ISSN: 2723-9535

Available online at www.HighTechJournal.org

HighTech and Innovation Journal

Vol. 5, No. 1, March, 2024

Powering through Challenges: Analyzing the Energy Crisis in the Western Balkans during the Pandemic Context

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Received 28 October 2023; Revised 09 February 2024; Accepted 16 February 2024; Published 01 March 2024

Abstract

This paper examines the current challenges in the energy sector of the Western Balkan countries, focusing on the energy sector of Kosovo as a case study during the pandemic. These countries are at crucial stages of their development, marked by significant achievements but with ongoing challenges in the energy sector as a factor for sustainable development. The region remains highly vulnerable to energy crises and geopolitical tensions, particularly due to its heavy dependence on fossil fuels such as brown coal for energy production. Our research focuses on the energy system in Kosovo, highlighting its historical reliance on a fragile energy sector, particularly characterized by inflexible thermal power plants using outdated technology and a lack of additional, more flexible capacity. The purpose of this study is to examine Kosovo's energy system, assess the challenges it encounters, and identify the factors that have contributed to the energy crisis from 2021 to 2023.

Keywords: Electricity Consumption; Electricity Market; Energy Crisis; Gas; Power System; Renewable Energy Sources.

1. Introduction

The undeniable necessity for electricity permeates nearly all human activities, supporting desired living standards and economic development. Ensuring sufficient sustainable energy capacity is a crucial prerequisite for societal progress, particularly as the increasing purposes and need for electrical energy drive increased demand. This reality is starkly evident in Kosovo, where approximately 85% of the nation's electricity consumption is met by outdated and unreliable lignite-fired thermal power plants.

Recent analysis of Europe's energy crisis and the EU's desire to achieve energy independence from Russian gas and increase renewable energy targets through the REPowerEU package has revealed disagreements among some countries. Some EU nations prioritize energy independence over decarbonization objectives, leading to divergences in their energy policies compared to those of the EU and of national plans due to the energy crisis and stricter decarbonization objectives [1]. Energy policy plays a crucial role in a country's national security and long-term economic stability. In the face of escalating concerns about global warming and increasing energy demand, selecting an appropriate energy strategy has become a multifaceted challenge, encompassing technological, social, and political dimensions [2].

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http://dx.doi.org/10.28991/HIJ-2024-05-01-08

The demand for electricity was influenced by lower temperatures during the winter seasons of 2021 and 2022. However, it is important to note that not all weather phenomena have a direct impact on natural gas consumption. In 2022, Southern Europe experienced low rainfall, resulting in a notably weak period for hydropower generation, directly affecting the expansion of gas-fired power. Elevated prices in international energy markets significantly reduced the demand for electricity, particularly within industrial sectors reliant on natural gas. However, the extent to which these factors contributed to enduring reductions in demand remains uncertain [3].

The international energy market's pricing and its connection to the gas supply issue, as analyzed in Germany, also influenced the energy crisis. Russia's invasion of Ukraine, impacting energy price hikes, has led to heightened tensions in global gas markets, particularly due to Europe's substantial reliance on gas in its energy composition. Analyzing supply and demand imbalances in the European gas market, considering factors like price volatility, stock levels, supply imbalances, and political unpredictability, suggests that EU supranational policy is responsible for the unsatisfactory energy situation and has led to increased energy demand [4]. The crisis in Europe's energy sector revealed industry weaknesses, highlighting Europe's strategic vulnerability to Russian energy imports and challenges related to the unsustainable use of nuclear reactors in France, coupled with a severe drought impacting hydropower plants in southern Europe [5].

Other studies have examined the recent global energy crisis in the context of the energy transition and the commitment to reduce carbon emissions. This transition has emerged due to the depletion of fossil fuel reserves, diminished investments in the power sector, the halt in oil production during the COVID pandemic, and the repercussions of the Ukraine-Russia conflict. The findings suggest a surge in fuel costs, particularly after the removal of COVID-related restrictions in 2021 and during the Russia-Ukraine conflict in early 2022, exhibiting variations in scale and diverse impacts across countries [6]. The 2022–2023 energy crisis underscored the importance of the clean-energy transition for ensuring affordable and secure energy supplies while aligning economic paths with decarbonization. Uncoordinated policies may threaten Europe's international competitiveness and market cohesion. As Europe shifts toward clean energy, investments in renewables need a long-term strategy to address vulnerabilities related to critical minerals, preventing a recurrence of issues seen in the natural gas crisis during the energy transition [7, 8].

This paper describes an interdisciplinary study that integrates geopolitical, economic, environmental, and technological perspectives to analyze comprehensively the causes and impacts of the energy crisis throughout the Western Balkan region, including the specific characteristics and circumstances of the energy system in Kosovo. This study will also focus on developing multifaceted solutions and energy strategies, as well as tariff structures to address vulnerabilities and ensure sustainable energy supply in the country.

In the analyzed studies, the key factor identified as the determinant of the energy crisis was the Russia-Ukraine war. The crisis occurred because Europe had already established a high dependence on gas and other energy resources from Russia. The war disrupted the energy supply in Europe, influencing both its economy and politics. Consequences included divergences in positions among European countries, especially in the political and economic spheres. These consequences present challenges for economic recovery after the pandemic, contribute to Europe's downturn, lead to a global rise in energy input prices, and intensify the tension between Russia and NATO, all directly linked to the energy crisis [9].

Differences in the research examined lie in the varying perspectives and foci on the causes and impacts of the energy crisis in Europe. Some studies emphasize the role of the Russia-Ukraine war and Europe's dependence on Russian energy resources as the primary determinants of the crisis. These studies delve into the geopolitical and economic implications of this dependence and the war's impact on energy supply and pricing. Other studies focus on the broader context of the energy transition, decarbonization, and the global energy market, highlighting factors such as weather phenomena, supply and demand imbalances, energy transition commitments, and the depletion of fossil fuel reserves as contributors to the crisis. These studies also underscore the need for coordinated policies and long-term strategies to address vulnerabilities and ensure a sustainable energy transition [10].

While all of the studies acknowledge the energy crisis in Europe, they clearly present different perspectives on the root causes and contributing factors, emphasizing the need for a more comprehensive understanding of the crisis and the development of multifaceted solutions. The gap lies in the emphasis on specific factors and the varying degrees of focus on geopolitical, economic, environmental, and technological aspects of the crisis. Closing this gap would involve integrating these diverse perspectives to form a comprehensive understanding of the energy crisis and its implications for Europe and the global energy landscape. This research aims to fill the gap in research so far regarding the factors that created the energy crisis in Europe, with a specific focus on the countries of the Western Balkans and particularly on the electrical energy system of Kosovo.

This paper’s methodology consists of historical analysis of results and regulatory policies, as provided in recent reports on the energy crisis. This work delves into the sensitivity of Kosovo's energy system to external and internal influences, examining the factors that caused the energy crisis between 2001 and 2023. Our analysis dissects the impact

of external factors such as the economic downturn in Europe during this period, with a particular emphasis on the internal elements that ignited Kosovo's energy crisis. These elements include limited production capacity, dependence on imports during the winter, increasing demand for electricity, significant technical and commercial losses, tariff policies, and the failure to build new capacity. Furthermore, we explore the challenges Kosovo faces due to electricity shortages, considering the country's efforts to meet consumer demands through various energy sources, to strengthen economic growth, and to ensure long-term supply security. This research seeks solutions to address the critical issue of reserve generation, prompting us to analyze the impact of electricity markets and local alternative energy sources on meeting Kosovo's energy consumption.

