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Scenarios for Energy Security of South Caucasus and Southeast Europe

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Abstract

Energy security is a critical issue for countries around the world, as access to reliable and affordable energy resources is essential for economic growth and development. However, the global energy landscape is rapidly changing, with shifting demand patterns, geopolitical tensions, and concerns about climate change all impacting energy security. An unreliable energy supply leads to volatility of energy prices, which damages businesses and consumers. Therefore, the research aims to examine the energy security of Southeast Europe and the South Caucasus, because the energy security of these two regions is dependent on each other. We have used Grey Relational Analysis (GRA) to examine the energy security indicators and how these indicators changed between 2012 to 2022. The research analysis is based on the 15 indicators that affect current and future energy security trends. In addition, the future scenarios developed by the Global Business Network (GBN). The findings show that Gross Domestic Production (GDP), Foreign Direct Investment (FDI), gasoline price, and greenhouse emissions are significant factors in the regions between 2012 and 2022. Therefore, four scenarios emerged: Crystalline Sky, Anarchy is the first word, Cloudy days, and the Apricity of the economy.

Keywords: Grey Relational Analysis, South Caucasus, Southeastern Europe, Energy Security, Global Business Network

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Introduction

Prosperity, economic development, and improving the human development index depend on energy security. Then, states seek to ensure the energy security of their citizens and economy. The energy crises in 1973 (Arab oil embargo), 1979 (Iranian revolution), 1991 (Persian Gulf war), 2007-8 (global financial collapse), etc. caused the energy policy should be a strategic goal of states. Due to the Russian invasion of Ukraine, the international system became more complex, and Geopolitical competition in Eurasia increased. Therefore, during 2021-2023, the energy markets experienced shortages and higher prices afterward the Covid-19 pandemic and the Ukraine war. Thus, global geopolitical changes and the surge in energy demand have made the issue of assuring energy security increasingly significant, both for independence and economic outlook.

Economic growth and reduction of CO2 emissions will not be realized, due to a shortage of fossil fuels and insufficient production of energy sources from renewable energy resources. The current situation makes it crucial to consider the social factor and rising energy prices. Therefore, the flare-up of frozen conflicts around Europe threatens European energy security and stability.

Azerbaijan is one of the energy suppliers of Eastern Europe, and four pipelines (Baku-Supsa, Baku-Tbilisi-Ceyhan (BTC), Baku-Tbilisi-Erzurum (BTE), and Baku-Novorossiysk) are responsible for the export of Azerbaijan's oil and gas to Europe. These pipelines are surrounded by three frozen conflicts, including Nagorno-Karabakh, Russia-Georgia, and Turkey-Greece disputes. These pipelines will become more significant than ever as Europe plans to import an extra 10 bcm of natural gas from Azerbaijan by 2027 (Rzayeva 2023). Therefore, the investments of European banks and companies in the gas fields development in Azerbaijan and pipeline infrastructures in the South Caucasus and Southeast Europe make stability in these regions more essential than ever.

The research aims to investigate the energy security future of the South Caucasus and Southeastern Europe. The authors examine 15 indicators that describe energy security in studied regions under the Availability, Affordability, Accessibility, and Acceptability (4As) during 2012–2022. The research method

to analyze the energy security of these regions is GRA, which belongs to the Multi-Criteria Decision-Making (MCDM). This method is important for determining the weight and ranking of the energy security indicators. Furthermore, we used the Shannon Index to calculate the arithmetic mean of the weight values.

We will develop scenarios based on the GBN method after assessing the countries' energy security by Grey Relational Grade (GRG) in the GRA method. As a result of the GBN method, four scenarios emerged, including Crystalline Sky, Anarchy is first word, Cloudy Days, and Apricity of Economy.

1. Literature Review

Numerous publications have been published on energy security issues. We discuss different articles and then compare their aims and methodologies (Table 1).

Biresselioglu et al. (2017) presented an analysis of energy security in Turkey based on a survey of the top 500 Industrial Companies. The study concluded the uninterrupted energy supply indicator is more important than the legal structure of energy policy. Furthermore, there was no clear fiscal support for the proposition regarding energy costs in supply chain management, which suggests that energy costs are not generally included in supply chains in Turkish industries. Mukhigulishvili (2020) analyzed the energy security indicators in Czechia, Georgia, and Slovakia. The research method is based on the Strengths, Weaknesses, Opportunities, and Threats (SWOT) method. This study concludes that energy security is a significant factor in the national security of selected countries. Therefore, the energy policy of the Georgian state focuses on a reliable energy supply at an affordable price for sustainable development. Crucial energy security indicators for Slovakia include reliable energy supply, cost-effectiveness, energy mix, and climate change.

Czech Republic’s energy security perspective is about the sustainable energy supply at reasonable prices for households and industries. Franki and Viskovi (2015) propose an innovative methodology for analyzing energy security; the

approach quantitatively measures and compares the energy sector based on energy security indicators, including reliability, energy cost, and sustainability. The authors apply Croatian energy statistics in this approach. The research suggested investment in renewable energy resources and new technologies in the energy sector. Although investing in renewable energy is costly, it helps to improve the quality of society, environmental issues, and the industrial sector. Prontera (2018) present an analysis of energy security in Italy based on the International Political Economy (IPE). The author analyzes the domestic and foreign energy policy of Italy and found that the states are the main catalyst in the new energy policy of Europe. It means the state's energy policy is limited to enforcing regulations and supplying economic incentives for energy projects.

