

# CHANGES ON THE ENERGY MARKET

impact on climate, energy prices and consumer attitudes in the context of RES

## INTRODUCTION

Currently, **extreme weather events**, rising water levels in seas and oceans, and prolonged droughts are intensifying all over the world. These are just a few of the many **negative effects of global warming**, the main cause of which is the **growing emission of greenhouse gases into the atmosphere**. In order to limit climate change, it is **necessary to develop renewable energy sources (hereinafter referred to as RES)**, which, in addition to environmental benefits, also provide financial benefits.

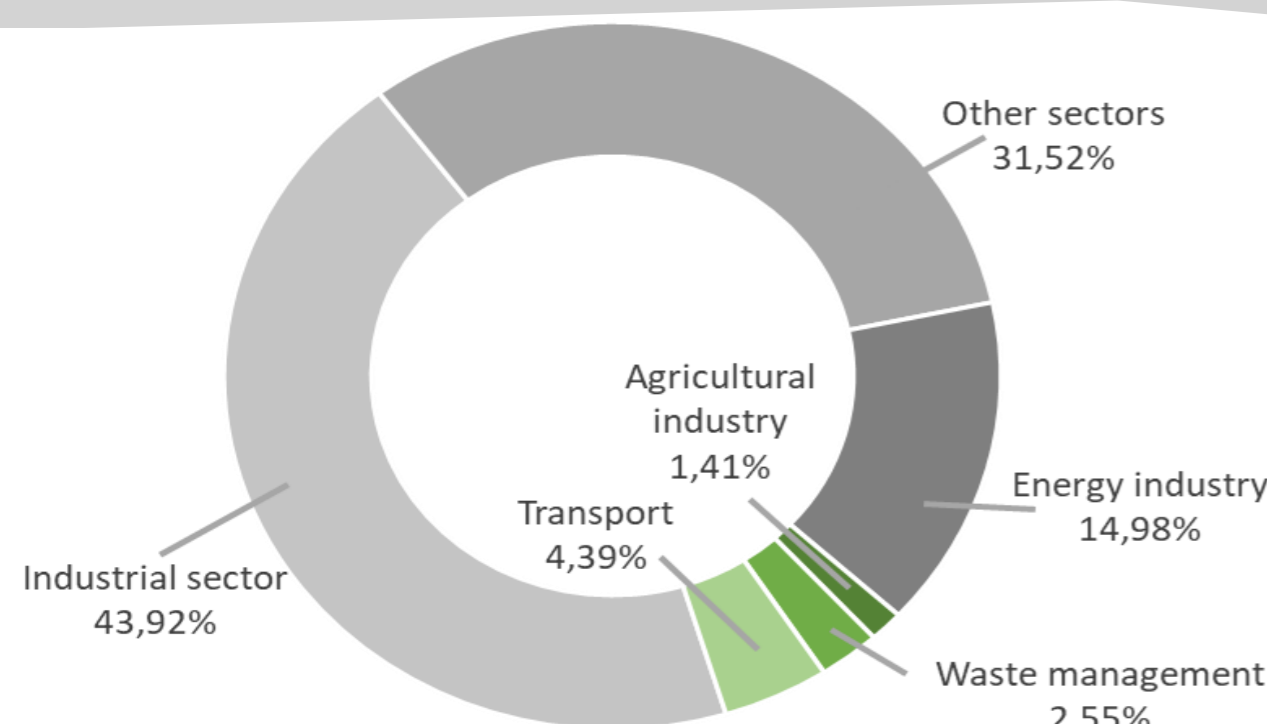
## PURPOSE OF RESEARCH

Demonstration of the positive impact of RES for climate protection and level of electricity prices in the economy, and verification of students' attitudes towards saving energy and using renewable energy sources.

## RESULTS

Among the sectors of the economy in Poland, **the largest emitter of CO<sub>2</sub> remains the energy sector, which is responsible for over 50% of total greenhouse gas emissions into the atmosphere**. Its share in energy consumption is **15%**, but **among emitters decreases year by year**, which allows for an optimistic view in the context of actions to reduce greenhouse gas emissions.