This article is divided into five parts: First, it summarizes the economic and energy challenges faced by Western Balkan countries, particularly focusing on the example of Kosovo's power system. Second, it summarizes and explores the global energy crisis, particularly its impact on Europe, driven by factors such as surging demand, the COVID-19 pandemic, and the Ukraine conflict. Third, it delves into external factors that influenced the increase in global demand for electricity during the years 2021 and 2022, focusing on the demand from the economy and the prevailing weather conditions. The analysis further concentrates on the energy crisis witnessed in Europe, encompassing climate challenges, post-COVID effects, limited wind energy, reduced natural gas, and political developments. Fourth, the paper describes the internal factors that have influenced Kosovo's energy sector during this period. The overview encompasses a detailed analysis of the sector, covering aspects such as energy demand, production, technical challenges, insufficient investment, the impact of imports, changes in prices in the market, tariff structure, and their overall impact on the ongoing crisis. Finally, policy suggestions are put forward as the findings and factors that caused this crisis are concluded, including lessons for the future to build an inclusive and self-sustainable policy in the energy sector.

2. Navigating Energy Challenges Focus on Kosovo's Economic Landscape and Power Sector Evolution

The Western Balkan (WB) countries, including Kosovo, Albania, Bosnia and Herzegovina, North Macedonia, and Serbia, are at crucial points in their development. Despite progress in their socio-economic transitions, these nations face significant and persistent challenges. Economic growth has slowed, and there is a need to identify new sources for productivity enhancement and economic transformation. The labor market's suboptimal performance has led to a migration of individuals seeking better opportunities elsewhere. Persistent inequalities and widespread poverty further complicate the development landscape. Additionally, poor air quality levels, stemming from polluting energy sources, have a detrimental impact on overall quality of life [11].

The region is vulnerable to the energy crisis and the Ukraine conflict. Most countries in this region rely on fossil fuels, especially brown coal, for energy, with less direct reliance on Russian gas compared to other parts of Europe. However, ACER's 2020 data shows high dependence on Russian gas provides high percentages of the market in Serbia (89%), Bosnia and Herzegovina (100%), and North Macedonia (100%) (see Figure 1). Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, and Serbia heavily depend on coal for electricity generation [12].

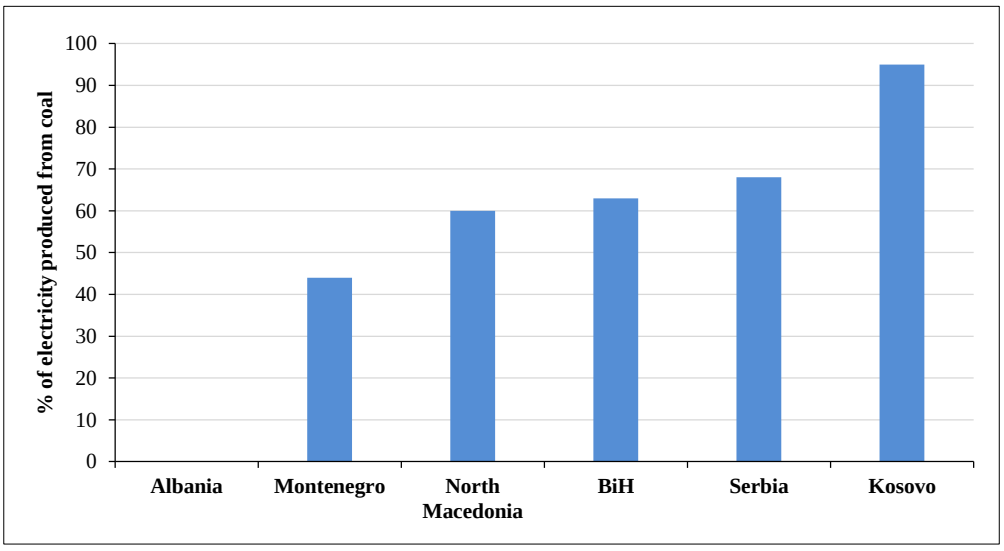


Figure 1. Share of coal in electricity generation in the WB

Kosovo's economic development has been hindered by a fragile energy sector characterized by instability, reliance on inefficient technologies, and vulnerability to external factors. The primary energy source in Kosovo is derived from thermal power plants, specifically electricity produced from lignite. The fundamental characteristic of electricity consumption is the deficit in production during daytime hours when demand is high and excess production during

nighttime hours, reflecting both seasonal and daily variations. The lignite plants cannot vary output easily or inexpensively. It is crucial to analyze daily consumption, as shown in Figure 2, which presents a cumulative annual diagram for each hour. Emphasizing significant consumption discrepancies between day and night is vital for optimizing energy resource efficiency. Specific maximum and minimum hourly consumption averages can influence energy production and distribution planning. Understanding these fluctuations is essential to ensuring that energy demand matches available capacity. Naturally, energy demand rises during the day when human activity peaks and declines at night when most people sleep. This shift in energy consumption has significant implications for energy infrastructure and resources. Effectively managing these variations is necessary to meet energy demand efficiently and reduce energy costs.

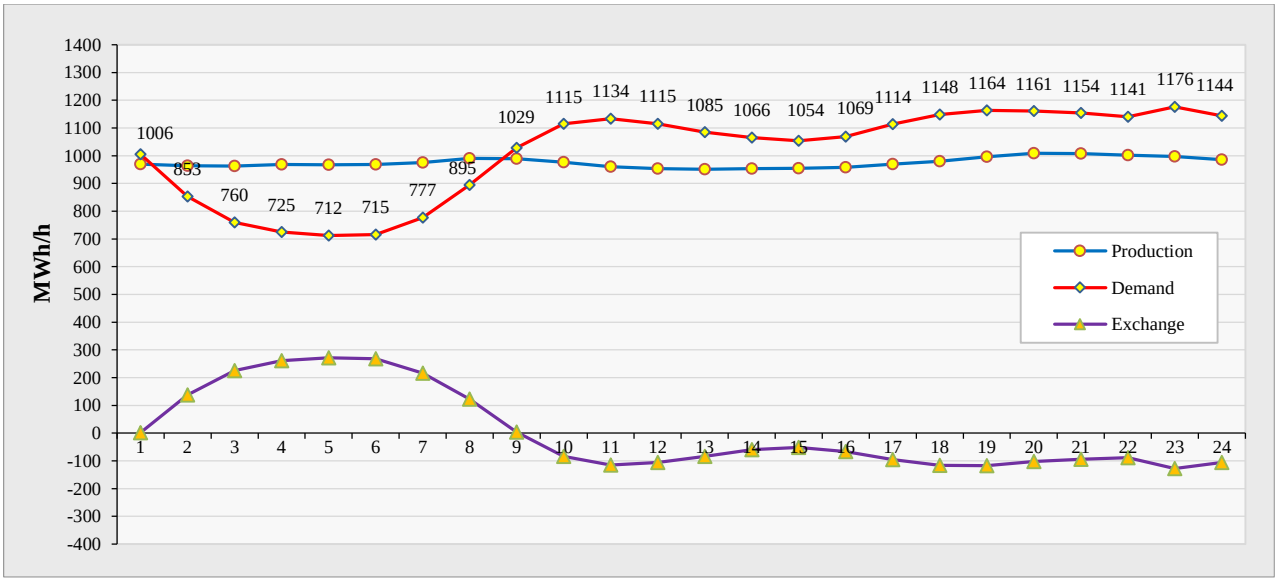


Figure 2. Typically, a daily diagram represents the annual average demand per hour for the Kosovo Power System

Kosovo's energy sector has historically been a driver of economic growth due to abundant resources and rising local and regional energy demand. However, the dependency on electricity, particularly during the winter, demands minimal tolerance for disruptions. Achieving reliable electricity supply, integrating and expanding the market, and incorporating new generation capacities all hinge on effective system planning.