Hasanov et al. (2020) present an energy security analysis for the European Union (EU) and South Gas Corridor (SGC). The authors explain that energy security indicators have a significant role in the import route choices of the EU. Their research method is based on Rational Choice Institutionalism (RCI). Due to the diversification of energy import routes, energy import from Azerbaijan is a rational choice, even though they are not economically feasible. Mouraviev (2021) presented Kazakhstan's energy security analysis from the consumers' perspective. The author used a qualitative method based on in-depth interviews. The research aims to identify the consumer's view on energy security supply, the role of renewable energy resources in energy security, and the relations between energy security and environmental sustainability. The author concluded the majority of participants views believed oil is the main factor in the independence and stability of the country. Furthermore, selected participants believed that energy security is a significant factor in the development of the economy.

Tavana et al. (2012) analyzed international routes of the Caspian Basin states to world energy markets. The research aims to evaluate alternative trade routes with the SWOT analysis based on the Delphi method. They stated that decision-makers must consider multiple factors, including internal strengths, and weaknesses, as well as external opportunities and threats. As a result of this method, decision-makers think systematically and carefully about uncertainty

factors in international export routes. Therefore, the article concluded the southern and western trade routes are the best to export energy products from the Caspian Basin to global energy markets.

Cobanli (2014) conducted a study on the Central Asian gas trade and its impacts on various actors. The research aimed to explain why different actors were interested in participating in the gas trade in Central Asia, treating it as a strategic game. To accomplish this, the author utilized game theory and developed a quantitative model that quantified the bargaining power structure using the Shapley value. The findings of the study indicated that Turkmenistan's most advantageous westbound route for gas trade is through the Caspian Sea to Turkey. Furthermore, as a transit country, Turkey experiences significant benefits from facilitating the east-west gas trade.

Rodríguez-Fernandez et. al (2020) examine developments of gas supply security in the EU during 2006 and 2009 (Gas crises). The research method is causal ordering risks. The authors concluded the energy security of the EU improved costly. Therefore, a group of states has seen their gas supply security worsen, another has made low improvement, and Latvia is the only one that has made significant progress. Several aspects of energy security have been covered in the literature review published, including energy security in a single country or a comparison of a group of countries. Furthermore, energy security indicators also have been investigated with different methods, including qualitative and quantitative methods.

A series of recent shocks, including Covid-19, the energy crisis in 2021-22, and the Russian invasion of Ukraine, are all threatening to slow down the process of achieving carbon neutrality, economic development, and human security. Therefore, the energy security of the European states is a significant factor for their future.

The role of Azerbaijan as one of Europe's energy suppliers also increased because currently, the country exports energy to Europe through four pipelines: Baku-Supsa, BTC, BTE, and Baku-Novorossiysk. South Caucasus plays a significant role as a transit and producer region in the energy security of Europe.

Therefore, the research aims to investigate the future of energy security in the South Caucasus and Southeastern Europe.

Authors/ Publication year	Aims	Methodology
Biresselioglu et al (2017)	Explore the perceptions of the Turkish industry on energy security issues	Survey, explanatory research
Franki and Viskovi (2015)	The article aims to introduce a framework that helps decision-makers to make suitable decisions for today and the future of energy security.	Analysis the energy security indicators by the vector mathematical structure in Cartesian coordinate system
Mukhigulishvili (2020)	Review the strategic documents and consult with key stakeholders on Georgia, Czechia, and Slovakia's perceptions of energy security. Analyze their national objectives and targets for energy security.	SWOT analysis
Prontera (2018)	In this article, the author analyzes the new patterns of old politics and energy diplomacy associated with Italian gas pipelines and infrastructures through a historical comparative analysis. (Case study Southern Gas Corridor (SGC) and the Trans Adriatic Pipeline (TAP))	Using the International Political Economy on the energy security issues by Susan Strange
Hasanov et al (2020)	The research seeks to determine whether supporting SGC is reasonable or not	Cost economics and Rational Choice Institutionalism (RCI)
Mouraviev (2021)	The research aims to identify the consumer's view on energy security (Supply, economic, and sustainability)	Depth interviews
Tavana et al. (2012)	The research aims to evaluate alternative routes with the SWOT analysis based on the Delphi method.	Hybrid model (SWOT analysis and Delphi method)
Cobanli (2014)	Develop a possible agenda for forecasting and responding to economic, social, and environmental changes.	Game-theory in a quantitative model and Shapley value
Rodríguez-Fernandez et al. (2020)	Evaluate the gas supply development in EU during the 2006 and 2009 gas crises	Causal ordering risk

Table 1: Comparison selected publications

Source: (Authors, 2025)

2. Methodology

At the end of the 20th century, although energy security was not a geopolitical issue, international trade of fuels, particularly oil, remained a critical issue. In this regard, natural sciences, engineering, and economics have become involved in energy security discussions because of vulnerabilities of complex technical systems, global limits, and market forces (Cherp and Jewell, 2011). Therefore, to better understand the current energy trends of Southeastern Europe and the South Caucasus, we use 15 indicators to assess energy security. Furthermore, the indicators are characterized by the 4As.

Availability: Oil is a fundamental energy resource for the development of countries. Therefore, the amount of oil in the world might not be able to keep up with the increase in energy demand. Furthermore, having alternative energy resources is beneficial to sustaining global consumption. Affordability: Uninterrupted energy supply sources at an economical price. Accessibility: Households and industries have reliable and affordable access to energy, such as oil, gas, and electricity. Acceptability: energy demand increased the emission of greenhouse gases into the environment and polluted air (Erahman et al. 2016). Figure (1) shows the relationship between Technology, Geopolitics, Economics, and Environment with the 4As.