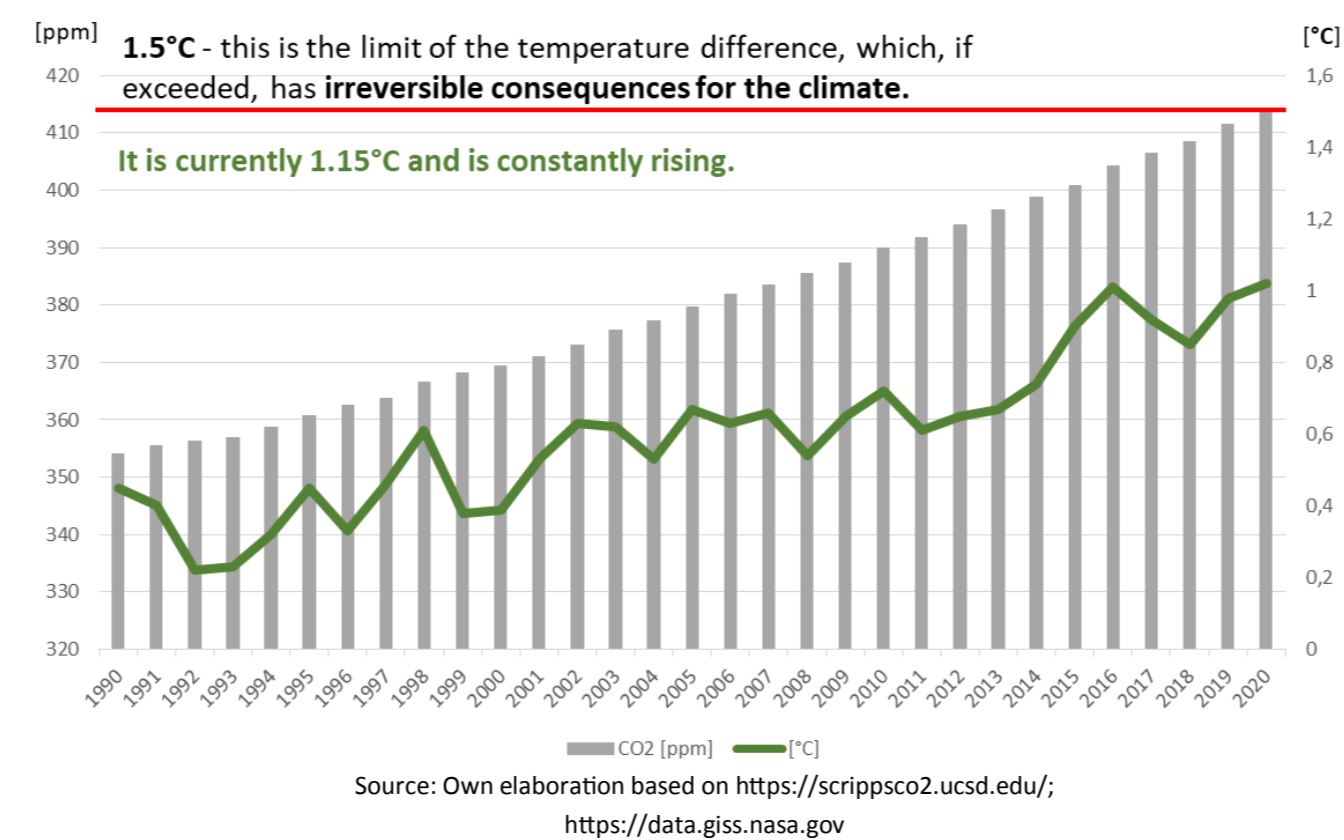
### Share of the largest sectors of the economy in energy consumption



Source: Own elaboration based on Polish Statistics: (GUS) Gospodarka paliwowo energetyczna w latach 2020 i 2021

