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Research Article

Transforming Albania's Energy Sector: Advancing Economic Growth, Sustainability and Regional Integration

Luçiana Toti[1*], Elda Cina[2], Ajakida Eski[3]
[1] *Assistant Professor, Information Technology Department, Information Technology Faculty, Aleksander Moisiu, University, Durres, Albania. lucianatoti@uamd.edu.al*
[2] *Associate Professor, IST/TNT Department, College of Engineering and Technology, American University of the Middle East, Kuwait. elda.Cina@aum.edu.kw*
[3] *Assistant Professor, Electrotechnical Department, Faculty of Electrical Engineering, Polytechnic University of Tirana, Albania. ajakidaeski@fie-upt.edu.al*

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ABSTRACT

Albania, as part of the European countries, is involved in a significant reform in its energy system. The effects of such endeavors are expected to impact not only the national level but also the wider region, including Southeast Europe. Several key areas will benefit from this transformation. A series of concrete measures have been taken by the government to transform the energy sector advancing economic growth and to facilitate the integration in the region, including documentation to support the internal energy market, guaranteeing energy security, increasing energy efficiency, and reducing greenhouse emissions. These reforms will contribute to Albania's economic development, energy supply stability, and environmental protection. They ensure the generation of income and the increase of jobs in various sectors, directly affecting the country's growth and macroeconomic stability. Socially, job growth contributes to enhanced personal and family well-being, increases tax revenues, and boosts investments in education, health, and other public services, eventually enhancing overall well-being and reducing poverty. This paper examines the factors driving the transformation of Albania's energy system, including national efforts in network security and information systems, which align with EU directives and the completion of SDG7 under the European Agenda. It analyzes the interconnectedness of national and regional energy systems, highlighting the importance of digital transformation, data security, and collaboration among stakeholders. The study's results indicate that Albania's energy strategies are already having a positive impact on the region and the wider Southeast Europe region. The final findings emphasize the need for strategic frameworks that prioritize sustainable development and public safety as key pillars of energy sector reform.

Keywords: Cybersecurity, Energy System, Economic Growth, SDG Directives, Sustainable Development

INTRODUCTION

The energy sector is a critical factor in the political, economic, and social development of all nations, particularly in developing countries like Albania. The Albanian government has taken concrete measures and drafted all the legal and by-laws following the European directives regarding the opening of the electricity market, the reduction of energy consumption, the decrease in CO2, the increase of energy efficiency, the increase of insurance energy through renewable sources, and more.

On the other hand, due to the investments planned and carried out by the Albanian energy companies to strengthen the capacities of electricity for distribution and transmission, as well as to boost the networks' effectiveness, there has been an improvement in the situation regarding the reduction of technical losses. This has led to an increase in the level of satisfaction of the customers reflecting on the level of receipts of payments for electricity bills (non-technical losses). The undertaking of the energy sector difficult reforms aimed at cutting down on energy losses has resulted in a decrease in energy loss from 45.04% in 2013 to 26.41% at the end of 2017, and a significant increase in the level of receipts from 38.6 billion ALL in 2013 to ALL 64.1 billion at the end of 2017.

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These steps facilitate Albania's efforts toward European integration within the broader European energy infrastructure. Moreover, due to the integration of the energy markets of Albania and Kosovo in the last years, has led to the creation of the Albanian Power Exchange with the objective of integrating into the European market; attaining a 15% reduction in energy usage overall by 2030; increasing the amount of renewable energy in total energy consumption to 42% by 2030; decrease of GHG emissions to 11.5% of total emissions by 2030 [1]. The Albanian Institutions' efforts in the last few years have been reflected in exceeding the objectives set in 2018. The new milestones have been targeted for 2030 as illustrated in **Table 1**:

Table 1*:* Objectives set in the energy sector for 2030

Contributions	**Goals for 2030**
Contributions to GHG emissions	18.7%
Energy efficiency	8.4%
renewable energy over the total required energy	54.4%

The energy situation in Albania is mainly dependent on hydropower, which is insufficient to cover energy needs during the summer season, even more so considering the climatic changes in the Western Balkans region. In these conditions, one of the challenges faced by Albania continues to be the internal supply of electricity, considering the increase in renewable energy capacities. The National Energy Strategy [1] claims that the energy intensity, a key measure of the nation's economic stability, was 0.219067 ktoe/billion euro GDP in 2014 and is predicted to rise to 0.175174 ktoe/billion euro GDP by 2030. **Figure** 1 illustrates the energy intensity trend between 2014 to 2030.