Kosovo has an installed production capacity of 1,567 MW, with the operational capacity at around 1,239 MW, mostly from thermal power plants (87.91%) and the remainder from hydropower, solar, and wind, as shown in Table 1. However, due to the age and inflexibility of the thermal power plants, imports and exports are necessary to balance the system. The transmission system, operated by KOSTT, manages energy flows and coordinates with the regional and European electric power systems [13].

Table 1. Generation capacities in Kosovo power system

Production units	Commissioning Year	Unit capacity (MW)		
		Installed	Net	Min/max
A1	1962	65	Out of Operation	0
A2	1964	125	Out of Operation	0
A3	1970	200	144	100-130
A4	1971	200	144	100-130
A5	1975	210	144	100-130
B1	1983	339	264	180-260
B2	1984	339	264	180-260
Total HPP		**132.4**	**132.4**	
Wind Power		**137.2**	**137.2**	
PV		**10**	**10**	
Total RES		**279.6**	**279.6**	
TOTAL		**1 567.5**	**1 239.6**	

Electricity consumption and peak demand in Kosovo surged by over 90% between 2000 and 2010, with consistent annual growth of 6.7%. The energy system experiences fluctuating demands influenced by seasonal changes and various consumer categories. In 2021, consumption reached 6,885 GWh, marking an 11% increase from 2020 (Figure 3) [13].

However, demand dropped to 6,547 GWh in 2022, reflecting a 4.9% decrease compared to the previous year. The absence of Transmission Capacity allocation at the Kosovo-Serbia border has significantly impacted the energy situation in the region, introducing substantial impediments to the operational efficiency of energy traders. Political considerations have impeded decisive action, and no consensus on capacity allocation has been reached to date [8, 14].

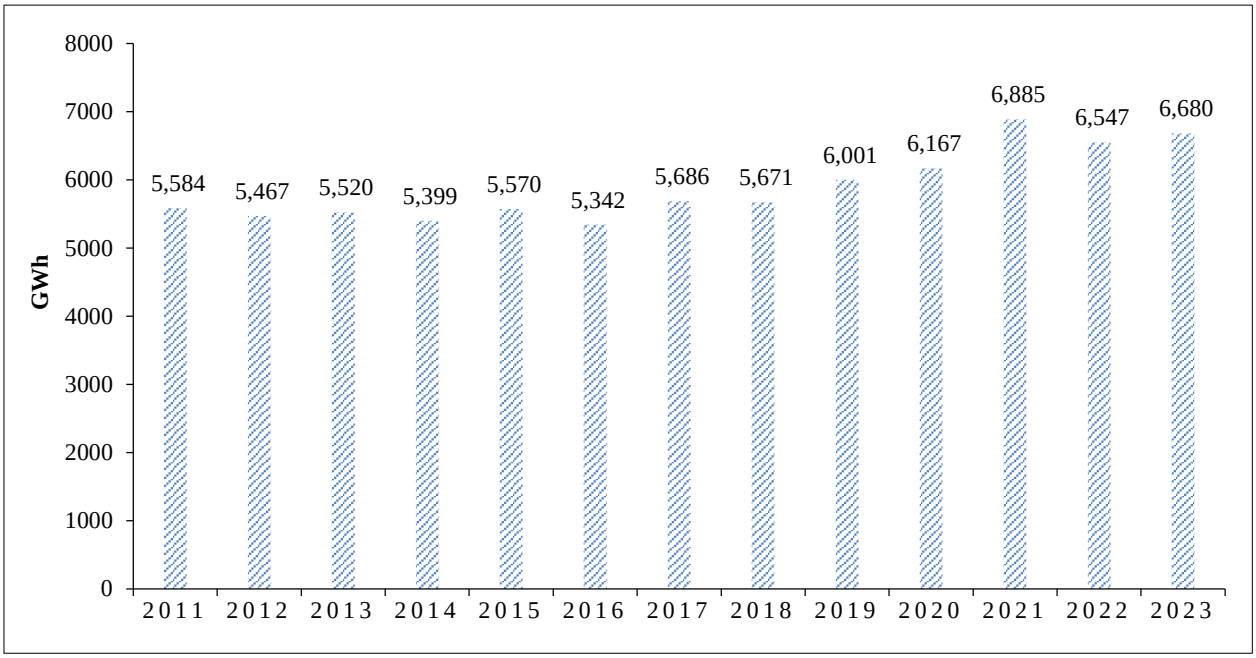
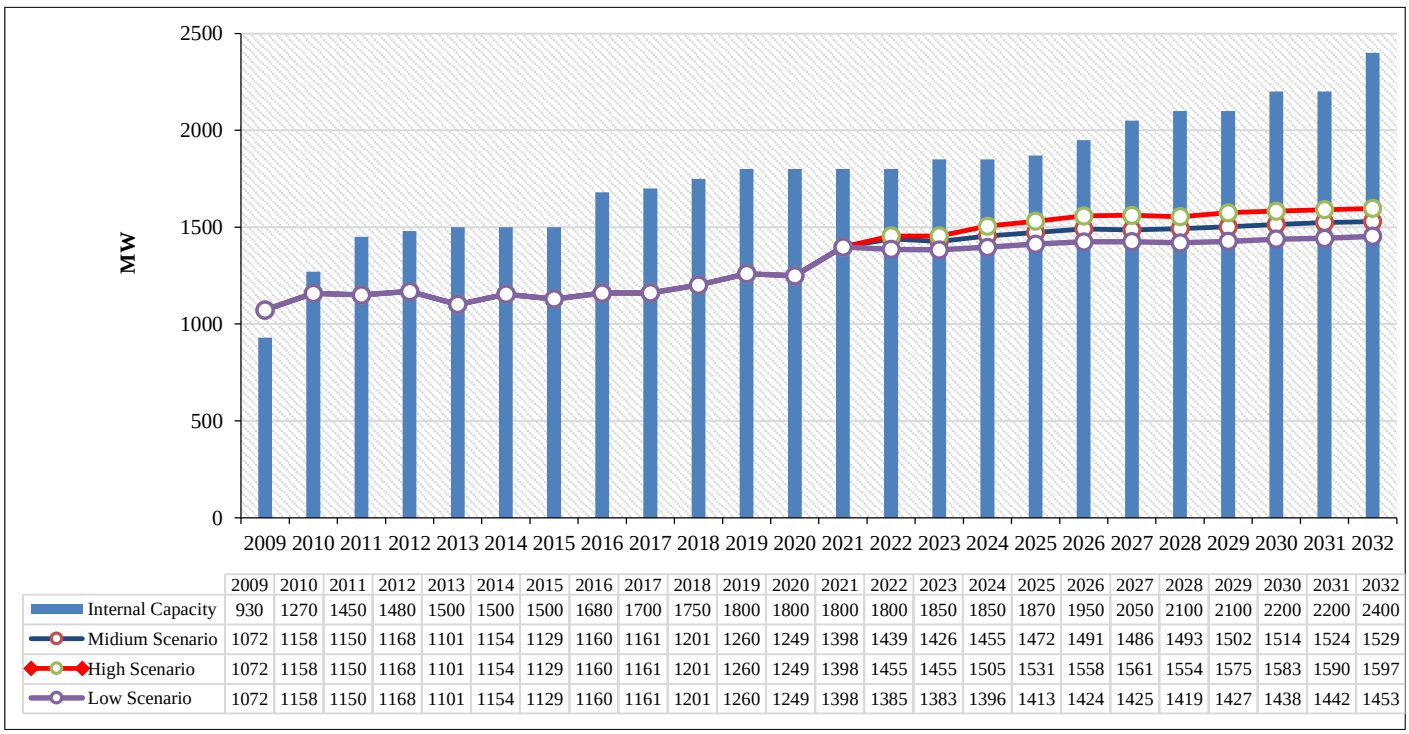