## CO<sub>2</sub> concentration in the atmosphere and average air temperature anomalies

Over the last 30 years, the concentration of CO<sub>2</sub> in the atmosphere is steadily growing. **There is a positive correlation (0.92, p-value <0.0001) between increases in CO<sub>2</sub> concentration and an increase in the anomaly of the average air temperature on Earth.**



## METHODS AND TOOLS

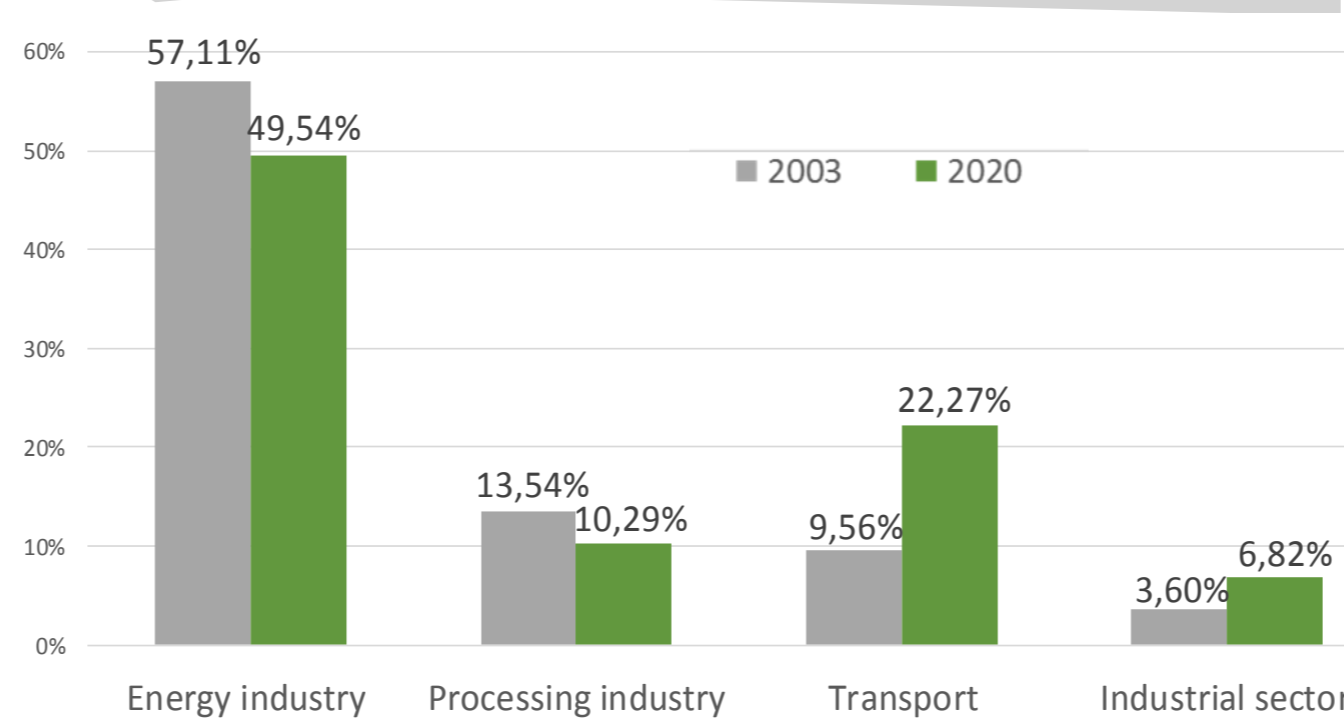
The following data was used to achieve the research goal:

- available in public statistics,
  - own research conducted among 315 students of the University of Information Technology and Management in Rzeszów (Poland).
- The descriptive method and graphical presentation of data based on cross-analysis and chi-square variable independence test performed with MS Excel and JMP Student Edition were used.

