work?
e) What is the difference between an aerothermal heat pump and ground source heat pump?

2. **Listening:**

Watch the video about heat pumps and answer the comprehension questions:
Kathy Hannun: How to heat your home without hurting the planet | TED Fellows

3. **Comprehension questions (True/False):**

a)	There are two types of geothermal heating	T	F
b)	Heat pumps don't need anything else to work	T	F
c)	Heat pumps are a cheap investment	T	F
d)	Green walls are a form of insulation	T	F
e)	Coal is the only way to heat your house	T	F
f)	Solar power can be used only to produce electricity	T	F
g)	Living near gas lines can be dangerous	T	F
h)	We do not need to worry about the availability of fossil fuels in the future	T	F
i)	Geothermal energy is the reason why cellars have a stable temperature all year round	T	F
j)	Fossil fuels are getting more and more expensive nowadays	T	F

4. **Match the words with their definitions:**

1.	Geothermal energy		a) power generated from the Sun
2.	Green walls		b) energy in Earth's crust
3.	Fossil fuels		c) the act of adding layers of certain materials on an object to improve heat retention
4.	Heat pumps		d) a container in which hot fire is made to boil the water
5.	Solar power		e) a mark indicating quality
6.	Insulation		f) greenery growing on outer walls of a building
7.	Room temperature		g) cleverness, inventive skill
8.	Ingenuity		h) heat found in the Earth's crust and can be used to produce energy
9.	Hallmark		i) devices which use heat found in natural environments to heat your house
10.	Furnace		j) range of temperatures most people prefer for indoor settings

5. **Listening**

Listen to the presentation about heat pumps by clicking on the following link:

A heat pump – Inżynier Budownictwa (inzynierbudownictwa.pl)

6. **Translate these words from the above listening exercise into English:**

1. samowystarczalny pod względem energetycznym	
2. dolne żródło ciepła	
3. górne żródło ciepła	
4. sprężarka	
5. parownik	
6. skraplacz	
7. zawór rozprężny	
8. czynnik roboczy	
9. niskotemperaturowy system grzewczy	
10. chłodzenie	
11. ogrzewanie	
12. bezobsługowy	
13. wspólczynnik wydajności cieplnej	

7. **Match the English phrases to their Polish translations:**

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

1. First and foremost
2. We are meeting to talk about
3. How does it work?
4. It is characterized by a long lifespan
5. It has a low failure rate
6. It requires very little maintenance
7. It depends on how it is used.
8. It's best to entrust the installation to a qualified design engineer
9. What about the financial aspect?
10. It's quite an expensive investment

a) Wyróżnia się długim okresem użytkowania.
b) Praktycznie nie wymaga obsługi.
c) Przede wszystkim/w pierwszej kolejności
d) Jest mało awaryjny.
e) To zależy od jego zastosowania.

f) Spotykamy się, żeby porozmawiać o…
g) A jak wygląda aspekt finansowy?
h) To dość droga inwestycja.
i) Jak to działa?

8. **Reading – Heat Pumps:**
Read about heat pumps and do the comprehension questions.

Heat Pumps

The principle of a heat pump is very simple. It uses low-temperature solar and geothermal energy **accumulated** in the soil and groundwater. The Earth heats up slowly and stores energy through spring, summer and autumn as a battery. Consequently, the stored energy is so large that it is easily sufficient to heat the house in winter.

This takes place as follows: low-temperature heat from the ground or water is passed through the **evaporator** to the installed pump. The pump is filled with low-boiling liquid which turns into a gas. The heated gas is **compressed** by a pump compressor which raises the temperature significantly.

In the **condenser** the water is then heated which fills the **heaters** and cooled fluid flows through the **expansion valve** back into the evaporator, and the entire process begins again.

The task of a pump is, therefore, **transferring** (not producing) a heat from the low-temperature source (lower heat source) to a higher temperature source (upper source, e.g. floor heating).

In order to achieve 100% heating power the heat pump uses approximately 70% energy contained in the ground or in the air and 30% electrical energy. The heat pump can be used not only for heating but also for preparing domestic hot water and even for cooling. A **parameter**, which compares the performance of heat pumps is the COP (Coefficient of Performance). It tells how much free heat from the natural environment the device uses in relation to current consumption. In other words, it determines the **efficiency** of a pump.