Figure 3. Electricity demand from 2011 to 2023

Kosovo's energy sector faces financing resources challenges in constructing new generating capacities, replacing existing ones, and utilizing renewable energy sources. High pollution levels from fossil fuel sources and outdated thermal power plants pose environmental and health risks. The sector also grapples with significant technical and commercial losses within the distribution network, hindering its efficiency and performance [15].



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Internal Capacity	930	1270	1450	1480	1500	1500	1500	1680	1700	1750	1800	1800	1800	1800	1850	1850	1870	1950	2050	2100	2100	2200	2200	2400
Midium Scenario	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249	1398	1439	1426	1455	1472	1491	1486	1493	1502	1514	1524	1529
High Scenario	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249	1398	1455	1455	1505	1531	1558	1561	1554	1575	1583	1590	1597
Low Scenario	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249	1398	1385	1383	1396	1413	1424	1425	1419	1427	1438	1442	1453

Figure 4. Load forecast

The electricity market in Kosovo operates primarily through bilateral contracts, regulated by the production regulator, ERO. However, there is an absence of a forward market, a spot market, or an index, making Kosovo's electricity trading landscape unique. Kosovo's energy portfolio lacks a gas market or related activities, although there are aspirations to establish connections with several projects, including the Trans-Adriatic Gas Pipeline in Albania.

Kosovo has been a net importer for many years, prompting efforts to attract expertise and private capital for the "Kosova e Re" project, with the goal of constructing a new thermal power plant. The project was envisioned to be developed in stages, with the first phase seeking to replace the 'Kosova A' power plant, meet local needs, and rehabilitate the 'Kosova B' power plant for increased reliability and compliance with EU environmental standards. The second phase would address increased demand and facilitate the closure of the 'Kosova B' power plant after revitalization. The 'New Kosova' thermal power plant has been identified as a vital project, strategically positioning Kosovo in the regional landscape for future electricity generation, as illustrated in Figure 4 [16].

3. Unraveling the Roots: Triggers Behind the Energy Crisis

In today's world, there is a significant energy crisis, driven by various factors. These include a growing demand for energy, thus exceeding available supply, as well as challenges such as the ongoing COVID-19 pandemic and the conflict in Ukraine. Despite knowing that resources like oil, gas, power, and water are finite, many people tend to take them for granted. There is a prevailing sentiment that insufficient measures have been taken to address the impending crisis. The rise in oil and gas prices, along with the gradual depletion of these resources, highlights the severity of the situation. Unfortunately, some dismiss the energy crisis as a myth, overlooking important historical events like the oil crisis of 1973 and the oil price spike of 1990. Over the past decade, increasing demand and diminishing energy resources have led to a surge in prices [3].

The energy crisis in Europe has significant global economic implications, with notable economic and political consequences. The region, lacking intrinsic energy resources, ensuring autonomy, has emphasized this objective since the formation of the Integration Bloc in 1992, anchored by the Maastricht Treaty with Germany and France. A crucial factor driving the current energy crisis is Europe's heavy reliance on external energy sources. Before the COVID-19 pandemic and the Russia-Ukraine conflict, the European Union (EU) relied on about 70% of oil and natural gas exports from Russia, highlighting its vulnerability to external factors. Despite efforts to maintain strategic reserves, the EU grapples with a critical challenge of energy dependence. Notably, Europe is actively investing in an energy transition for environmental sustainability while deeming energy autonomy crucial to addressing ongoing and future crises. The energy crisis has implications for the post-pandemic world economic recovery, given the EU's pivotal role in the globalized economy. The subsequent analysis will explore economic and political implications, highlighting sustainable initiatives to address the issue, with the conclusion shedding light on their impact on post-pandemic economic recovery [8, 9, 17].

At the same time, the trajectory of electricity demand expansion has shown a notable slowdown in 2022. After a strong 6% surge in global electricity demand in 2021, driven by a rapid economic rebound as COVID-19 restrictions eased, projections indicated a reduction in growth to approximately 2.4% for 2022. Whether those were accurate projections, this aligned closely with the average growth rate observed between 2015 and 2019. The underlying causes of this moderation include a sluggish global economic expansion, increased energy costs following Russia's incursion into Ukraine, and the reinstatement of health-related limitations, particularly within China [18].

During the COVID-19 pandemic, a global decline in energy demand resulted in reduced non-fossil fuel electricity production. Following the easing of public restrictions, increased demand led to a natural gas shortage in Europe. The crisis deepened due to the Russian military buildup near Ukraine, disrupting the energy supply chain. This turmoil led to a substantial surge in natural gas prices across Europe. Gazprom, Russia's state-controlled gas company, received authorization to boost gas supply to European nations, temporarily reducing energy prices in November 2021. However, prices rebounded in December due to factors such as Germany's refusal to approve the Nord Stream 2 pipeline, closures of nuclear and coal plants, and increased military activity near Ukraine. Gas prices in Europe surged by an unprecedented 600% in 2021, including a 37% increase in UK wholesale gas prices within 24 hours in early October [6, 19].

In early 2022, energy prices rose further due to sanctions imposed on Russia during its invasion of Ukraine, disrupting energy supplies and causing increased prices for gas and electricity. Heightened energy prices prompted European nations to explore alternative, albeit costly, energy sources. The crisis also impacted the food industry, resulting in higher prices. The overall effects were evident in increased living costs and housing prices across various European countries, including the United Kingdom and some central and eastern European nations [6].