## RESEARCH HYPOTHESES

- ⇒ The increase in CO<sub>2</sub> in the atmosphere negatively affects the observed temperature differences on Earth.
- ⇒ Traditional energy sources (fossil) emit the most CO<sub>2</sub>.
- ⇒ In Poland, an increase in the share of RES in energy production is observed.
- ⇒ The price of energy depends on the amount of demand for it.
- ⇒ The largest amount of CO<sub>2</sub> (as a sector of the economy) is emitted by industrial processing.
- ⇒ Most students believe that even small actions have an impact on environmental protection.
- ⇒ The majority of students is aware that:
  - renewable energy is cheaper to produce than this from fossil sources;
  - by how much energy prices increased in 2022.

### CO<sub>2</sub> emissions by largest sectors



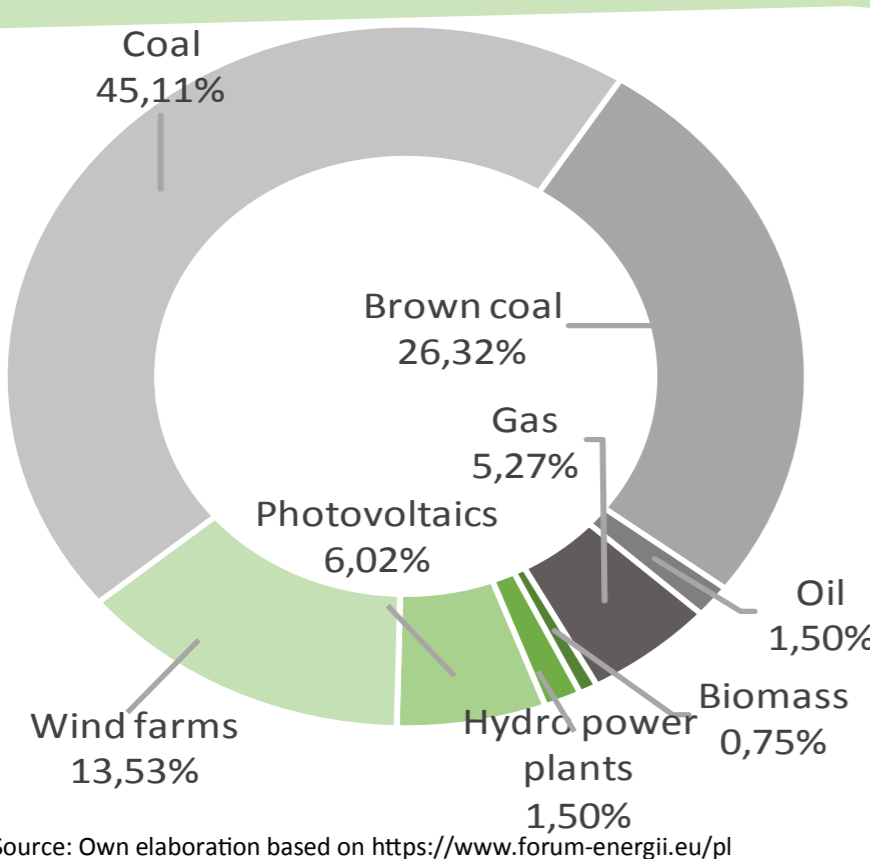
### How much CO<sub>2</sub> do each energy source emit?

Energy source	Made energy in TWh	CO <sub>2</sub> emissions in billion tonnes/1TWh
Coal	122,52	14,586
Oil	5,57	8,0
Gas	17,51	7,960
Water	0,06	2,514
Wind	0,19	2,514