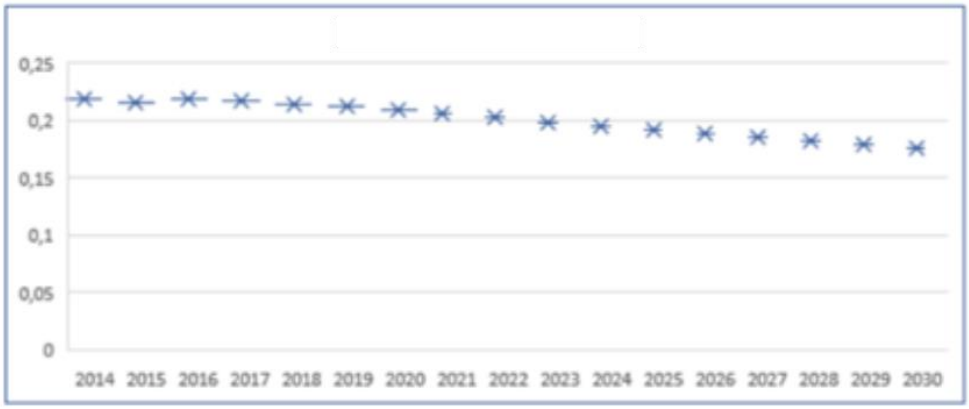

Figure 1. Energy intensity ktoe / billion Euro [1]

Based on the studies carried out to ensure sustainable energy development, the following are needed:

- maximize energy indicators globally according to SDG 7 on access to contemporary energy services for all
- boost the use of renewable energy sources
- increase energy efficiency

By 2030, Albania is expected to provide universal access to modern, safe, and reasonably priced energy services, per an INSTAT analysis. The Albanian energy sector must, however, overcome numerous obstacles to sustainable economic growth in a variety of areas, including enhancing the trend toward lowering energy intensity, boosting energy supply security through increased energy efficiency, boosting the use of renewable energy sources and other domestic energy sources, and enhancing well-being through regional cooperation and integration [2]. The energy saving target related to the final energy consumption is estimated as in **Figure 2**:

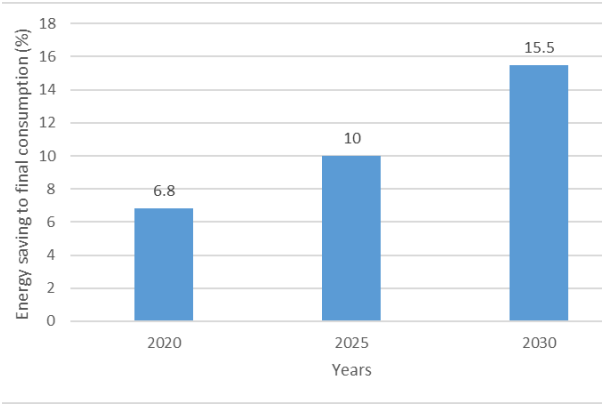

Figure 2. Energy saving related to the final consumption (%)[2]

The following part of the paper follows: The current developments in energy systems and sustainable development are described in the literature review in Section 2. Research methodology is outlined in Section 3, the findings are addressed in Section 4, and conclusions and next steps are covered in Section 5.

LITERATURE REVIEW

Energy challenges continue to be a significant barrier to economic development in both developing and developed countries, impacting efforts to improve living conditions, protect the environment, and meet growing energy demands. Researchers, engineers, and experts worldwide have given special attention to these factors, which are central to the framework of the sustainable development of energy systems. Governments and responsible institutions must adopt adequate policies to promote and facilitate the use of renewable energy, enabling the energy sector to overcome the obstacles they encounter and drive long-term progress.