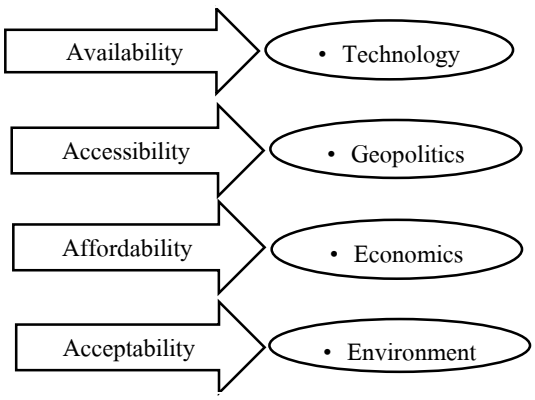

Figure 1: 4 As

Source: (Authors, 2025)

We present adopted indicators and their descriptions in Table (2).

4As	Indicators	Explanation
Availability	Primary energy consumption	Primary energy consumption is the total demand for energy in a country (Eurostat statistics, 2023).
	Renewables (%)	As a part of the total supply of primary energy, renewable energy is defined as the contribution of renewable sources (Makieła et al., 2022).
	Energy per capita	It is a measure of how much energy each individual consumes in a country (Coccia, 2010).
	Energy import dependency	The energy dependency rate indicates how much energy of economy imports (European Parliamentary Research Service, 2012)
	Electricity generation	Electricity generated from renewable sources, fossil fuels, and etc. (OECD, 2023).
Affordability	Energy per GDP	GDP to energy usage indicates energy efficiency (World Bank, 2017).
	Human Development Index (HDI)	HDI indicates average achievement in key dimensions of human development: longevity, knowledge, and decent standard of living (United Nations, 2022).
	FDI	The term FDI refers to investments from private parties into business of other countries with a view to establishing sustainable interest (Corporate Finance Institute, 2019)
	GDP	In economic terms, GDP is the monetary value of all goods and services produced in a country during a particular period of time, i.e., those sold to the final user (IMF, 2019).
	Gasoline price	The Gasoline price is influenced by supply and demand. Additionally, it responds to geopolitical events that affect the oil industry (Wagner, 2022).
Acceptability	CO2 Emission	The term “emissions” refers to the CO2 released from the combustion of oil, coal, natural gas, and etc. (Arvin et al. 2015)
	CO2 Emission per capita	CO2 emission per capita are calculated by dividing its total emissions by its population (Bento, 2016)
Accessibility	Market concentration (Herfindahl-Hirschman Index (HHI))	Market concentration refers to how many companies are participating in a given market (Krivka, 2016)

	Access to electricity (%)	The percentage of the population that has access to electricity is known as access to electricity (Shyu, 2014)
	Access to clean fuel and technology for cooking (%)	The percentage of overall population that uses clean cooking fuels and technologies (Gill-Wiehl, 2021)

Table 2: Dimensions, Indicators, Units, and Explanations
Source: (Authors, 2025)

The methods used for the study include Grey Relational Analysis (GRA) and Global Business Network Scenario Planning. Furthermore, we collected of our data from the World Bank database (World Bank, 2023), BP statistical review (British Petroleum, 2022), our world in data-base (Our World in Data, 2022), and International Energy Agency database (IEA, 2022).

2.1. Grey Relational Analysis

Deng developed the GRA method to solve uncertainty problems relating to discrete data and incomplete information. Furthermore, the negative information is defined as black, while positive information is defined as white. Those situations between black and white indicators are identified as grey, hazy, or fuzzy indicators. GRA has several major advantages, such as displaying the original data and having simple, straightforward calculations. The procedures are summarized as follows (Wang et al. 2013):

Step1: Constructing a decision matrix. It is constructed a decision matrix containing a set of alternatives = (A_1, A_2, …, A_m) and criteria = (C_1, C_2, …, C_m):

$$Y=\begin{bmatrix} y_{11} & y_{12} & \cdots\cdots & y_{1\square} \\ y_{21} & y_{22} & \cdots\cdots & y_{2\square} \\ y_{m1} & y_{m2} & \cdots\cdots & y_{mn} \end{bmatrix} \longrightarrow \text{decision matrix}$$

Step2: Calculating the normalized decision matrix. There are three types of data treatment; larger-is-better, smaller-is-better, and nominal-is-best. All of the indicators inform between [1 to 0] after normalized.

$$X_{ij} = \frac{y_{ij} - \min(y_{ij})}{\max(y_{ij}) - \min(y_{ij})} \quad \text{---------- > Larger is better}$$

$$X_{ij} = \frac{\max(y_{ij}) - y_{ij}}{\mathrm{Max}(y_{ij}) - \min(y_{ij})} \quad \text{---------- > Small is better}$$

$$\text{---------- > Nominal } X_{ij} = \frac{|y_{ij} - y^*|}{\max\left(\mathrm{Max}(y_{ij}) - y^*, y^* - \min(y_{ij})\right)} \quad \text{is best}$$

$$\text{Normalized } X = \begin{bmatrix} x_{11} & x_{12} & \cdots\cdots & x_{1\square} \\ x_{21} & x_{22} & \cdots\cdots & x_{2\square} \\ x_{m1} & x_{m2} & \cdots\cdots & x_{mn} \end{bmatrix} \quad \text{decision matrix}$$