4. External Factors

In 2021, global electricity demand surged by an unprecedented 6%, exceeding 1,500 TWh. This growth, the most significant since 2010 as shown in Figure 5, resulted from a rapid global economic revival and extreme weather conditions, notably a colder winter. The expanding industrial sector drove the rising demand, followed by contributions from the commercial, service, and residential sectors [18].

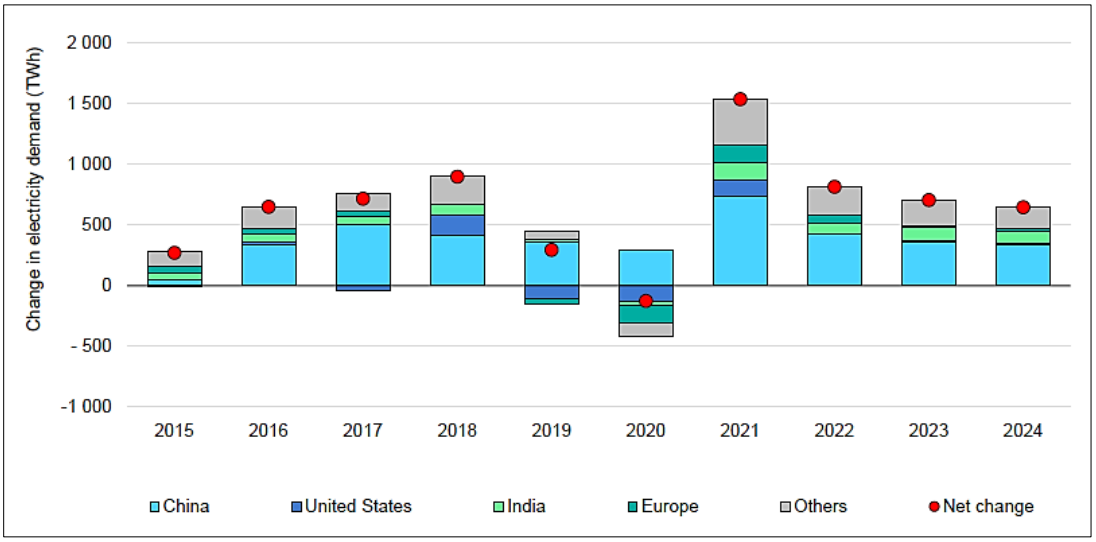


Figure 5. Global changes in energy requirements [18]

Europe faced an energy crisis in 2021 influenced by climatic conditions, the aftermath of the COVID-19 pandemic, limited wind energy generation, reduced natural gas resources, low reserves, the absence of a strategic reserve, electricity price formulation, EU-Russian political developments, and climate policies. Various authors express differing opinions on the causes of the crisis, marked by increased energy and market prices, stemming from both external and internal factors. Governments strive to balance energy security, affordability, and sustainability, implementing measures to alleviate the impact on consumers [20].

By 2020, Europe relied on gas imports due to declining internal production. Depleting gas fields in the North Sea and the Netherlands led to increased reliance on imports, mainly from Russia and Norway. The International Energy Agency (IEA) urged Russia to send more gas to Europe amid concerns about lower supplies in Russian-controlled storage facilities. The IEA proposed increased gas availability for the winter heating season [21].

In Q1 2022, European energy markets experienced a fivefold increase in short-term gas prices, attributed to enduring trends and recent events. Factors included changes in customer and investor dynamics, carbon tax influence, heightened global demand post-COVID-19, and the unfolding conflict in Ukraine [22].

The anticipated gas price trajectory in Europe for 2021 foresaw a notable 600% surge, with wholesale gas prices in the UK escalating by 37% in just 24 hours in early October, as illustrated in Figure 6. This spike raised concerns in various industries, leading stakeholders to seek assistance from the UK government. The heightened prices contributed to the closure of smaller energy providers and disruptions in specific industrial sectors. Consequently, there was a visible push to reduce reliance on fossil fuels and nurture a robust renewable energy sector [23].

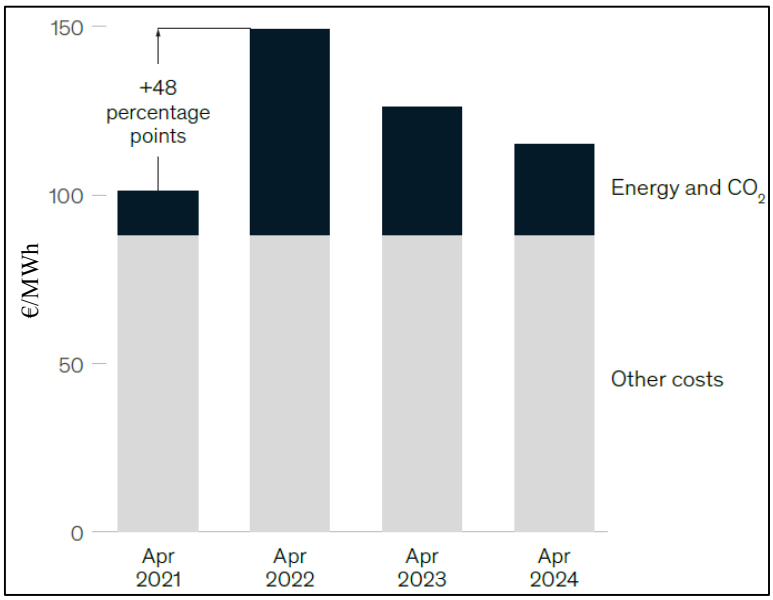


Figure 6. Impact of the Rise in Production Costs on Electricity Prices [18]

5. Internal Factors Analysis in Kosovo

The year 2021 saw a significant increase in electricity prices in European markets. This surge was driven by factors such as heightened gas demand in Asia, low gas reserves in European stocks, and an increased need for electricity following the economic recovery after the COVID-19 restrictions. These factors, combined with global economic, atmospheric, and political dynamics, contributed to the price escalation.

Kosovo's manufacturing sector initially remained unaffected by the price and supply crisis, benefiting from lower demand during warmer months and sufficient production capacity. However, the second half of 2021 saw an unprecedented spike in electricity prices. The combination of these factors led to prices on the Hungarian Electricity Exchange (HUPX) reaching €376/MWh, representing a staggering 563% increase compared to the beginning of the year. As a net importer of electricity, Kosovo faced rising dependence on imports due to the escalating prices in Europe. The price fluctuations in Kosovo during 2021 highlighted the growing sensitivity of electricity demand, raising concerns about security (Figure 7) [24].