Falcone offers an in-depth analysis of the challenges and opportunities involved in implementing sustainable energy policies in emerging countries, including Albania, Brazil, India, and Kenya.[3]. According to the author, underdeveloped nations have a harder time implementing such programs because of financial constraints, institutional challenges and technological limits. These nations should shift to sustainable energy. By promoting collaboration, learning from both their successes and failures, and prioritizing sustainable development goals, developing countries can play a pivotal role in leading the global transition to a low-carbon and sustainable energy future. By uniting, they can make a substantial contribution to safeguarding the planet's health for future generations. Based on a different study, the favorable impact of renewable energy production on environmental sustainability is further enhanced by increasing the fiscal capacity of local governments and implementing policies for green finance and geopolitical risk [4]. Experts emphasize that countries develop strategic relationships as a result of globalization and regional integration. Sustainable development is positively impacted by complex regional integration as well. Sustainable growth in Asia and Europe is positively moderated by the interaction between regional integration and renewable energy transitions. [5], [6].

The authors stress that the funds and expenditures allocated to renewable energy are seen as supporting the achievement of other SDGs including poverty alleviation, food security, health, and global warming, among others, in addition to providing "energy for all" [7].

In the study by Wayan G. et al., energy plays a crucial role in achieving the Sustainable Development Goals (SDGs), such as reducing poverty and hunger, improving people's well-being, and protecting the environment [7]. Energy planning needs to be reviewed due to countries aiming to integrate SDGs into their development programs should anticipate an increase in energy usage [8].

Rizza Zbotek in his article "Cyber security in the energy industry" explains that the energy industry, which includes oil, gas, electricity and renewable sources, supports the functioning of modern civilization. This reliance on technology also exposes the sector to cyber threats that can disrupt operations, lead to data breaches and compromise security [9].

Considered by the World Summit for Sustainable Development (WSSD) as an energy efficiency strategy, an environmental protection mechanism, and an explicit development tool for poverty reduction, energy resources have

become increasingly important in sustainable development policy [10]. Sustainable energy is built on three key pillars: energy security, quality of life, and environmental sustainability. While each of these factors helps to achieve sustainable energy, no one by itself nor even when combined completely characterizes sustainable energy [11].

The regional trends report on sustainable energy development in Asia and the Pacific emphasizes that countries must address increasing environmental and social challenges, along with the financial difficulties of securing energy resources and building the necessary infrastructure for development. Energy affects both local and global ecosystems, social inclusion, and progress, and is closely tied to economic growth at both national and household levels.[12].

Armin Razmjoo et al. stress the significance of government and the preservation of national authority, advocating for strategies that move beyond relegating the public and local governments to minor, supportive roles in sustainable energy governance networks. Their research highlights that municipal governments can play a crucial role in developing sustainable energy solutions. Additionally, even in the face of challenging national political conditions, national governments can overcome obstacles and successfully drive energy sustainability policy objectives. [13].

The transition to renewable energy provides the necessary technology, capacity, and financing, but policies and procedures must be in place to lower market risk, facilitate, and support investments. These procedures and regulations include reducing administrative costs and bottlenecks in the planning, permitting, and regulatory processes [14].

METHODOLOGY

The investigation of how national energy policies affect sustainable regional development within the energy industry is developed based on the results obtained for different energy indicators with a focus on meeting the objectives of the European Agenda SDG7.

To extract the results, simultaneous programs were used to process the data mainly obtained from EUSTAT and INSTAT. The data are of quantitative and descriptive categories. Quantitative data are summarized in tables or presented in graphic form. From their processing, results have been extracted which explain in the political, economic, and social context how development at the national level in the energy sector can affect sustainable regional and wider development.

The data refers to primary energy sources for a long period of time (more than two decades), but they have been analyzed in such a way as to predict the results of energy capacities and the improvement of indicators until 2030

The analysis is developed in relation to the indicators that support the transformation of the energy system, such as energy security, its efficiency, the impact of a country's energy system on the regional energy system, decarbonization of the environment, indicators of energy security, the internal energy market, research and innovation. The study analyzes and presents a very effective set of factors, the elements of which increase the security of the energy system against cyber-attacks and mitigate the risks to them.

RESULTS AND DISCUSSIONS

The analysis of this study is based on macroeconomic drivers, one of which is population development. The data are founded on the 2021 Statistical Database and provided by the Albanian Institute of Statistics (INSTAT) which means that the population is projected to decline, as illustrated in **Figure 3**.