COP = Q / Qe (Q- heat passed during measurement, Qe- electricity consumption during the measurement). A heat pump works most **effectively** when the COP reaches a maximum value, which is closely related to two temperatures:

1. at input to the heat pump from a lower source and
2. at the power supply of the heating system. The smaller the difference between these temperatures, the greater the efficiency of the pump…

…The theoretical maximum value of COP is 9. This value is **unattainable** in practice. For example, for brine/water heat pumps of different manufacturers, COP is from approximately 4.0 to 5.0 for parameter B0W35. Very high values of COP that **deviate** from the required EN 14511 standard can be found in various promotional brochures

or technical data of heat pumps. This problem is very important because a number of customers decide to choose a particular device based on **the COP coefficient** specified by the manufacturer…

SOURCE: http://www.optimapolska.com.pl/heat-pumps/ [Retrieved 18.01.2023]

9. **Vocabulary** – Fill in the blanks using the vocabulary words from the text.

1. Heat pumps use low-temperature solar and geothermal energy _____ in the soil and groundwater.
2. The heated gas is _____ by a pump compressor.
3. The water is then heated in the _____.
4. The cooled fluid flows through the _____ _____back into the evaporator, and the entire process begins again.
5. A _____ which compares the performance of heat pumps is the COP (Coefficient of Performance).
6. A heat pump works most _____ when the COP reaches a maximum value
7. The theoretical maximum value of COP is 9, although it is _____ in practice.

10. **Discussion questions**

1. What do you think about presented methods of heating residential buildings?
2. Is there any other way to reduce CO_2 in a process of heating our houses?
3. Are you interested in changing the way your house is heated from coal to more eco-friendly methods?

Unit 20. Cleaning up Poland's Air

1. **Introduction:**

a) What is acid rain?
b) What chemicals are released into the atmosphere when we burn coal?
c) What effect do these chemicals have on our environment?
d) What can be done to reduce the negative effects of burning coal?

2. **Read an excerpt of an article about efforts to improve Poland's air. Fill in the gaps with the correct vocabulary word. Answer the comprehension questions.**

a) industrial, **b)** constructed, **c)** pollution,
d) combustion, **e)** effectiveness, **f)** emissions,
g) chamber, **h)** chimney, **i)** converting, **j)** fertilizer

Scientific Forum 2015: Electron Beams Help Poland's Coal-Driven Power Industry Clean Up its Air

Nicole Jawerth, IAEA Office of Public Information and Communication

The pilot flue-gas treatment plant in Poland is helping the country to explore the (1)_____ of electron beam accelerators for removing pollutants from flue gases produced by coal-fired power plants…Radiation technology is expected to play an increasing role in Poland and other countries in cleaning up air (2) _____ to meet regulatory requirements and to protect the environment.

An IAEA-supported project in Poland has helped the country to build a full-scale electron beam accelerator facility to treat flue gases from coal-driven power plants, leading to a significant reduction in (3) _____ of sulfur dioxide, nitrogen oxides and polycyclic aromatic hydrocarbons, which threaten human health, damage the environment and can lead to economic losses. Acidic pollutants in the air can also drift to other countries through acid rain…

"Poland is producing 90% of its electricity from coal (4) _____. So air pollution is a big problem, and Poland has to meet regulations regarding air pollution control," said Lech Sobolewski, Chief Engineer in charge of construction and operation of the electron beam cleaning installation, built with IAEA support, at the Pomorzany Power Plant…This electron beam treatment facility efficiently removes up to 95% of sulfur dioxide (SO2) and 70% of nitrogen oxides (NOX) present in flue gases, allowing the coal-fired power plant to meet emission limits. The by-product of the process is a high quality (5) _____ used in agriculture…

Slow to catch on, but effective

The use of electrons to treat flue gases is not a new concept. The technology was first developed in Japan in the 1970s, but its slow emergence at (6) _____ scale meant many older coal power plants were fitted with other, more costly cleaning devices. However, despite the initially slow industrial-level progress, several countries are now actively pursuing this technology to reap its benefits… Pilot plants have been (7)_____ in Bulgaria, China, Malaysia, South Korea, Russia and Turkey. Brazil, Chile, the Philippines and Ukraine are also looking into technology transfers, while heavy oil combustion systems in Saudi Arabia and Denmark have undergone preliminary laboratory tests…

THE SCIENCE – Electron beam dry scrubbing

Before flue gases — the combustion exhaust gases produced by power plants — escape through the (8)_____ of a power plant, they are sent through a "cleaning" process called electron beam dry scrubbing.

