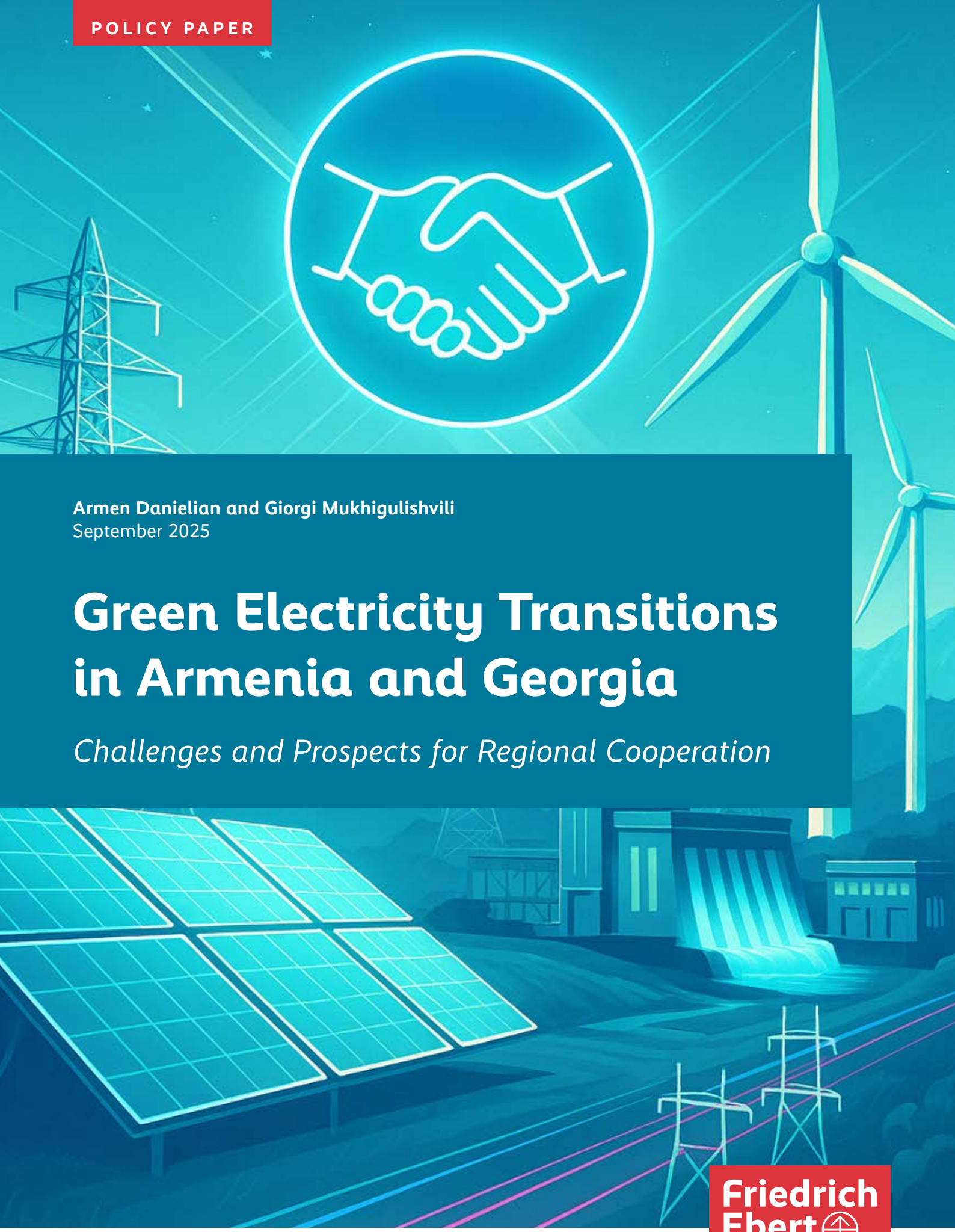
POLICY PAPER



Armen Danielian and Giorgi Mukhigulishvili
September 2025

Green Electricity Transitions in Armenia and Georgia

Challenges and Prospects for Regional Cooperation

Friedrich Ebert Stiftung

Competence Centre
Climate and Social Justice

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Challenges and Prospects for Regional Cooperation

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1
Introduction

Regional energy integration is increasingly vital as it enhances energy security, facilitates the efficient integration of variable renewables, and supports decarbonisation goals amid growing global energy interdependence and climate commitments. The importance of regional energy integration in the South Caucasus is important on several levels. Firstly, the transition to renewable energy systems, in particular with higher shares of variable sources such as solar and wind energy, can be attained more efficiently if countries can trade electricity and energy with each other. Secondly, the recent instability exhibited by larger regions, both to the north (due to the Russian-Ukrainian conflict) and to the south (due to the Israeli-Iranian conflict), showcase the need for the South Caucasus to become more resilient as a region, especially as its own conflicts have not been fully resolved. In light of this, cooperation with the European Union (EU) would provide another extraregional cooperation format for the South Caucasus, allowing a greater diversification of energy sources. This study focuses on Armenia and Georgia as the two countries in the region that lack domestic fossil fuel reserves, making the question of energy security more acute for them than for Azerbaijan.