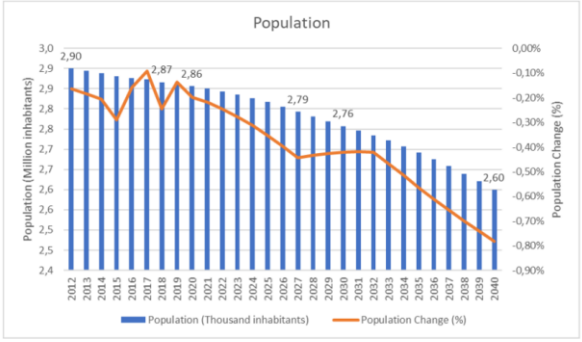

Figure 3. Population and the development trend for the years 2012 – 2040 [2]

The population is projected to experience a slight contraction from 2.87 million in 2018 to 2.76 million by 2030 and up to 2.60 million by 2040.

The energy sector is affected by population development, gross domestic products, structural changes (industry, agriculture, services), technological costs of production, etc. [15].

The Energy Strategy for Albania 2018-2030 is in complete harmony with the goals of the European Green Pact as well as other national policies and strategies:

- The distribution of safe, inexpensive, and clean energy
- Building and remodeling, encouraging a cleaner construction industry
- Quickening the transition to intelligent and sustainable transportation
- Eradicating pollution through swift and successful pollution reduction methods.

The five dimensions that support the energy system are shown in **Figure 4**:

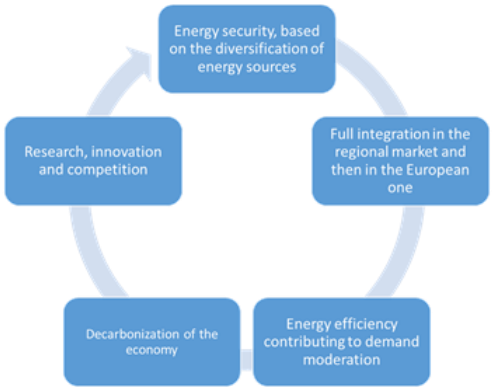

Figure 4. Factors that support the transformation of the energy system

The first supporting factor for energy systems is the increase in energy supply. To increase the energy supply, the government is focused on 6 main directions such as diversification of energy and fuel sources, establishing adequate and decentralized systems for producing energy, protecting networks and transmission systems, guaranteeing the smooth operation of energy markets, and formulating a long-term, transparent energy strategy that promotes investment and boosts energy efficiency.

Diversification of energy sources: Albania seeks to enhance energy efficiency (EE) across different consumption sectors and diversify renewable energy (RE) sources within its energy system. These changes are essential not only for improving the sustainability of Albania's energy system but also for the wider region. They are vital for macroeconomic outcomes (such as employment, state budget, and value creation), health benefits (including reduced local air and water pollution), and social impacts (such as reducing energy or fuel poverty, improving living conditions and health, and decreasing inequality) [16] [17].

The total amount of primary supply of energy (TFEP) defines the current renewable energy standards. The table below shows the TFEP's current renewable energy share as well as the projection through 2040, accounting for current policies. **Figure 5** displays the total amount of renewable energy (RE) sources in the net primary electricity supply, whereas **Table 2** displays the value of alternative energy holders in TEFP. As observed, the largest share of the total primary energy supply is provided by hydroenergy, followed by wood energy, with solar energy in third place. The total value of primary energy is projected to grow by more than 60% by 2040.

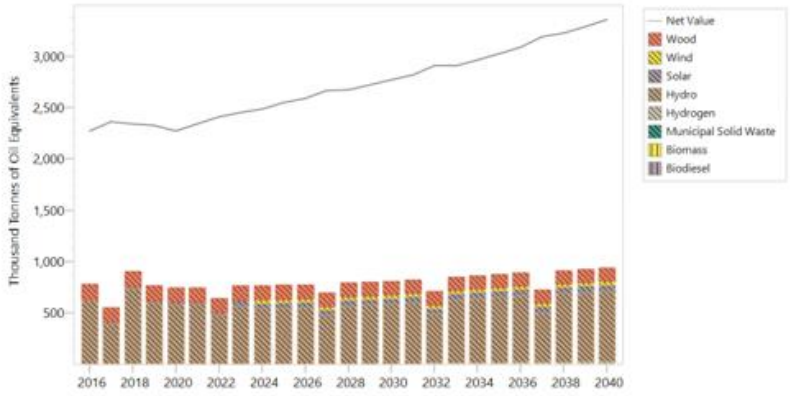

Figure 5. Energy supply through renewable sources, total net consumption from 2016 to the present, and estimated values up to 2040 **[1]**