In this process, the gases are cooled to between 70°C and 90°C with a spray of water and then diverted into a reaction (9) _____. There the wet gases are exposed to low energy electron radiation from an accelerator, which acts similarly to the tubes found in old television sets. Ammonia is then added to neutralize the SO2 and NOX, causing them to change chemical form and become solid aerosols. A high efficiency machine gathers and filters these sticky particles, (10)_____ them into high quality fertilizer. The remaining "cleaned" gases leave through the chimney.

Though radiation is used to treat the gases, there is no residual radiation in the cleaned gas or the fertilizer by-product.

SOURCE: https://www.iaea.org/newscenter/news/scientific-forum-2015-electron-beams-help-polands-coal-driven-power-industry-clean-up-its-air [Retrieved 24.01.2023]

3. **Comprehension Questions:** Answer **True** or **False**.

1.	Electron beam accelerators can be used to remove pollutants from flue gases produced by coal-fired power plant.	T	F
2.	The technology was first developed in Bulgaria.	T	F
3.	No other country except for Poland is interested in using this technology	T	F
4.	Ammonia is added to flue gases to change them into a solid.	T	F
5.	There is no residual radiation in the cleaned gas or the fertilizer by-product.	T	F

Acid rain, explained:
https://www.nationalgeographic.com/environment/article/acid-rain

Areas in danger from acid rain:
https://open.uj.edu.pl/mod/page/view.php?id=1319

Unit 21. Business opportunities

1. Scan the advertisement for business opportunities in Poland. Can you think of any other business opportunities in the coming years connected to energy efficiency and decarbonization?
2. Put the words in the box below in the proper place in the text.

a) solutions, **b)** demand, **c)** carbon footprint,
d) suppliers, **e)** industrialised, **f)** decarbonizing, **g)** efficiency

Business Opportunities in Poland

We welcome you to learn about the business opportunities in (1) _____ Poland's industry, the drivers and (2)_____ needed in this field.

Poland is an (3) _____country, with high level of emission from industry as compared to other European economies. The reasons are e.g., heavy fossils dependence and low energy and materials (4) _____ in production plants. Lots of Polish production is exported so the pressure to decarbonize comes from the consumers and international partners, which strive to reduce their (5) _____ _____ and therefore (6) _____certain emission reductions from their (7)_____.

Points of interest and solutions wanted in Poland are:

1. *RES & waste heat utilisation*
2. *alternative methods of production to reduce energy consumption in processes*
3. *process optimisation and advanced control*
4. *general interest in innovations in production*
5. *waste management and circular solutions*
6. *in longer perspective larger players consider CO_2 capture and utilisation*

Funds for industrial energy efficiency and circularity of materials are provided in Poland from various sources including RRF. Other instruments applicable specifically for decarbonisation are Innovation Fund, Just Transition Fund and Modernisation Fund.

SOURCE: https://www.businessfinland.fi/en/whats-new/events/2022/business-opportunities-in-poland--decarbonizing-industries [Retrieved 06.05.2023]

3. **Discussion Questions:**

1. How does **waste heat utilisation** work?
2. How can we reduce energy consumption in industrial processes? Give some examples.
3. What is **CO_2 capture** technology? How does it work?

4. **Listening:**

Watch the film about CO_2 carbon capture technology developed by company Climeworks. (42) Climeworks – Capturing CO_2 from air – YouTube

What are your thoughts about this technology?

5. **Reading:**

Read the description of their product and do the vocabulary exercises below.

Climeworks is capturing CO_2 from air with the world's first commercial **carbon removal** technology. Our **direct air capture plants** remove CO_2 from the atmosphere to supply to customers and to unlock a negative emissions future. We built and operate the world's first commercial direct air capture plant in Hinwil (Switzerland), removing 900 tonnes of CO_2 from ambient air per year (as seen in the video).

Our plants capture atmospheric carbon with a filter, using mainly **low-grade heat** as an energy source. The pure CO_2 gas is sold to our customers in key markets, including: commercial agriculture, food and beverage industries, the energy sector and the automotive industry. Customers utilise this atmospheric CO_2 in carbonated drinks or for producing carbon-neutral hydrocarbon fuels and materials.

By using Climeworks' CO_2, our customers can reduce their overall emissions as well as lowering their dependence on fossil energy. Our plants are **modular, scalable** and can be located independently of emission sources, allowing security of supply wherever there is atmospheric air.