As a result, stronger EU-South Caucasus energy cooperation offers mutual benefits by advancing EU decarbonisation and diversification goals while supporting Armenia and Georgia in energy security, infrastructure modernisation, and regulatory alignment, ultimately fostering stability in a geopolitically sensitive region, while simultaneously advancing the EU's own decarbonisation and diversification goals.

Armenia and Georgia are strategically located at the EU's eastern frontier, with complementary energy profiles and untapped potential for exploitation of renewable energy sources, making them key partners in efforts to promote regional electricity integration and aligning neighborhood policy with the European Green Deal and REPowerEU objectives, especially as both countries have clearly aired aspirations for deeper integration with the European Union through regulatory harmonisation, energy reforms, and infrastructural connectivity.

Armenia and Georgia already engage in active energy cooperation, particularly in the electricity and gas sectors, with three power transmission lines linking their grids and enabling emergency electricity exchanges. Supported by the EU, a new high-voltage transmission line is under construction to further strengthen this connectivity and facilitate exports to third countries. This existing collaboration – as illustrated by Armenia's record electricity exports to Georgia in 2022[1] – demonstrates that regional integration efforts are building on a solid foundation rather than starting from scratch.

The transition to sustainable electricity systems is an opportunity and a challenge for Armenia and Georgia, two South Caucasus states with distinct energy landscapes yet shared regional opportunities. As both countries strive to integrate renewable energy, enhance energy security, and align with global decarbonisation goals, understanding the dynamics of their electricity sectors becomes crucial. **This research examines the transformations in Armenia's and Georgia's electricity systems, assessing renewable energy development, policy frameworks, and existing challenges.** Given the region's interconnected nature, the study further explores **potential avenues for collaboration both between the two countries and with the EU** which could enhance resilience and sustainability. By identifying key policy recommendations, this research contributes to the discourse on regional energy cooperation and facilitates informed decision-making for a low-carbon energy future. This collaboration aligns with the EU Green Deal's objective of strengthening sustainable energy partnerships beyond its borders, ensuring long-term stability and reliability in the regional energy network.

The study employed a methodology combining policy analysis and quantitative data interpretation to assess Armenia and Georgia's renewable electricity transitions. It drew on national strategies and regulatory documents, complemented by energy data from national and international sources (International Energy Agency, IEA, and International Renewable Energy Agency, IRENA), to examine energy supply, demand, and the potential offered by renewables. Infrastructure projects such as the Black Sea Submarine Electricity Cable and cross-border interconnection projects were used to explore regional integration, while EU-aligned frameworks provided a lens with which to assess regulatory convergence and cross-border trade readiness.