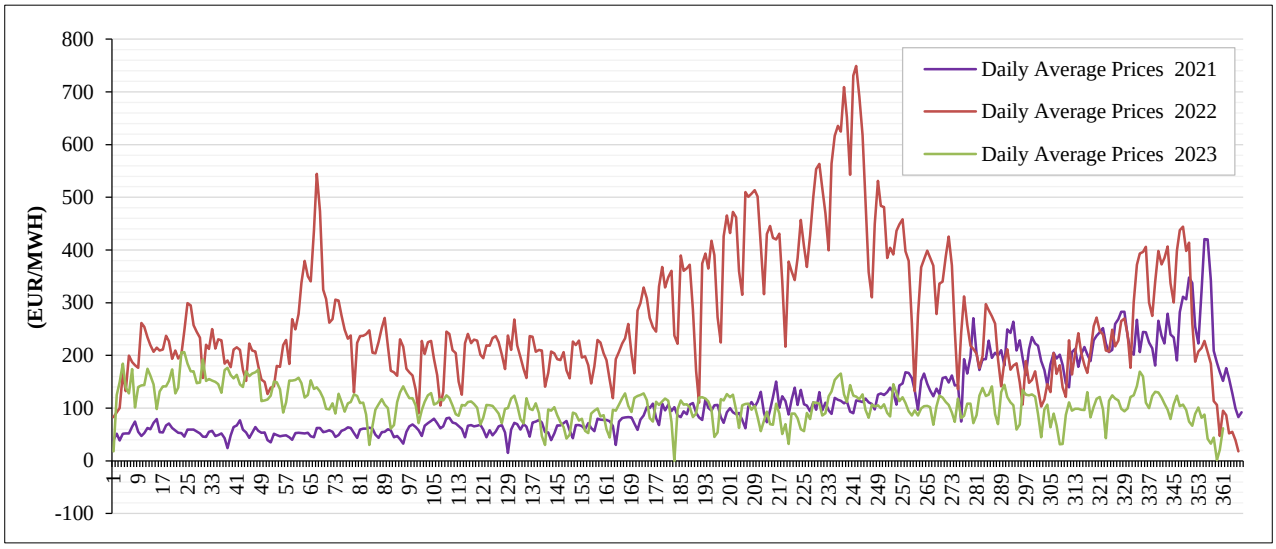


Figure 7. Daily average prices in HUPEX for the years 2021, 2022, and 2023

In December 2021, electricity consumption in Kosovo surpassed normal growth records by 10.8% compared to the previous year. The maximum load in the transmission systems peaked at 1,398 MW, with an average hourly consumption of 1,198 MWh/h. This increase in consumption was influenced by consumer spending, particularly in the last months of 2021. The majority of electricity demand during periods of low consumption is typically met by local production. However, due to the aging thermal power plants and their limited ability to adjust to fluctuating demand, especially during peak times and high-demand periods, the need for imports becomes essential [18, 25].

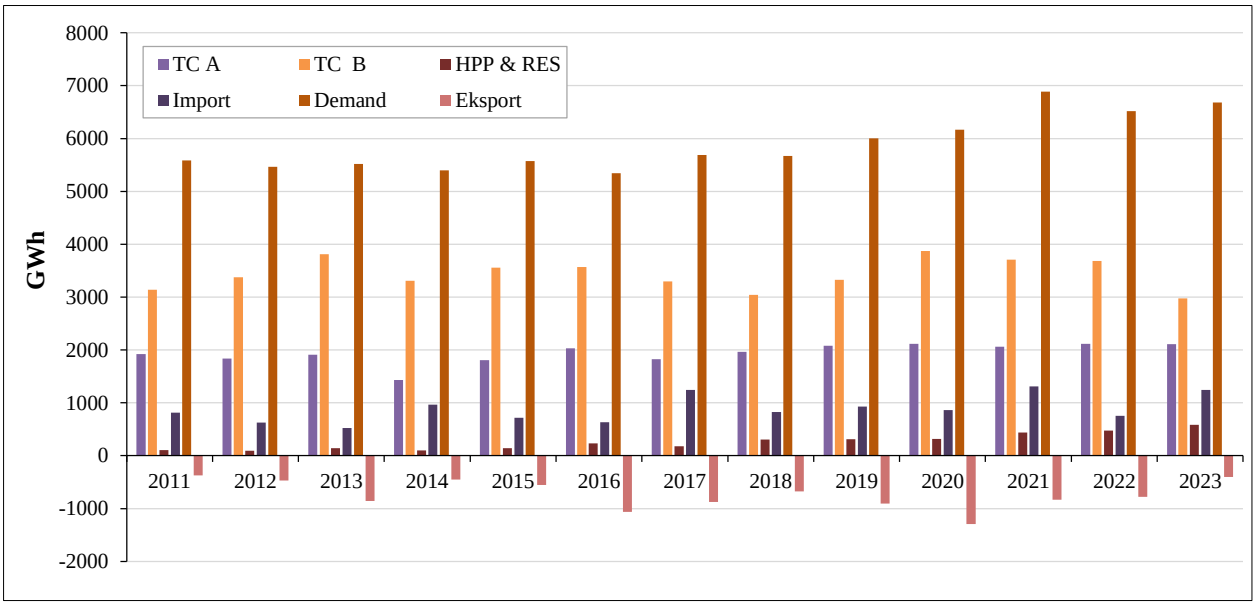


Figure 8. Electricity production, import, export, and demand

The graph above shows the trends in electricity production, imports, exports, and demand over the past decade. Notably, the data in the graph highlights a consistent increase in electricity demand from 2011 to 2021.

In recent years, the modest expansion of power generation capacities, driven by the integration of various renewable sources, has not been enough to meet the high peak loads of Kosovo's electric power system. To address this energy shortfall and meet national demand, Kosovo heavily relies on importing electricity. With a combined operational capacity of 1,236 MW and a maximum load of 1,398 MW this year, the electric power system falls short during peak periods. This situation results in a generation adequacy ratio of 88.4%, as illustrated in Figure 8. The monthly variations in maximum and minimum loads throughout 2022 and 2023 are detailed in Table 2 [13].

Table 2. Maximum and minimum monthly bases during the year

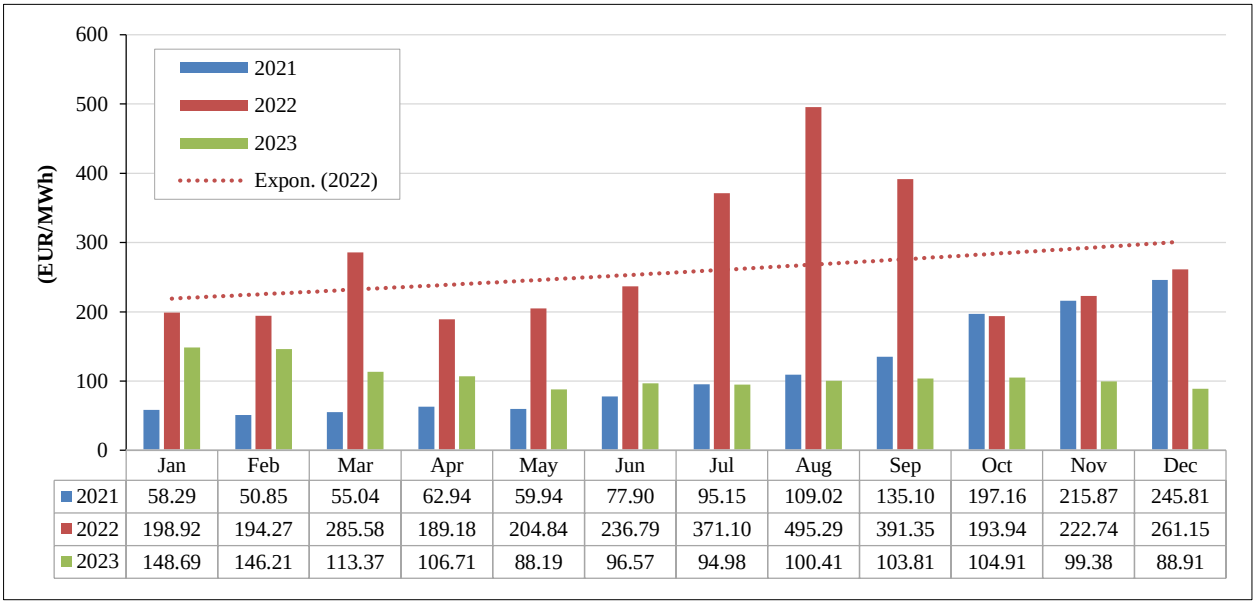
Load	MW	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2022	Max	1,429	1,291	1,311	1,077	857	721	768	764	699	879	1,135	1,372
	Min	715	562	487	369	294	306	337	332	324	350	413	782
2023	Max	1,265	1,413	1,179	1,219	809	768	873	870	744	961	1207	1401
	Min	602	554	477	419	323	311	358	390	335	342	399	508