Table 2. Absolute values of resources in the total energy supply expressed in Ktoe

	2016	2017	2018	2020	2025	2030	2035	2040
Lënda drusore si lëndë djegëse	154,1	149,4	150,0	146,6	141,7	136,4	131,1	132,1
Eolike	0,0	0,0	0,0	0,0	28,2	28,2	28,2	28,2
Diellore	11,1	12,0	13,2	16,5	54,7	58,9	61,7	65,0
Hidrike	613,6	388,7	736,1	576,2	542,2	582,1	646,0	686,8
Hidrogjen	0,0	0,0	0,0	0,0	0,0	0,0	8,2	19,4
Mbetjet e ngurta urbane	0,0	0,0	0,0	0,4	0,0	0,0	0,2	1,3
Biomasa	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Biodizel	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Totali	2275,8	2361,3	2342,7	2273,2	2552,4	2773,8	3027,9	3358,9

Regarding the percentage in the transport sector (BRE-T), the effects of multipliers for the use of electricity in road and rail transportation are included in the percentage of energy used in the transport sector (BRE-T), which accounts for the notable increase [18]. As the proportion of wood used as a heat source declines, so does the proportion of renewable energy for heating and cooling (BRE-N&F). Hydropower generation has a major role in determining the share of renewable electricity (RE-E), whereas solar panel growth is predicted [19]. The setting up of renewable energy resource facilities has a significant potential to create jobs.

Integration in the energy markets, at both the regional and EU levels, the Albanian government has made supporting the country's increasing energy needs, energy source diversity, and the efficiency and adaptability of the national energy system a strategic priority. Albania has to make investments in the infrastructure for electrical connectivity in order to accomplish this goal. Increased trade with other nations, regional cooperation, and improved gas and energy integration will all be made possible by power interconnectors [20]. Regional collaboration would gain from the liberalization of these sectors [21].

It is imperative that Albania's energy policy goals and associated plans align with the EU's emissions reduction targets and political objectives on global warming, given its status as a candidate nation and as mandated by its membership in the Energy Community.

The expansion of renewable energy sources and ongoing reforms in the electricity sector, particularly the creation of an energy exchange, will make it possible to export electricity to neighboring countries.

The amount of voluntary family income might be significantly increased by energy efficiency policies in the housing sector. Policies promoting energy efficiency in the housing sector have a big chance of increasing family income that is available for spending. Energy efficiency (EE) has many other advantages outside reducing energy poverty, like improving public health, reducing the need for subsidies for energy through social programs, increasing property values, creating employment opportunities, and reducing layoffs. [22].

Efficiency (EE) and Renewable Energy (RE) policies impact various aspects of the state budget. For instance, job creation can drive changes in the state budget. However, policies involving tax reductions and subsidies aimed at enhancing EE and increasing the use of RE may lead to higher public spending or a reduction in tax revenues, including VAT and energy taxes [23].

Impacts on employment are crucial as lowering the unemployment rate and creating job opportunities are two of the main goals of policy. The two primary factors that drive the direct effects of EE on employment are investments in EE-related measures and the resulting energy savings, which lower the long-term demand for energy supply. Theoretically, initiatives that increase energy efficiency (EE) in the housing sector—both in the stock of buildings and in appliances and other equipment—have the potential to increase household disposable income and lower energy poverty. Reducing public energy expenditure is possible through policies that increase EE for public consumption of energy, such as improved EE in public complexes and bring benefits to the state budget.

As far as decarbonization is concerned, all sectors must contribute to the transition to an economy with low carbon according to their potential in the sectors of electricity production, construction, buildings, transportation, industry, and agriculture [24], [25]. The following areas have seen significant investment illustrated in **Figure 6.**

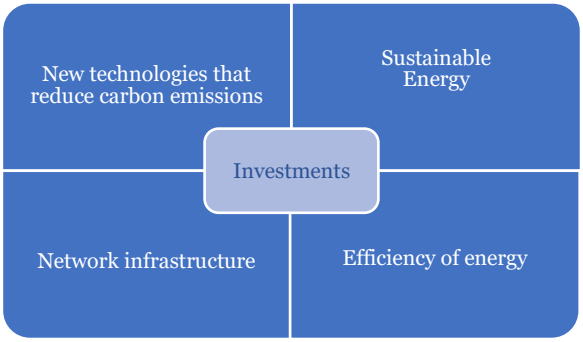

Figure 6. The Albanian government's investments to lower carbon emissions [19]