Step3: Figure out the distance of Δ_{ij}, the absolute value of difference between X_{oj} and X_{ij} point. The formula is:

$$\Delta_{ij} = X_{oj} - X_{ij}$$

Step4: Using a grey relational equation to figure out the grey relational coefficient ri(j) using the following equation:

Distinguishing coefficient (r)= 0.5

$$\gamma\,(x_{oj}, x_{ij}) = \frac{\Delta_{min} + r\Delta_{max}}{\Delta_{ij} + r\Delta_{max}}$$

Step 5: After calculating all the coefficients, the grade of the grey relation is calculated with the following formula:

$$(x_{oj}, x_{ij})\Gamma(x_o, x_i) = \sum_j^n w_j\,\gamma$$

w_j= entropy Method= weight of the indicators

Entropy formula:

$$E_j = -k \sum_{i=1}^{m} x_{ij}^{*} ln x_{ij}^{*}, j = 1,2,\ldots\ldots,n$$

$k = \frac{1}{lnn}$ ln is a constant that guarantees Ei $\in$ [0, 1].

$$w_i = \frac{1 - E_i}{\sum_{i-1}^{m}(1 - E_i)}$$

Weight of the indicators

Negative numbers have no logarithm, so when calculating a variable's weight, the smallest negative number is added to all variables.

2.2. Global Business Network Scenario planning

In an uncertain and volatile world, GBN is a leading method that assisted organizations in scenario planning. Scenario planning was one of the most well-known tools used by the GBN. As a result of scenario planning, a surprising and plausible future is created by juxtaposing current trends in unpredictable combinations, sometimes called alternative worlds. Therefore, GBN aims to identify different "realities" of what may be expected in the future based on a specific set of uncertainties (Great Business Networking, 2016).

GBN encourages leaders to consider "what if" questions about future events. The purpose of scenarios is to reflect possible future states of the world; while combining theory and story-telling that facilitates creative thinking and exploration. Then, it is crucial to understand what is happening now to make predictions about what will happen in the future. Analyzing trends and scanning the current environment is the best way to accomplish this (Haq 2016).

Energy security indicators weight of South Caucasus and Southeast Europe and GBN method help us to develop scenarios. Therefore, first, we ask ourselves questions with this theme: What will happen if the convergence in this region increases? What will happen if the divergence in this region rises? What will happen if the frozen conflicts flare up? What will happen if the investments in the field of energy increase or vice versa?

3. Conflict around the Southeastern Europe and South Caucasus

Three conflicts around the South Caucasus and Southeastern Europe include Nagorno-Karabakh, the Russo-Georgian war, and Turkey-Greece disputes. In the following, we discuss about conflicts and their impacts on the energy security of the regions.

3.1. Nagorno-Karabakh

In 1923, Nagorno-Karabakh oblast (95% of the residents of the population were Armenian) established by the Soviet Union within Azerbaijan's Soviet socialist republic. Although Nagorno-Karabakh location in Azerbaijan, the legislature adopted a resolution to join Armenia. In the aftermath of the Soviet Union's collapse in 1991, Nagorno-Karabakh declared independence. Then, the war flares up between the Republic of Azerbaijan and Armenia. As a result of the war, Armenia controlled Nagorno-Karabakh and occupied 20 percent of the Republic of Azerbaijan territory in 1993. Therefore, Russia made a ceasefire between the two countries (Bishkek protocol) in 1994. As a result of the Bishkek protocol, Nagorno-Karabakh left as a de facto independence, but the region had close economic, political, and military ties with Armenia (Broers, 2015).

In September 2020, the Nagorno-Karabakh war erupted between the two countries again. There was a six-week war between Armenia and the Republic of Azerbaijan, which was ultimately ended by a ceasefire borked by Russia (Gamaghelyan and Rumyantsev, 2021) Furthermore, both countries' infrastructures were destroyed, and services were disrupted. Energy infrastructure, such as pipelines and refineries, has been threatened during the second Nagorno-Karabakh War.

The critical transit oil infrastructure in South Caucasus includes Baku-Supsa and BTC pipelines. First, the Baku-Supsa oil pipeline passes through Georgia and reaches the Supsa port of Georgia on the Black Sea coast. Second, oil is transported from Azeri-Cheragh-Gunashli (ACG) and Shah Deniz fields in Azerbaijan to Ceyhan port in Turkey through the BTC pipeline.

The South Caucasus gas pipeline is another crucial infrastructure network of international importance. Since 2007, Azerbaijan has been carrying its natural

gas by BTE to Erzurum Port in Turkey. These infrastructures are critical for the European energy market. Therefore, if there is an interruption in the supply of these pipelines, it will affect the energy security of the South Caucasus and Southeast Europe countries.

3.2. Russo-Georgian war

The Georgian civil war erupted in 1991 when the country became independent. As a result of the civil war, Abkhazia and South Ossetia separatists became independent and gained control of these two provinces. Furthermore, the central government of Georgia made close relations with Russia and joined the Commonwealth of Independent States. The civil war ended in 1994, but tensions simmered in its two breakaway provinces, which remained part of the country until 2008 (Akcakoca et al. 2009).

The first war of the twenty-first century began on August 8, 2008, when Russian troops began their invasion of Georgia. South Ossetia was at the center of the Russia-Georgia war in 2008. At the end of the war, Russia gained control of two breakaway regions (Abkhazia and South Ossetia). Georgia as a transit country of Caucasian pipelines, has a significant role in the Europe and South Caucasus energy security (German, 2009). EU member-states rely heavily on suppliers located on the Union's periphery. Due to reliable and safe export routes, the South Caucasus has become interconnected with the international community. The Russia-Georgia war in August 2008 demonstrated the threat unresolved conflicts pose to the Caucasus stability and energy security supplies.