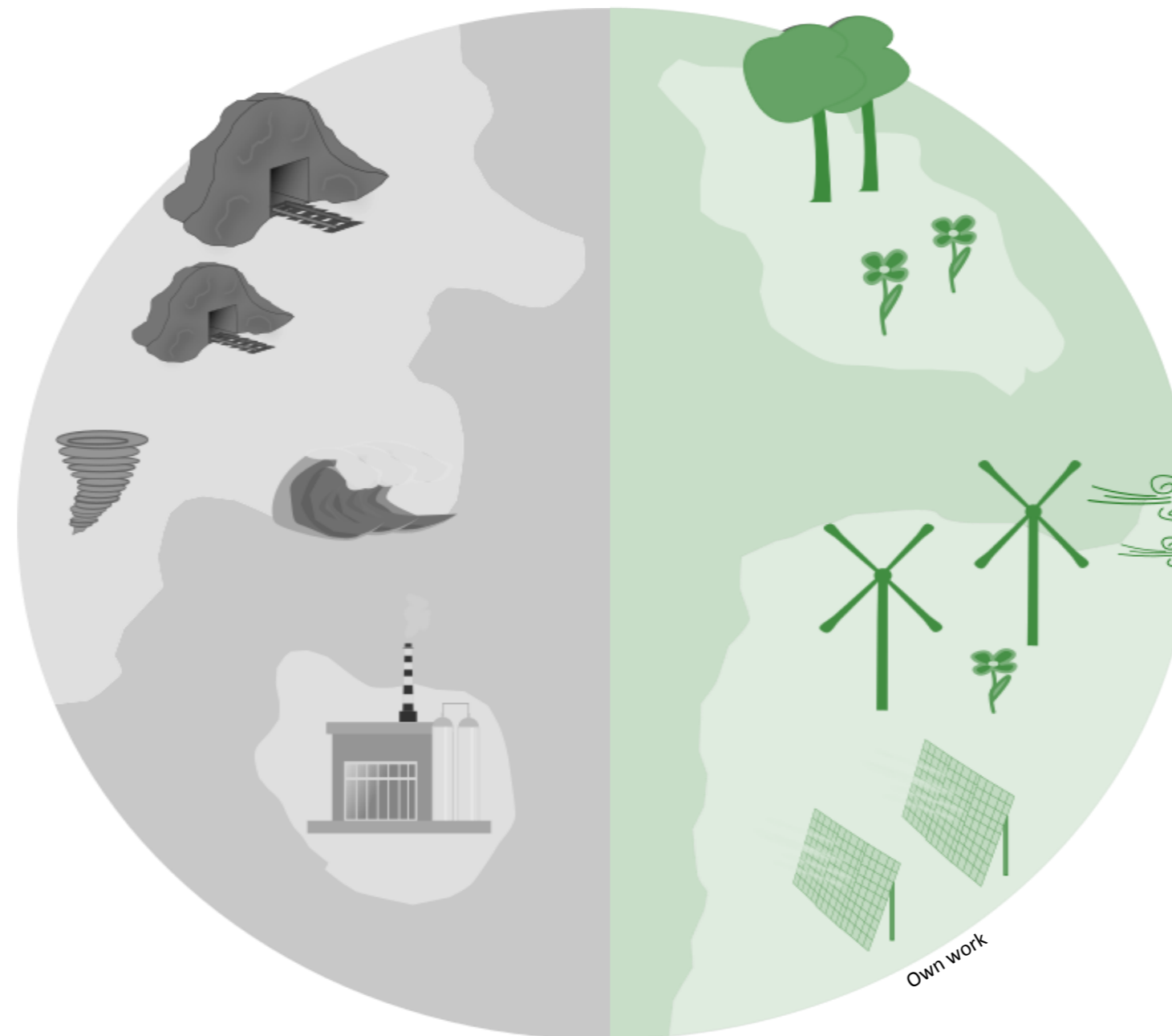
Source: Own elaboration based on Grudziński Z. (2010). Konkurencyjność wytwarzania energii elektrycznej z węgla brunatnego i kamiennego. Polityka Energetyczna, T. 9 spec. 1, pp. 521-534.