Importantly, our plants can be utilised for negative emissions, which will be vital in the quest to limit a global temperature rise of 2°C. Compared to other carbon removal technologies, direct air capture does not depend on **arable land**, has a small physical footprint, and is fully scalable.

SOURCE: https://renewable-carbon.eu/news/climeworks-launches-worlds-first-commercial-plant-to-capture-co2-from-air/ [Retrieved 03.04.2023]

6. **Translate the words from English into Polish:**

Carbon removal	
Direct air capture plant	
Low grade heat	
Modular	
Scalable	
Arable land	

7. **Discussion Questions:**

1. What do you think about carbon capture technology?
2. Will it make sense to install such systems in Poland?
3. Have you heard of any other companies trying to capture carbon?

Answer key

- **Clean Energy Studies at Bialystok University of Technology**
  1. geopolitical; 2. civil; 3. broad; 4. international; 5.generators; 6. turbines; 7. panels; 8. lungs; 9.employees; 10. radiation; 11. versatile; 12. mathematics

- **Unit 1. Energy, Power, Work**
  Match the words: 1b, 2c, 3a

- **Unit 2. Various Forms of Energy**
  Vocabulary: 1. thermal, 2. nuclear, 3. chemical, 4. mechanical, 5. electromagnetic
  Reading: 1. energy of an object, 2. work, 3. energy of motion, 4. gravitational potential energy,
  5. kinetic energy, 6. frictional force, 7. hydropower energy, 8. wind power

- **Unit 4. Measuring Energy**
  3. 1d, 2a, 3c, 4b, 5c, 6a, 7b

- **Unit 6: Volcanoes or Humans?**
  Comprehension Questions: 1. 60x more; 2. burning fossil fuels, cement production, deforestation;
  3. yes

- **Unit 7. Air Quality**
  Vocabulary: 1d; 2g; 3f; 4a; 5b; 6e; 7c

- **Unit 8. Conflict among Poland's Neighbors**
  Vocabulary: 1f, 2d, 3b, 4a/j, 5a/j, 6g, 7i, 8h, 9c, 10e
  Comprehension questions: 1. 24.4%; 2. decarbonization of the energy sector; 3. nickel, graphite, manganese, lithium
  Word formation: to decelerate; stagnation; to invade, to contribute; motivation

- **Unit 9. Insulation of Buildings**
  Video comprehension questions: (1) false; (2) true; (3) false; (4) false; (5) true; (6) false; (7) true; (8) false; (9) true; (10) false
  Vocabulary: 1C; 2A; 3H; 4F; 5I; 6B; 7J; 8D; 9G; 10E

- **Unit 10. Public Transport**
  Grammar: (1) a/any; (2) of; (3) because/since/as; (4) take; (5) with; (6) was/were; (7) home; (8) by; (9) that/which; (10) while; (11) spent; (12) would; (13) not
  Vocabulary: 1d; 2a; 3e; 4b; 5g; 6c; 7f

- **Unit 11. Electric Vehicles**
  Gap Fill: (1) shifting, (2) exhaust fumes, (3) opted for, (4) vicious cycle, (5) derived from, (6) counteract, (7) **eager**
  Car Batteries: (1) b, (2) a, (3) c, (4) j, (5) g, (6) n, (7) m, (8) i, (9) f, (10) h, (11) k, (12) e, (13) d, (14) o, (15) l.

- **Unit 12. Poland's Energy Mix**
  Vocabulary: 1d; 2f; 3a; 4c; 5b; 6e

- **Unit 13. Coal**
  Listening: 1. T; 2. F (80%); 3. T
  Comprehension questions: 1T; 2T; 3F; 4T; 5.F; 6.T; 7F

- **Unit 14. Hydropower**
  Reading: 1. favourable; 2. independent; 3. constructed; 4. accumulator 5. refilled

- **Unit 15. Nuclear Energy**
  Comprehension questions: (1) 1970's, (2) 50 km (31 miles), (3) 1982, (4) 70 ha, (5) 86,1%, (6) 20 (7) $2 billion
  Sentence Order: 1b, 2e, 3d, 4h, 5c, 6g, 7f, 8a
  Comprehension questions: (1) Westinghouse, KHNP, EDF; (2) 6-9 GW; (3) AP1000

- **Unit 16. Innovation in Nuclear Energy**
  Vocabulary: 1e; 2a; 3d; 4b; 5c
  Comprehension questions: 1. district heating, desalination, hydrogen production; 2. accident tolerant fuels, digitalization, nuclear fussion.