3.3. Turkey-Greece disputes

The Aegean Sea dispute between Turkey and Greece revolves around issues of sovereignty and rights. In 1987 and early 1996, Greek-Turkish relations had adversely affected by the series of conflicts that have twice come close to escalating into military hostilities. The dispute encompasses various aspects, including:

- the delimitation of territorial waters
- national airspace

- exclusive economic zones (EEZ)
- demilitarized status of Greek islands
- Turkish claims of grey zones with undetermined sovereignty.

One major point of contention is the interpretation of maritime law, with Turkey not ratifying key conventions on the continental shelf and the Law of the Sea (Stamouli, 2022). Efforts were made between 1998 and 2010 to facilitate Turkey's accession to the European Union, but securitization of the Aegean issues led to political crises and hindered progress in resolving the problems between the two countries (Kalkan 2020).

Turkey's role as an energy transit country is crucial for Europe's energy security. Tensions between Turkey and Greece pose a risk to the energy security of South Caucasus and Southeast Europe, as significant pipelines like the Trans Adriatic Pipeline (TAP) and Trans Anatolian Pipeline (TANAP) pass through these countries. The TAP pipeline, proposed in 2003 and operational since 2020, has a capacity of ten bcm per year (NS Energy 2020). It transports Azerbaijani natural gas from the Caspian Sea's Shah Deniz gas field to Southeastern Europe through the South Caucasus pipeline, TANAP, and TAP, as shown in Figure (2).

Figure 2: TAP and TANAP pipelines

Source: (Jam-News, 2022)

4. Results

This section presents the research results based on the methodology developed and the data adopted. The weight of energy security indicators shows their effectiveness in the South Caucasus and Southeast Europe. The following indicators have had important impact on energy security in the South Caucasus and Southeastern Europe based on the Shannon index from 2012 to 2022.

- 2012: GDP, FDI, CO2 emissions, and primary energy consumption
- 2013: GDP, FDI, CO2 emissions, and primary energy consumption
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- 2016: GDP, FDI, CO2 emissions, and primary energy consumption
- 2017: GDP, FDI, CO2 emissions, and primary energy consumption
- 2018: GDP, FDI, CO2 emissions, and primary energy consumption
- 2019: GDP, FDI, CO2 emissions, and primary energy consumption
- 2020: HHI, CO2 emissions, GDP, Primary energy consumption
- 2021: Gasoline price, FDI, CO2 emissions, and primary energy consumption
- 2022: HHI, FDI, electricity generation, and primary energy consumption

The significant variables between 2012 and 2018 included: FDI, GDP, CO2 emission, and primary energy consumption but with the outbreak of Covid-19, the variables changed that included: HHI, CO2 emission, GDP, and primary energy consumption. The Covid-19 pandemic caused the government around the world to make some restriction and these restrictions damaged economic growth and FDI flows (Jena et al., 2021; Goel et al., 2021). Therefore, the Covid-19 pandemic has brought about a new era of economic development, where countries are placing greater emphasis on attracting FDI and securing access to energy resources (see figure (3). This has become crucial for countries seeking to rebuild their economies and ensure sustainable growth in the aftermath of the crisis.

Since the Russian invasion of Ukraine, the world has faced several geopolitical challenges around the world. The rising tensions between nations and the increasing competition for resources have underscored the need for diversification in energy supply. In this regard, the states seek to explore alternative energy-importing routes; and focus on renewable energy sources such as wind, solar, and hydroelectric power, which offer a more sustainable and reliable option for meeting energy needs. Furthermore, the states offering incentives and creating favorable business environments to encourage companies to invest in their countries. This has become a key driver of economic development, as foreign investment not only brings in capital but also expertise and technology that can help to improve the efficiency and sustainability of energy production.

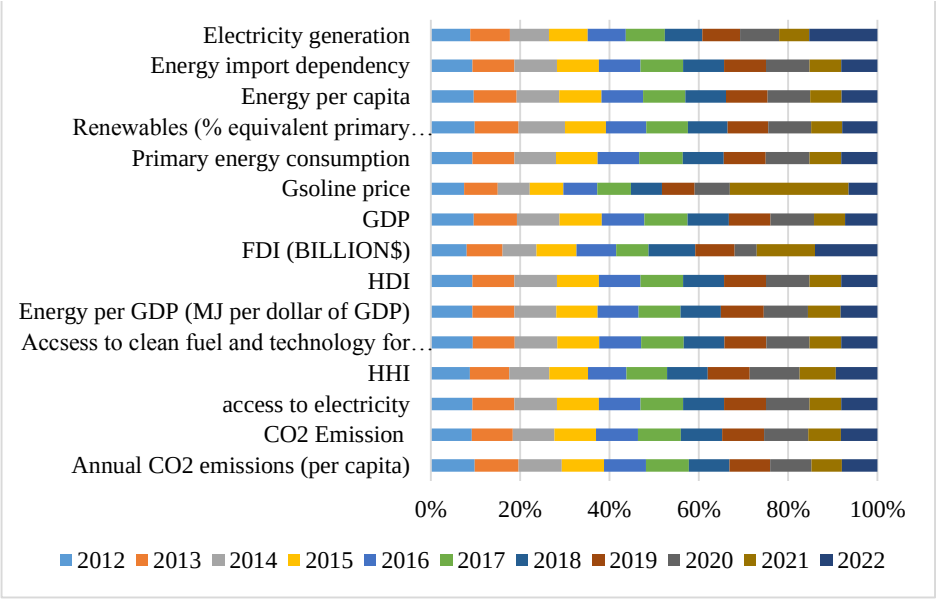

Figure 3: Weight of the indicators

Source: (Authors Calculation, 2025)

According to Figure (3) weight of gasoline prices immediately increased because of the Covid-19 pandemic decline, and the economic activity back to before the Covid-19 era. In 2021-2, the Covid-19 restrictions were lifted to some

extent. Therefore, the countries tried to put themselves on the path of economic growth, which is why the price of gasoline increased significantly. In addition, investment in the countries' infrastructures also increased (Al-Kasasbeh et al., 2022), then the weight of FDI was again among the four influencing factors of energy security.