**Energy obtained from renewables compared to this obtained from the combustion of fossil fuels emits approx. 317% less CO<sub>2</sub> into the atmosphere FOR THE SAME amount of electricity.**

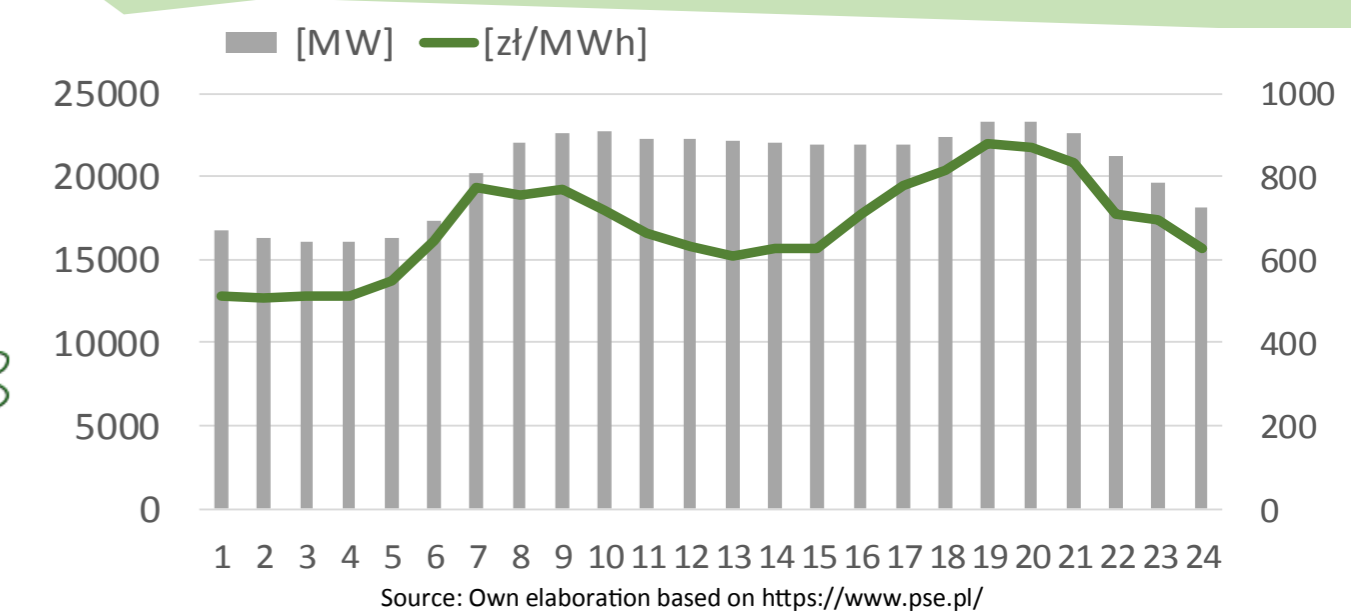
### Energy mix in Poland — October 2022



In 2021, the total share of RES in energy production electricity accounted for **17%** and fossil sources for 83%. Compared to 2000, the share of RES increased by **15.45 pp.**, which is a positive change for the Polish sector energy.



### Demand and market price of energy [as of October 25, 2022]



**With the increase in energy demand for market - the price of energy is rising.** It is the most expensive in the morning, between 7<sup>00</sup> - 9<sup>00</sup> AM and in the evening around 7<sup>00</sup> - 9<sup>00</sup> PM. This is important because for **intermediaries**, i.e. energy suppliers, unlike consumers, the price is not fixed and varies depending on the type the source from which it was produced.

### Students attitudes

Research group: 315 students (183 female i 132 male)  
49% pay their own bills,  
62% is working (making money)

Significance level:  $\alpha = 0,05$   
Chi-square test -  
dependent variables when p-value <  $\alpha$

To whom, in your opinion, belongs to obligation to reduce CO<sub>2</sub> emissions?

The politicians who rule the country 15%

I have no opinion 7%

To every citizen, regardless of age 52%

To entrepreneurs and large factories 26%

⇒ 64% believe that RES energy is cheaper in production, while the remainder points to fossil sources. (p-value 0,0025)

⇒ 5 out of 6 working people are aware of the increase in electricity prices. Among those who are not working, it is 7/8 people. (p-value 0,5544)

⇒ 58% of those paying bills in person correctly indicated the increase in electricity prices. Among those whose bills are paid by their parents or partner, it is 46% (p-value 0,1108)

What attitudes are declared by students?