Albania has taken quick steps in reforming scientific research institutions including the scientific, technological, and innovative diaspora of Albanians. Academic institutions or scientific research centers have increased investments in innovation and scientific research through public funds or alternative sources [26], [27]. Participation in projects financed by Universities, governmental or international institutions in the field of energy has had a positive impact on the energy sector in the processes of evaluation, testing, determining the paths for sustainable development, increasing cooperation with international institutions, and has improved I feel the infrastructure of scientific research in this direction illustrated in **Figure 7** [28].

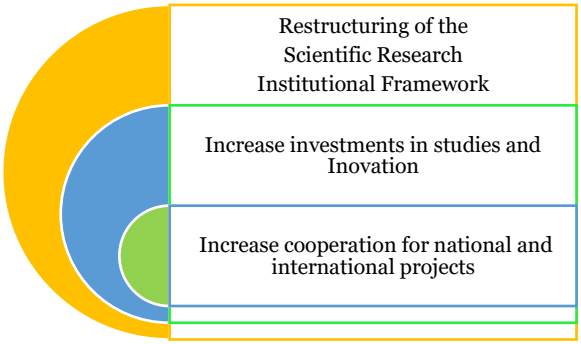

Figure 7. National objectives that affect research, innovation, and competitiveness in the energy sector

One of the most delicate issues in the energy sector is preserving the energy infrastructure and opposing online dangers to ensure an uninterrupted supply of energy and the protection of national security and public safety [9]. Cybersecurity in the energy sector is critical for several reasons, with the primary factors being the complexity of energy systems and the increasing use of smart technologies.

Energy systems are very complex and interdependent, including energy generation, transmission, and distribution. A breach in any segment can lead to major power outages, financial losses, and even environmental disasters.

The adoption of smart and Internet of Things (IoT) technologies has increased the attack surface, giving hackers additional ports of access to exploit vulnerabilities.

A strong cybersecurity framework mitigates these risks and fosters investor confidence, regulatory compliance, and long-term sustainability. Securing the energy industry against cyber threats requires a strategic and adaptable approach [29]. After in-depth studies in the evaluation of the energy situation on cyber security [30], it turns out that the essential best practices adapted to the unique challenges of the sector are related to many factors, which are presented in a summarized way in Figure 8. All organizations, including the energy system, that offer services through information and communication technology can face growing cyber risk, but it is very important to know and find the right ways to avoid and mitigate the risks from cyber-attacks.

Therefore, researchers need to find the factors that provide energy security and the safe operation of the energy infrastructure[31]. This way we will be able to avoid attacks like the one on July 17, 2022, to the National Information Society Agency (AKSHI) in Albania. They damage economic stability, as well as the security of the citizens not only at the national level but also in the region and beyond. **Figure 8** illustrates the main factors that affect the security of the energy industry against cyber threats.