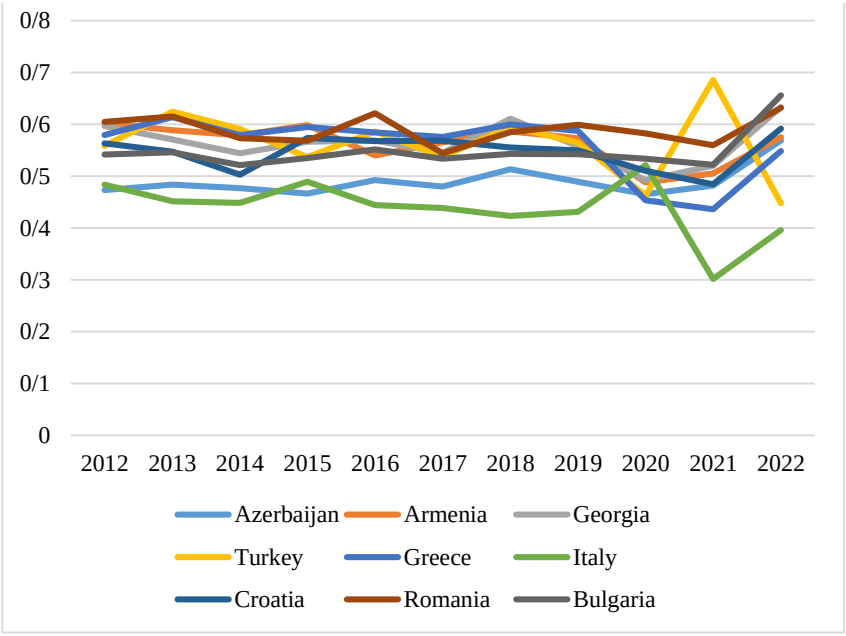

Figure 4: GRG of countries based on GRA

Source: (Authors Calculation, 2025)

The Covid-19 pandemic prevention strategies, energy consumption adjustments, and industry efficiency fluctuations caused the states to face energy security challenges. Then, the energy supply and demand structure were directly or indirectly affected (Jiang et al., 2021). Furthermore, the global energy demand drops and consumption decline damage the energy industries (Alam et al., 2023). Therefore, the energy security of producer countries and transit countries is affected. The energy security of Azerbaijan, Turkey, and Georgia declined and has affected more than consumer countries like Bulgaria, Armenia, Greece, Italy, etc.

Figure (4) Compare the level of energy security in target countries. Then, we

can see Italy, Greece, and Romania experienced low energy security in 2021 because of the Covid-19 decrease, and these states focused on the attracted investment to develop their economy. In contrast, Turkish and Georgian energy security as transit countries and Azerbaijan as a producer country improved with the energy demand growth. Armenia and Bulgaria experience stable energy security in comparison to other countries because of their low population and economy.

In 2022, according to figure (4) energy security levels of the states improved, while Turkey experienced a decline due to a significant increase in gasoline prices. This price hike negatively impacted the country's energy security, as it made it more difficult for citizens and businesses to afford and access energy resources. In addition, Turkey's heavy reliance on coal for electricity generation has made CO2 emissions a significant factor in the country's energy security (Selçuklu et al., 2023). The high levels of CO2 emissions from coal-fired power plants not only contribute to climate change but also pose health risks to the population. Therefore, Turkey's energy security is closely tied to its ability to diversify its energy sources and reduce its dependence on fossil fuels. By investing in renewable energy and promoting energy efficiency, the country can improve its energy security and contribute to a more sustainable future.

5. Future Scenarios

We prepared four scenarios based on five driving forces, which include: GDP, FDI, CO2 emissions, Gasoline price, and primary energy consumption (See figure 5).

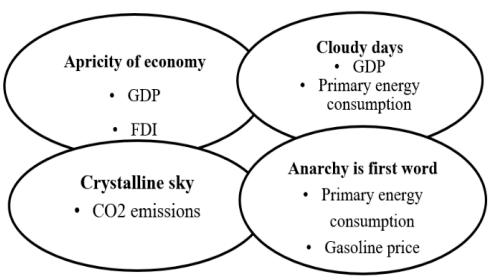

Figure 5: Future Scenarios, Source: (Authors, 2025)

5.1. Crystalline sky

Climate change is one of the most important factors affecting energy security in the South Caucasus and Southeast Europe. In this scenario, geopolitical conflicts and regional competitions will have a minor impact on energy security. Because Global and regional cooperation is necessary to reduce greenhouse gas emissions (Uddin & Taplin, 2015; Asheim et al., 2006). Therefore, global and regional order will be shaped by the convergence of international norms, institutions, values, and principles. In this case, countries will take actual steps in climate change issues with regional and global cooperation.