Uses energy-saving light bulbs

Turns off the light after leaving room

Removes the plugs from the socket, When not using the device.

How do you think energy costs have changed in 2022 compared to the end of 2021?

Increased by 5% 37% answer

Decreased by 20% 2% answer

Decreased by 5% 9% answer

They stayed on the same level 9% answer

Are steps being taken in Poland to switch from non-renewable energy to renewable energy?

Yes 23%

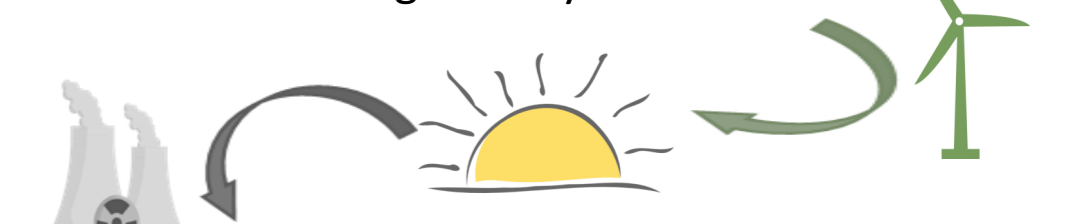
No 45%

I have no opinion 32%

Increased by 25% 43% answer

### Evolution of energy prices during the day

The cheapest energy, i.e. solar and wind energy, is used first during the day.



When the energy generated by renewables runs out, more and more expensive power plants are put into operation. As a result, the price of energy sold on the exchange is almost always shaped by the most expensive units, i.e. gas and coal power plants. **The price offered by the most expensive unit at a given moment is the marginal price.**

## RESULTS

- ⇒ The increase in CO<sub>2</sub> concentration in the atmosphere increases the average air. As the concentration of CO<sub>2</sub> increases, the temperature on the surface increases Earth, which can lead to catastrophic consequences on a global scale.
- ⇒ Energy from renewable sources emits less CO<sub>2</sub> than energy obtained from burning fossil fuels.
- ⇒ The largest emitter of greenhouse gases is the energy industry, but its share in total emissions is steadily decreasing.
- ⇒ Increasing the share of RES in the energy mix may lead to a decrease in greenhouse gas emissions in the energy sector.

- ⇒ Daily changes in energy production prices are affected by (1) the time of day and (2) the amount of energy consumed. Depending on the amount consumed energy, more and more expensive energy generation sources are activated.
- ⇒ A decrease in energy prices could be caused by (A) Reducing the amount of energy used and/or (B) increasing the share of RES among energy generation sources.
- ⇒ Students are aware of the positive impact of small actions to protect the environment, as well as decisions each person to reduce CO<sub>2</sub> emissions.
- ⇒ 2/3 of students believe that RES energy production is cheaper.
- ⇒ Nearly half of the students do not realize the increase in energy prices, or does not see how much its price increased during 2022.

## COMMENTS

The lack of statistical significance of some of the obtained results indicates the need to expand the research group in the future.

## REFERENCES

1. Forum Energii: <https://www.forum-energi.pl/>;
2. GISS Surface Temperature Analysis (NASA): <https://data.giss.nasa.gov/>;
3. Grudziński Z. (2010). Konkurencyjność wytwarzania energii elektrycznej z węgla brunatnego i kamiennego. Polityka Energetyczna, T. 9 spec. 1, ss. 521-534.
4. Polish Statistics: Ochrona Środowiska (statistical yearbooks from 2003 to 2020);
5. Polish Statistics: Gospodarka paliwowo energetyczna w latach 2020 i 2021;
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7. Polskie Sieci Energetyczne: <https://www.pse.pl/>;
8. Polski Komitet Energii Elektrycznej: <https://pkce.pl/>;
9. Clipart images