- **Unit 17. Poland's Energy Sector for 2040**
  Reading: 1g, 2e, 3a, 4c, 5c, 6b, 7c, 8h, 9j, 10d

- **Unit 18. Energy Efficiency**
  Vocabulary – 1e, 2g, 3a, 4f, 5b, 6d, 7c

- **Unit 19. Geothermal Energy and Heat Pumps**
  Listening comprehension questions: 1T, 2F, 3T, 4T, 5F, 6F, 7T,8F, 9T,10T.
  Translation: 1. Energy self-sufficient; 2. Lower heat source; 3. Upper heat source; 4. Compressor;
  5. Condenser; 6. Expansion valve; 7. Operating medium; 8. Low-temperature heating system;
  10. Cooling; 11. Heating; 12. Maintenance free; 13. COP Co-efficient of Performance
  Translation: 2f, 3j, 4a, 5d, 6.b, 7e, 8g, 9i, 10h
  Vocabulary: 1. accumulated, 2. compressed, 3. condenser, 4. expansion valve, 5. parameter,
  6. effectively, 7. unattainable

- **Unit 20. Cleaning up Poland's Air**
  Reading: 1e, 2c, 3f, 4d, 5j, 6a, 7b, 8h, 9g, 10i
  Comprehension questions: 1T, 2F, 3F, 4T, 5T

- **Unit 21. Business Opportunities**
  Reading: 1f, 2a, 3e, 4g, 5c, 6b, 7d

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Other Useful Links:

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[5] Invention of the Leyden jar – https://www.britannica.com/science/electromagnetism/Special-theory-of-relativity

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[16] Geoengineering VS Climate Change: How To Keep The Earth Alive (interestingengineering.com)
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[3] https://www.english-practice.at/b2/grammar/b2-grammar-index.htm

Further Research Questions

[1] Hydrogen has been discussed as an alternative to the combustion engine. What are some of the challenges to implement hydrogen as a fuel?
[2] Where do resources to make lithium-ion batteries come from? Do we have such resources in our country? Are there any alternatives to such batteries?
[3] Energy production with renewable resources has many challenges. One of them is storage. What solutions for energy storage coming from RES have you heard of?

Abstract

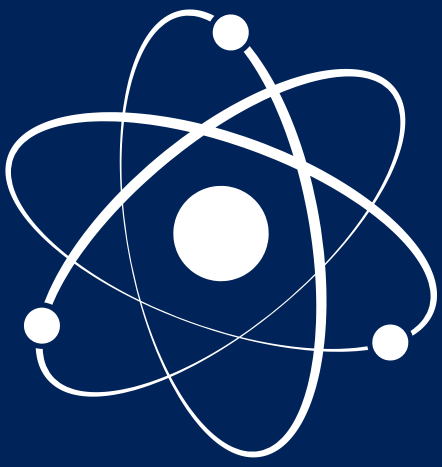
This English as a Foreign Language (EFL) handbook is an attempt to systemize knowledge about the current energy situation in Poland from the point of view of sustainable development (S.D.). How can we build a resilient energy system that will allow Poles to be less dependent on our neighbors to meet our energy needs? How can Poland better align with European Union norms? The handbook is divided into four parts: (1) Basics of Energy and Power; (2) Current Energy Issues in Poland; (3) Electrification (4) Future Opportunities. It is to be used with students who are familiar with the English language on a B1/B2 level, to allow them to meet the requirement of B2 language proficiency at the end of their studies.

Keywords: energy, power, English as a Foreign Language (EFL), Education for Sustainable Development (ESD)

Streszczenie

Niniejszy podręcznik jest próbą usystematyzowania wiedzy o aktualnej sytuacji energetycznej w Polsce z punktu widzenia zrównoważonego rozwoju. Jak możemy zbudować odporny system energetyczny, który pozwoli Polakom być mniej zależnymi od naszych sąsiadów w zaspokajaniu naszych potrzeb energetycznych? Jak Polska może lepiej dostosować się do norm Unii Europejskiej? Podręcznik podzielony jest na cztery części: (1) podstawy energii i zasilanie; (2) bieżące problemy energetyczne w Polsce; (3) elektryfikacja (4) przyszłe możliwości. Ma być stosowany ze studentami, którzy znają język angielski na poziomie B1 / B2, aby umożliwić im spełnienie wymogu znajomości języka B2 pod koniec studiów.

Słowa kluczowe: energia, zasilanie, język obcy, edukacja dla zrównoważonego rozwoju



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