The delay in implementing reforms to support renewable energy sources and strategic investments, particularly through well-defined energy efficiency programs, reflects persistent, unsustainable, and shortsighted policies and decision-making. Legal uncertainties surrounding the enactment of crucial laws, such as those related to renewable energy sources, and the establishment of an auction market for potential investors in renewable sources, as well as the execution of subsidy schemes, remain significant obstacles in this sector.

The inflexibility in Kosovo's energy sector stems from a lack of competitive resources, particularly in the realm of renewable energy, notably hydroelectric power. This rigidity is compounded by the absence of a comprehensive policy for integrating renewable resources, hindering Kosovo's progress in aligning with the green agenda outlined by the European Union.

The energy crisis in Kosovo in 2021 marked a notable escalation in pricing dynamics within the European electricity markets, driven by factors such as heightened gas demand in Asia, depleted gas reserves in European stocks, and increased electricity consumption following the post-COVID-19 economic resurgence. This surge in electricity prices exemplifies the intricate interplay of economic and political factors on a global scale.

In the initial phase, Kosovo's energy sector showed resilience during the prevailing price and supply crisis by taking advantage of reduced demand in warmer seasons and having sufficient domestic production capacity. However, the latter part of 2021 saw a significant increase in prices. This led to international electricity exchange rates, particularly on the Hungarian Electricity Exchange (HUPX), as illustrated in Figure 9, soaring to €376/MWh, a 563% increase from the beginning of the year. As a net importer of electricity, Kosovo was greatly affected by the high prices seen across Europe [24].



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021	58.29	50.85	55.04	62.94	59.94	77.90	95.15	109.02	135.10	197.16	215.87	245.81
2022	198.92	194.27	285.58	189.18	204.84	236.79	371.10	495.29	391.35	193.94	222.74	261.15
2023	148.69	146.21	113.37	106.71	88.19	96.57	94.98	100.41	103.81	104.91	99.38	88.91

Figure 9. Comparisons of average monthly prices in HUPEX for 2021 and 2023

In 2021, Kosovo experienced a substantial 41% increase in electricity consumption compared to 2017. This surge, particularly during the winter months, created pressure on the energy supply infrastructure. The higher demand for electricity may be attributed to increased use for heating following changes in the tariff structure. The removal of block and seasonal tariffs likely led to lower winter electricity prices, especially for high consumption (>600 kWh/month), prompting households to use electric heating more and thus increasing overall electricity usage, as illustrated in Figure 10 [13, 26].

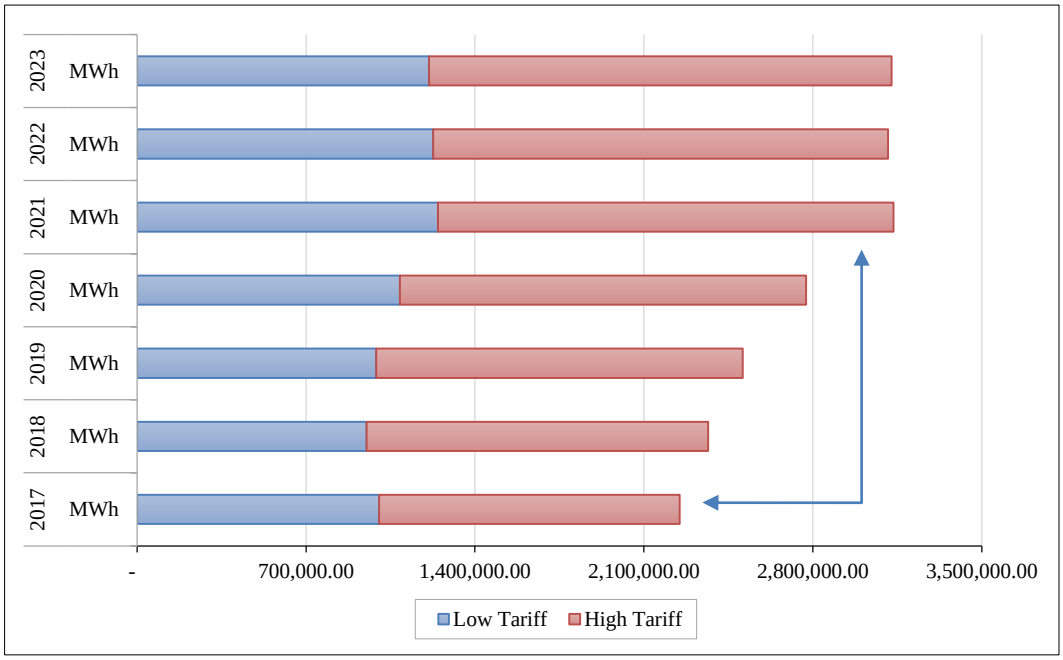


Figure 10. Share annual electricity consumption for households

Furthermore, the energy sector in Kosovo encountered additional complexities in 2021. During this time, European electricity markets experienced a price surge due to factors such as increased demand for gas in Asia, depleted gas reserves in European stocks, and higher electricity consumption driven by the global economic recovery after the initial COVID-19 restrictions. This surge in electricity prices demonstrates the intricate interplay of economic and political factors on a global scale [25].

Considering the technical specifications of the generating units Kosovo A and B, which are crucial for meeting consumption needs and maintaining the balance of the electrical system, the reliance on local production, while inflexible, necessitates the importation of electricity. This need becomes particularly evident during peak times and the winter season, which are characterized by generally higher prices. At the same time, there are instances of surpluses, especially during off-peak hours and seasons with lower demand for electricity, requiring strategic exports. To meet the nation's domestic electricity needs, both KESCO and KOSTT actively import electricity from the regional market, facilitated by strong commercial contracts with reputable traders. As a result, the dynamics of import prices are closely linked to fluctuations in international electricity exchanges. This connection highlights the complex relationship between local energy demand, regional market dynamics, and the broader international energy landscape.