Regional organizations will be established to constrain greenhouse gas emissions. The regions would apply carbon fines considerably higher than they do currently, assuming environmental policies are implemented effectively. Then, oil-producing states like Azerbaijan also use their oil revenue to develop renewable energy and diversify their economies. Producer countries have different ways to decarbonize the economy, including developing electrical systems, green hydrogen, solar photovoltaic system, wind energy, and Carbon sequestration (Borup et al., 2021; Cheekatamarla, 2021). Due to the development of electrical systems and cars, gasoline demand will decrease, and as a result, its price will decrease as well.

The economy will shift from fossil fuels such as coal, oil, and gas to renewable energy such as solar panels, wind, green hydrogen, biomethane, geothermal, etc (Muradov and Veziroglu, 2008). Therefore, the South Caucasus and Southeastern Europe will make significant progress in the development of renewable energy infrastructure. These regions will benefit from renewable energy by creating jobs, new industries, and new science in their universities (McCauleyJennie and Stephens, 2012). Also, with renewable energy development, electricity production from renewable energy will increase, and buildings and smart machines will be built. Furthermore, FDI will flow into renewable energy industries, and shares of renewable energy in mixed energy consumption of the regions will increase. In other words, Fossil fuel demand will decrease as renewable energy grows. Therefore, the countries such as Georgia,

Armenia, Turkey, Italy, Croatia, Romania, and Bulgaria, which are highly dependent on energy imports, supply their energy consumption with renewable energy.

By developing renewable energy resources, access to clean fuels and advanced technologies for cooking food will increase (Yue et al., 2022) in Countries like Georgia, Armenia, Romania, and Belarus. Furthermore, a Research and development (R&D) increase in clean energy will make the supply security and cost-effectiveness of energy in the region because these states will be connected to inexhaustible energy sources such as solar and wind. In this regard, new faculties and scientific disciplines in clean energy are expanding in this region. Then, the states' dependence on energy imports will decrease or even reach zero, which will increase the energy security of these countries.

5.2. Anarchy is first word

In this scenario, geopolitical competition that exists in the region will spread to other regions, and in this case, the energy security supply will be at risk. Therefore, according to the realism theory, the states looking for their security and rely on their capabilities (Sorokin, 1994; Rynning, 2010). Therefore, regional cooperation will decrease and damage the states' economic growth and climate change issues in the region.

Structural realism scholars believe that in anarchical situations of international relations “relative gain is more important than absolute gain” (Powell, 1991). Therefore, the priority of the states in this situation will be given to bilateral contracts with relative gain over multilateral agreements with absolute gain. In addition, regional divergence destroys the possibility of scientific growth and attracting investment in infrastructure.

Due to the population, competition, and economic growth, fossil fuel demand will increase (Howey, 2023). Therefore, producer countries and organizations such as OPEC and OPEC+ will also have the upper hand in the energy political economy. In order to gain access to energy sources, states in the region have become increasingly competitive for energy. This competition can lead to proxy wars, the construction of new energy corridors, and instability in the region.

The regions experiencing the lowest economic growth and HDI will decrease due to regional conflicts and competition. Furthermore, a decrease in the HDI leads to a decrease in human capital. Therefore, according to the mutual relationship between HDI and economic growth (Khodabakhshi, 2011), both indicators will decrease sharply.

For sustainable development, the states should spend subsidies and fiscal budget to clean energy resources (Barbier, 2020), but the anarchical situation of the region's investment in renewable energy to diversify energy mix consumption portfolios is reduced. Furthermore, the gasoline price will rise, due to the rising demand for fossil fuels and regional competition. Divergence and competition in the region cause regional goals such as connecting the power grid of the countries aren't achieved. Fossil fuel subsidies will increase due to the lack of investment in renewable energy and regional competition.

Since the energy consumption portfolio will have the least change from now to then, consumers will face more challenges than producers. Turkey will benefit the most as an energy hub in the region.

5.3. Apricity of economy

In this scenario, states focus on the development of their economy and avoid tension and conflict with each other. They seek to resolve their political disputes through diplomatic solutions.

In the years after Covid-19, regional wars such as the Nagorno-Karabakh war, and the transition from the energy security crisis in 2022, countries will pay more attention to their economic growth and attraction of FDI in the short term than environmental issues. States need a sustainable and affordable energy supply to achieve economic growth. In the short term, therefore, the demand for fossil fuels in developing economies is expected to increase compared to the past, whereas investments in carbon reduction will be made in the long term to reach 2050 targets (Sarkodie and Strezov, 2019). It is expected that the 2050 targets will not be met, because the share of fossil fuels for energy supply increase in the short term. Furthermore, fossil fuel shares in the primary consumption demand will decrease as economic stability and sufficient growth are achieved in the long

term. Nuclear power plants will also increase to supply the energy demand by the countries.

In the short term, subsidies will be given to fossil fuels, and the fines for energy-consuming industries will be removed or mostly reduced. Therefore, environmental activists may organize protests due to insufficient attention to climate change.

The countries' energy security will continue to be considered a crucial issue due to the reliance of energy-importing countries on oil and gas, and ensuring access to energy sources, including nuclear and renewable energy, will be an important political issue. Furthermore, due to fossil fuels will dominate the market, Geopolitics become a crucial issue for energy consumers and producer countries (Bompard et al., 2017). In this regard, with the disruption in the energy supply, we can expect an increase in the price of gasoline and other consumed energy.