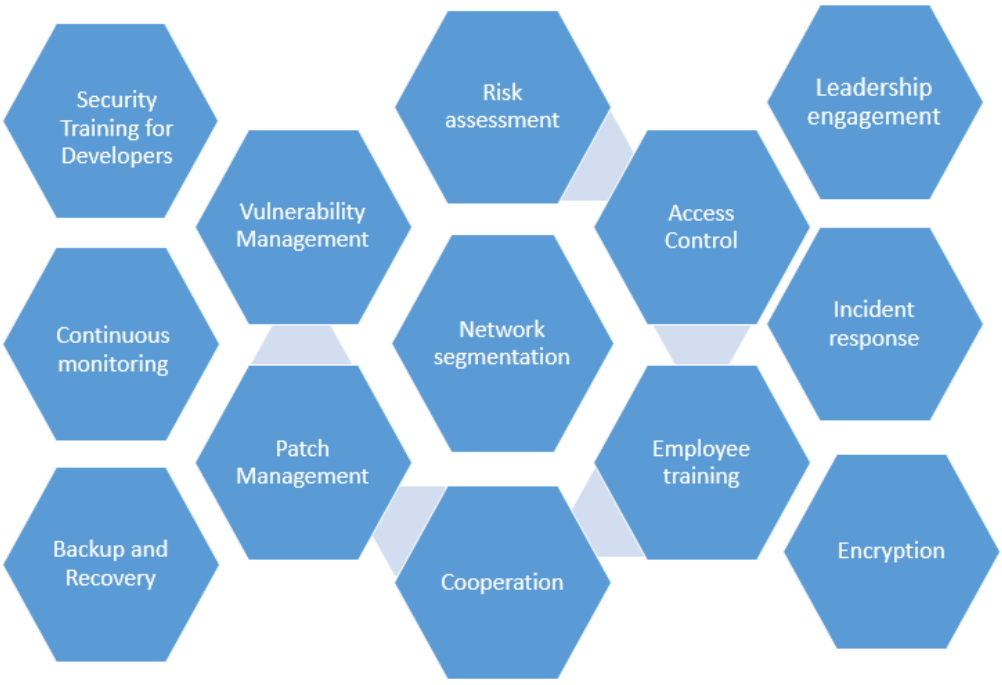

Figure 8. Factors affecting the security of the energy industry against cyber threats

National and international reports were investigated in order to have a deeper awareness of how the local energy system affects the regional system. The findings clearly show the gross export and import values between Albania and every other country in the region, indicating the necessity of regional energy exchange. The electrical energy exchanges between Albania and the surrounding countries over the last four years are shown in Figure 9, which is based on the electricity balance for Albania in 2023 [32].

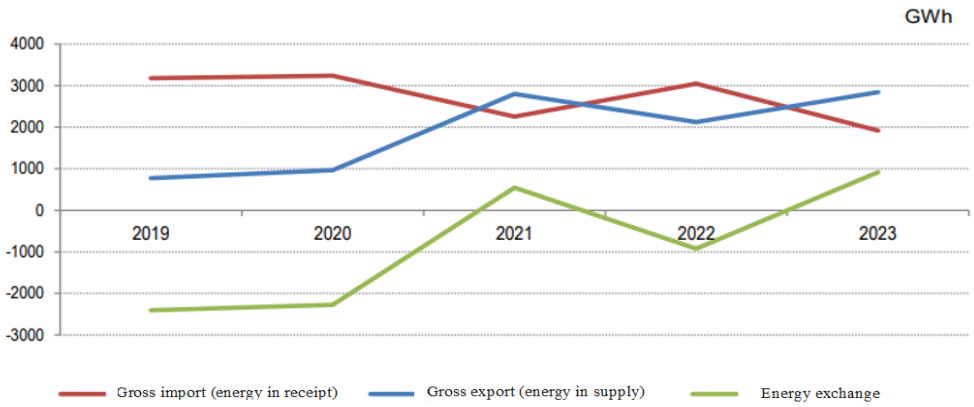

Figure 9. Electricity exchanges between Albania and the countries of the region [32]

The electricity exchange (the difference between gross energy imports and exports) was 921 GWh negative in 2022. After the analysis, it is noted that in 2023, the electricity exchange achieved a positive value of 920 GWh. These values clearly show that the difference between the gross export of energy and its gross import has an exceptional improvement in the situation. Of course, for the year 2024, this parameter is being carefully monitored.

CONCLUSION

Market-driven, interconnected, and diverse regional energy systems are influenced by changes in the national energy system. The energy demand must be met by this system in order to promote the sustainable growth of the economy, environmental preservation, climate action safety, and improvement of regional well-being. It must also guarantee supply safety and quality. The significant responsibilities that authorities, non-governmental organizations, civil society, corporations, international organizations, multilateral financial institutions, and customers as individuals have in relation to sustainable energy challenges are essential. The process of evolution, sensitive data protection, preserving operational integrity, and guaranteeing public safety, must nevertheless, take precedence as the energy system embraces digital transformation for sustainability and efficiency. Setting the proper framework conditions and ensuring that public institutions collaborate successfully with other societal and economic actors to achieve mutually beneficial goals are a common denominator across all sectors and geographies. When energy is used sensibly and safely, it may significantly advance sustainable development. However, stakeholders must place a high priority on protecting sensitive data, maintaining operational integrity, and ensuring public safety as the energy sector embraces digital transformation for sustainability and efficiency.

Scientific researchers should continue analyzing energy systems throughout the process of their transformation, support the digitization of this sector; to evaluate and test cyber security on infrastructure and technological platforms in this sector.

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