In December 2021, electricity consumption in the country exceeded typical growth records by an extraordinary 10.8% compared to the previous year. During this time, the Transmission System recorded an unprecedented peak load of 1,398 MW, with an average hourly consumption of 1,198 MWh/h. These figures indicate a significant increase in consumption, largely driven by the widespread adoption of electric heating practices, particularly in the final months of 2021. In response to the energy crisis, key stakeholders within governmental institutions and regulatory frameworks took pivotal actions. Financial measures were implemented to mitigate the significant costs associated with imports, leading to a state of emergency in Kosovo's energy sector. Operators were required to implement measures aimed at reducing energy consumption and promoting conservation. Simultaneously, the Office of the Energy Regulator initiated a comprehensive analysis of available options for reforming electricity tariffs for end-users, prompting an extraordinary review of the Maximum Allowable Revenues applicable to regulated enterprises [13].

The energy crisis in Kosovo was compounded by a deficiency in electricity production from local sources, stemming from a chain of issues. The aging infrastructure, unreliability, and unplanned output of thermal power plants contributed to supply shortages, significant energy imbalances, and extraordinary deviations in energy costs.

At the end of 2021 and the beginning of 2022, the energy crisis in the country worsened, primarily due to the inadequacy of local electricity production. Technical malfunctions in aging generating units, combined with external

adversities, led to a surge in electricity demand, particularly during the peak season of energy consumption. The unexpected shutdown of these generating units had a ripple effect, as the Pristina city heating plant relies on steam from these units in a cogeneration process. During the high season, this plant provides heat to over 12 thousand families, resulting in increased electricity demand and significant strain on the interconnection system, culminating in a state of crisis.

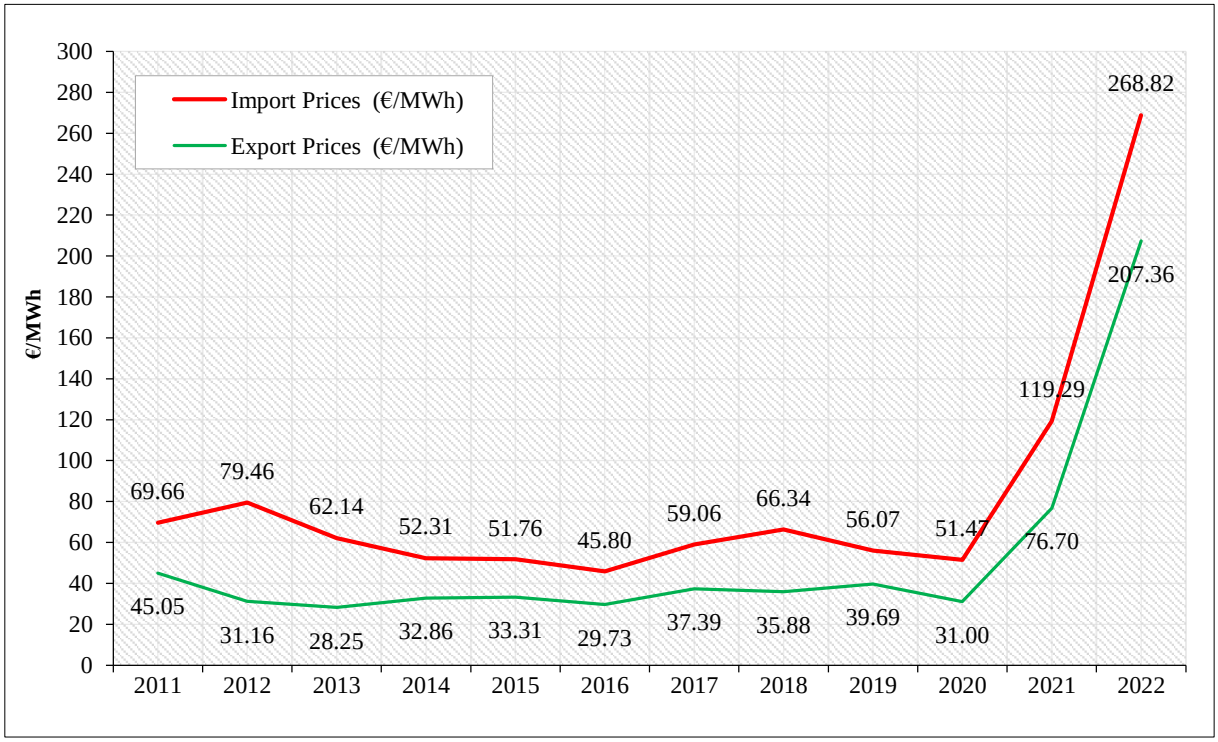


Figure 11. Average import and export prices over the years

The technical challenges encountered in Unit B2 of TC Kosova B further complicated the situation, with the defect expected to be resolved by the first quarter of 2022. The disruption in the operation of Unit B2 had a profound impact on meeting consumption demand. Concurrently, the global energy crisis led to a substantial escalation of electricity prices in international markets, significantly affecting import costs. In December 2021, the supply and distribution operator imported electricity totaling 32.3 million euros, constituting 12% of the maximum revenues allowed for the entire year of 2021. These multifaceted challenges highlight the need for strategic interventions and the formulation of sustainable energy policies to navigate the complex landscape of the contemporary energy crisis.

6. Conclusion

This paper focused on the challenges facing Kosovo's electricity supply security during the pandemic years of 2021–2023 due to the lack of new energy sources and the integration of the regional energy market. These deficiencies led to the country's being vulnerable during crises, necessitating urgent action and strategic reform. The absence of thorough consideration of the tariff structure in 2017 led to unintended consequences, including a persistent surge in consumption, particularly for heating purposes, deviation from the intended trend, and resultant difficulties managing demand and network loads. Therefore, a thorough policy review of tariffs by relevant institutions is essential.

Kosovo must develop a robust energy strategy utilizing renewable energy sources such as solar and wind, along with other viable options. This proactive approach is crucial to safeguarding the country from energy shortages and uncontrolled surges in electricity prices, which would be detrimental to institutions and consumers alike. However, the transition from a predominantly lignite generation system to a diverse and environmentally friendly portfolio presents both economic and technical issues. Given these multifaceted challenges, a comprehensive, evidence-based policy is essential to ensuring supply security, price affordability, and generation resource diversification. The current crisis underscores the unsustainable nature of the conventional business model, necessitating urgent action in three key areas: making tariffs reflective of costs, increasing investments in both new generation and grid enhancements, and fostering a conducive environment for sustainable energy practices. Addressing these critical areas will lead Kosovo to a more resilient and sustainable energy future, mitigating risks and ensuring the safety and affordability of its electricity supply.

7. Declarations

7.1. Author Contributions

Conceptualization, A.G. and V.R.; methodology, A.G., V.R., and R.B.; software, V.R.; validation, A.G., V.R., R.B., M.C., and I.K.; formal analysis, A.G., V.R., and I.K.; investigation, A.G. and V.R.; resources, A.G.; data curation, A.G. and V.R.; writing—original draft preparation, A.G. and V.R.; writing—review and editing, R.B., M.C., and I.K.; visualization, A.G.; supervision, A.G., and V.R.; project administration, V.R.; funding acquisition, A.G. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Institutional Review Board Statement

Not applicable.

7.5. Informed Consent Statement

Not applicable.

7.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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