As economic growth increases, the HDI is likely to rise as well since the country's economic growth will also increase when the HDI increases. As a result, regional cooperation will be based on the economy. Regional organizations will also be formed and more active because the states follow absolute gain. Furthermore, economic growth will increase electricity demand (Yoo, 2005).

5.4. Cloudy days

In this scenario, the relationship between countries is a combination of competition and cooperation. In such conditions have a significant impact on CO2 emissions, GDP, and HDI growth. Therefore, Regional cooperation structures are also fragile. Due to the energy demand of states for economic growth, states invest and inflows FDI in the fossil fuels (Mohsin et al., 2022). In this fragile structure, greenhouse gas emissions of developing economies will increase because they will invest more in fossil fuels for economic development. But developed economies will seek to reduce greenhouse gas emissions by investing in renewable energy. Therefore, investment in fossil fuels will have limited growth. In other words, environmental issues are important in developed

economies, but in developing economies, environmental issues are secondary priorities. Then, the income of energy-producer states such as Azerbaijan will decrease. Developing economies and producer states should seek to diversify their consumption portfolio.

The frozen conflict, such as the Nagorno-Karabakh, Russo-Georgia war, and Greece-Turkey disputes, become the competition board of the states. Thus, countries will use these conflicts for their political and economic interests. By negotiating and preventing tensions, one can be optimistic about the growth of the HDI and GDP of the states. Furthermore, if tensions also increase in conflicts area, energy prices will experience limited growth as developed countries such as Italy and Croatia reduce their dependence on fossil fuels.

5.5. Comparison of scenarios

Driving forces	Crystalline sky	Anarchy is first word	Apricity of economy	Cloudy days
GDP	Increase	Decrease	Increase	Increase
HDI	Increase	Decrease	Limited growth	Increase
Economic growth	Increase	Decrease	Increase	Increase
FDI in fossil fuels	Decrease	Increase	Short term: Increase Long term: Decrease	Limited growth
CO2 emissions	Decrease	Increase	Short term: Increase Long term: Decrease	Developing economy: Increase Developed economy: Decrease
State's gain	Absolute gain	Relative gain	Absolute gain	Relative gain
Renewable energy investment	Increase	Decrease	Short term: Decrease Long term: Increase	Short term: Decrease Long term: Increase

Fossil fuels dependency	Decrease	Increase	Short term: Increase Long term: Decrease	Developing economy: Increase Developed economy: Decrease
Energy price	Decrease	Increase	Decrease	Limited growth
Energy mix consumption	Increase	Decrease	Increase	Developing economy: does not change much Developed economy: Increase
Cooperation or competition	Cooperation	Competition	Cooperation	combination of competition and cooperation
Oil producer revenue	Decrease	Increase	Short term: Increase Long term: Decrease	Decrease
Energy export and import routes importance	Short term: increase Long term: decrease	Increase	Increase	Increase
Fossil fuels demand	Decrease	Increase	Short term: Increase Long term: Decrease	Developing economy: Increase Developed economy: Decrease

Table 3: Comparison of Scenarios

Source: (Authors Calculation, 2025)

Conclusions

Energy security is a crucial concept for economic development, human security, and climate change in the future of developed and developing countries. The article investigated the energy security of the South Caucasus and Southeastern Europe with the GRA method based on 15 indicators that characterize 4As. The GRA method helps us to identify the significant factors for scenario planning. Therefore, the significant indicators from 2012 to 2019, according to the

obtained weight, are as follows: GDP; FDI; CO2 emissions; primary energy consumption

In 2020, with the outbreak of the Covid-19, the variables that affected energy security changed, which include: HHI, CO2 emissions, GDP, and primary energy consumption. Therefore, the market concentration became significant, and the energy revenue for the producer countries decreased; but in 2021, with the reduction of the Covid-19, the indicators of energy security changed to the Gasoline price, FDI, CO2 emissions, and primary energy consumption.

Future scenarios prepare possible visions based on uncertainties for the decision-makers from the future. Future scenarios also help policymakers to shape the future based on the possible opportunities and overcome the possible challenges. Therefore, according to the significant driving forces in the paper analysis, four scenarios emerged: Crystalline sky, Anarchy is the first word, cloudy days, and Apricity of the economy.

The crystalline sky is about climate change, and the imagined cooperation between the countries based on the absolute gain will help restrict emissions. In the second scenario, anarchy is the first word; this scenario shows the geopolitics competition of states increases, and also the states follow the relative gain. The third scenario is the Apricity of the economy and shows the states' focus on their economic growth. In the Apricity of the economy, the short-term oil consumption increases but in the long-term decrease. The fourth scenario is the cloudy days. This scenario is a combination of competition and cooperation between states. The developed countries help the developing countries to achieve their relative gain. Furthermore, developing countries in the region have limited economic growth.

The resulting scenarios show that the divergence in the South Caucasus and Southeast Europe regions will make these regions look like a chessboard. Therefore, the states use their relative advantages over each other as pressure levers, such as geography, natural resources, economy, etc. In addition, divergence can cause the formation of blocs and more competition in these areas. The influence of great powers also contributes to these conditions and causes

further divergence of the states in the region, which causes slow economic growth, HDI, renewable energy, FDI, and asymmetric dependence in this region. On the other hand, convergence and cooperation in the region will cause countries to seek absolute profit instead of relative profit, and blocs will disappear in regional convergence. In this situation, bilateral agreements will be replaced by multilateral agreements. Convergence decreases the competition between states and increases cooperation in environmental issues and investment in renewable energy. In addition, it contributes to economic growth, HDI, FDI, energy price control, and the influence and activity of regional organizations.

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