The reduction of greenhouse gas emissions is a priority for the European Union (EU) and a binding target for member states. This requires a shift away from burning fossil fuels, which entails a fundamental change in energy infrastructure for some European countries, including Poland, where most energy is still generated from coal combustion. Replacing fossil fuels requires the development of renewable energy sources, especially in the area of solar and wind power. However, these sources are considered unstable due to their seasonal nature and dependence on weather conditions, which lead to irregular energy generation. Even with a high installed capacity of these sources, there will be periods of low-energy generation or generation of excess energy. This implies potential, large, and uncontrollable volatility of energy prices.

A strategy based solely on increasing the capacity of renewable energy sources is insufficient to ensure a continuous supply of energy and to maintain low prices. Currently, two solutions to this problem are proposed. The first is energy storage, although this is usually inefficient (except for pumped-storage power plants). The second is supplementing the missing capacity through cross-border trade or through selling surplus energy. The effectiveness of this solution depends on the uncorrelated supply of energy in neighbouring markets. In practice, this trade is intended to equalise electricity prices in adjacent markets. If one market experiences a low-energy supply, it can be supplemented by high supply in another. In this project, we will examine the extent to which the existing transmission infrastructure between Central and Eastern European countries activates the mechanism of equalizing electricity prices and limiting their volatility. We will also investigate the impact of energy trade on the balance of greenhouse gas emissions. Although the ultimate goal for the EU countries is to produce electricity exclusively from non-emitting sources, they are still rather a long way from achieving this target.

The choice of Central and Eastern European countries is justified by several factors. First, these countries have a diverse electricity mix and electricity markets of different sizes. Second, they were heavily dependent on the import of fossil fuels from Russia, which, after its aggression against Ukraine in February 2022, caused significant disruptions in the energy markets of the region. Third, these countries are currently undergoing an intensive energy transition, although they are at different stages of this process. Finally, they have not previously been studied from this perspective.

A unique feature of electricity markets is that energy demand in a given country is highly seasonal. For example, analysing peak and off-peak hours makes it possible to study markets of different sizes, which helps to determine under what conditions the capacity of cross-border interconnections is sufficient to exert a significant impact on energy markets. The project will use data of varying frequencies, including monthly, weekly, and hourly data, as well as advanced econometric methods that allow us to analyse different aspects of the electricity market.

Within the project, we will address four research questions. The first concerns the convergence of prices in the electricity markets of Central and Eastern Europe. The second aims to assess the role of cross-border trade in price convergence. The next question focuses on the impact of electricity trade on prices and volatility in the markets. The last research question relates to the impact of trade on the balance of greenhouse gas emissions.

The results of our research may offer new insights into electricity price convergence and the impact of cross-border trade on the level and volatility of electricity prices and greenhouse gas emissions. Some aspects of this research are novel in terms of the methodologies and markets used, which have been little studied. The results of our project are also relevant for policymakers, as they will show the extent to which cross-border flows influence price formation processes in neighbouring markets. A study carried out in different seasons, hours of electricity consumption, and corresponding to different market sizes, will allow us to determine which interconnection capacities will be sufficient to ensure price equalisation and a significant improvement in energy security. Consequently, the results of this project can help decision makers to optimise the design of cross-border interconnection systems.