1 Economic Cooperation Between Armenia and Georgia: Potential and Challenges Ahead – Caucasus Watch

2
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Armenia

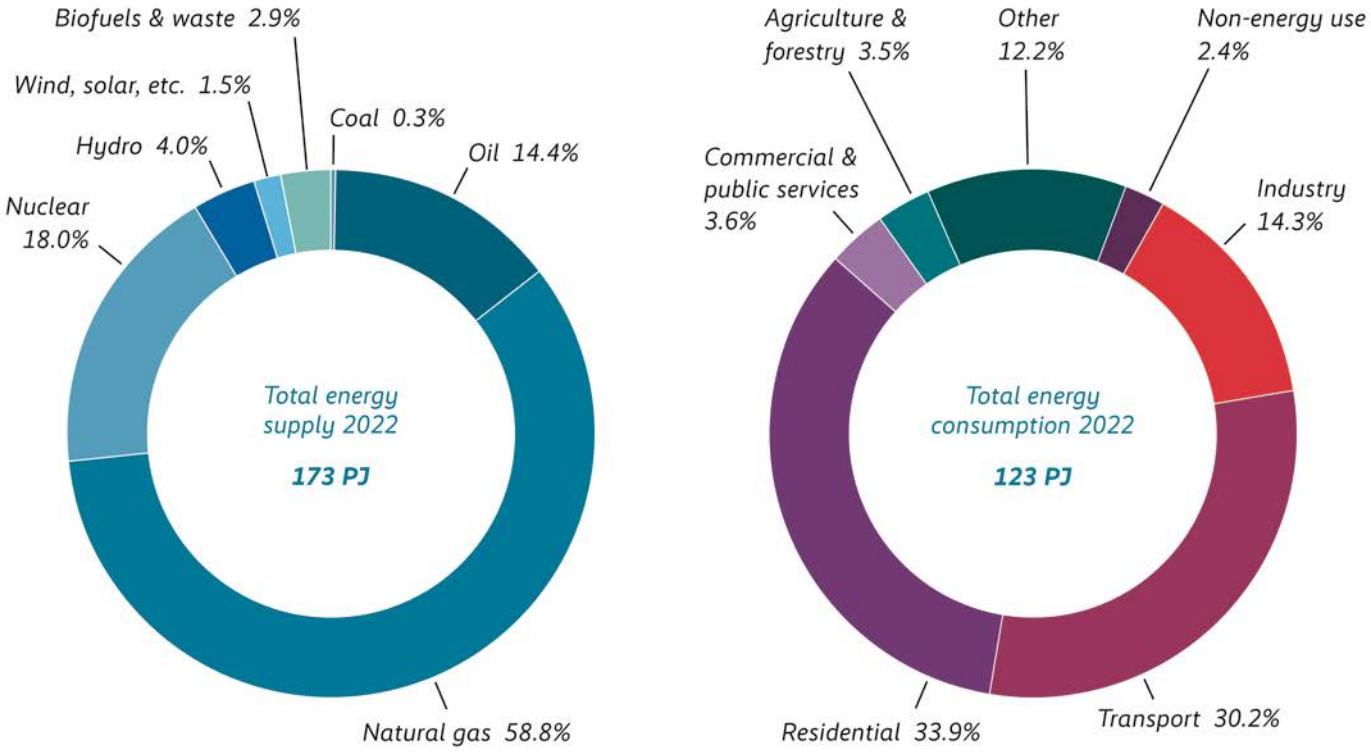
Current Energy Mix and Renewable Energy Potential

Armenia's overall energy mix exhibits a high share of imported fossil fuels, uranium imports, and local renewable energy generation. Fossil fuels account for over 70% of the primary energy supply, and about 37% of electricity generation. In 2024, the country imported 2.7 billion cubic meters of natural gas, of which 83% came from Russia, and 17% from Iran.[2] Only a small portion of the primary energy supply comes from local energy production provided by renewable sources, and mainly serves electricity generation. In terms of consumption of energy, the residential and transportation sectors are the two largest ones, each accounting for approximately a third of energy consumption.

Armenia's present electricity generation mix comes from a combination of gas-powered plants, nuclear power, and renewables (hydropower and solar) in roughly equal proportions. The system has an installed capacity (including dispatchable capacity) much higher than the current peak demand of approximately 1,300 MW, although a significant part of the capacity is unavailable due to ageing infrastructure. The two reactors at the Metsamor nuclear power plant, constructed in 1976 and 1980, were shut down in January 1989, with only one reactor then being

Armenia's primary energy supply and total energy consumption (by sector)

Figure 1

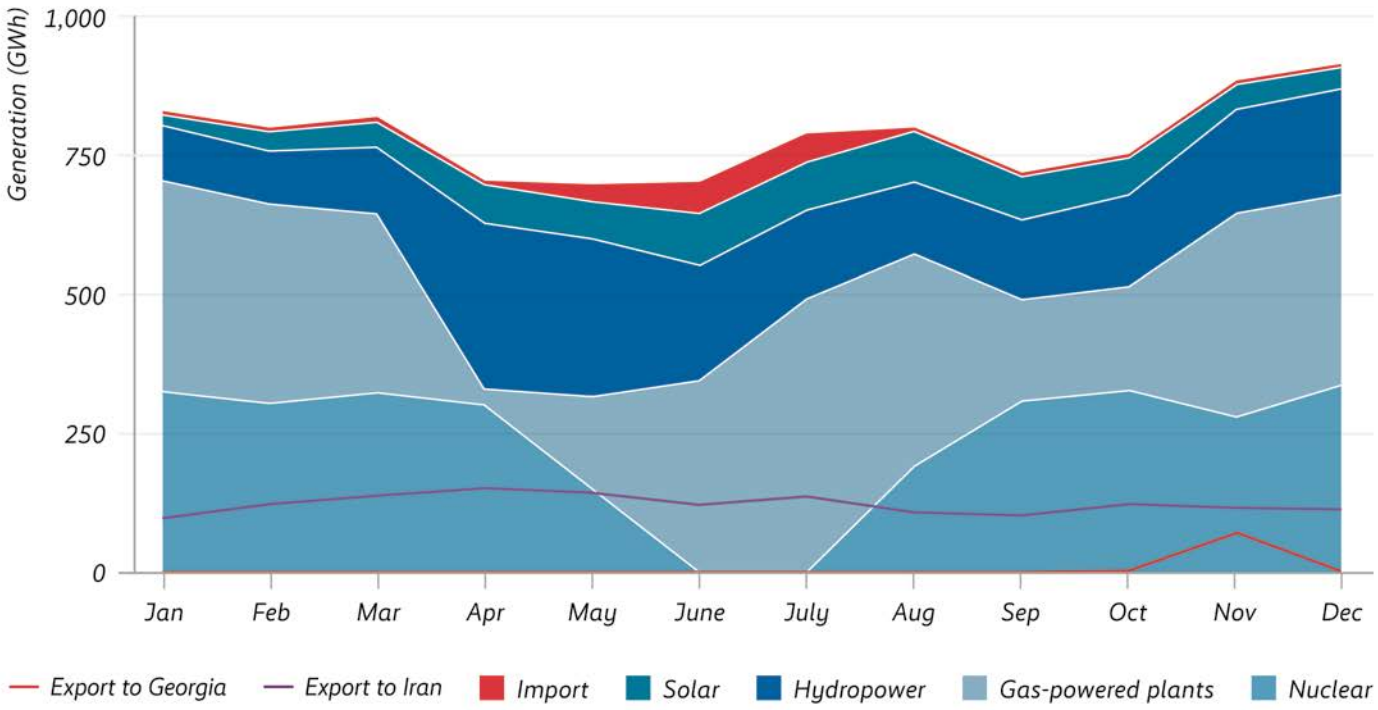


Source: IEA

2 psrc.am

Figure 2

Armenia's electricity generation by source as well as exports in 2024



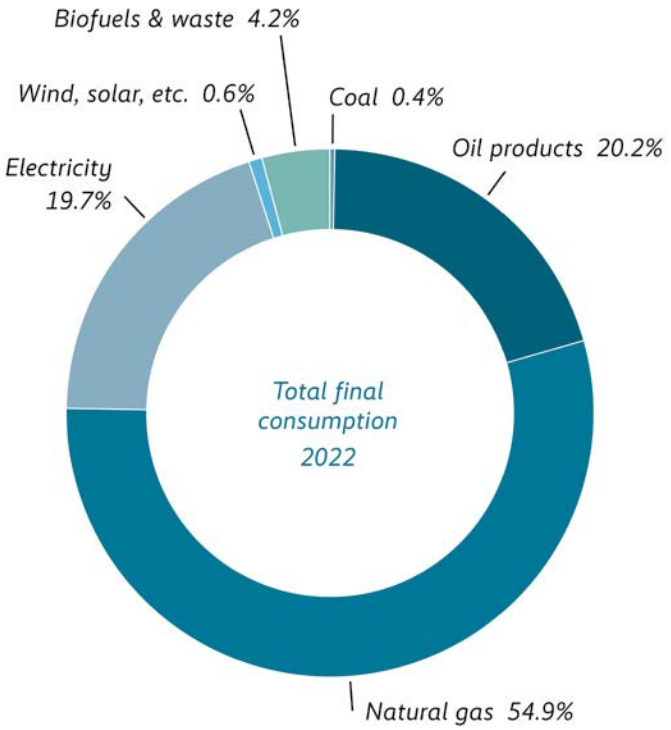
Source: Graph by the author based on data from psrc.am.

restarted in 1995 – currently with 440 MW of installed capacity. About 954 MW of capacity is available from thermal power plants and approximately 1,300 MWs from hydropower.[3] Solar power has grown rapidly over the past few years, reaching over 600 MW of installed capacity.[4] Electricity generation by source varies by season. In particular, renewable electricity generation is lower during winter months (due to less water and solar resource availability), while natural-gas-powered generation accounts for a higher share in periods when the nuclear power plant is undergoing refueling or maintenance work.

Looking at total consumption of energy by source, most of it is consumed in the form of natural gas and oil products for transportation, heating, and industrial uses. As a carrier for final consumption, fossil fuels provide almost all the energy consumed by the transportation sector, two-thirds of the residential sector's, about 60% of the industrial sector, and 70% of the commercial sector.[5] Taking into account the significant share of natural gas in electricity generation as discussed above, it becomes evident that every single sector's consumption in Armenia is highly reliant on imported fossil fuels.

Figure 3

Armenia's final energy consumption by energy sources



Source: GEOSTAT

3 https://www.german-economic-team.com/wp-content/uploads/2024/07/GET_ARM_PB_02_2024_EN.pdf

4 https://www.ecolur.org/en/news/energy/15684/

5 https://www.iea.org/countries/armenia/efficiency-demand

Examples of projected capacities according to Armenian governments' plans

Table 1

Republic of Armenia Energy Sector Development Strategic Program to 2040 (2021)	Government strategy: → 1000 MW solar by 2030, 1500 MW by 2040* → Up to 500 MW wind by 2040
World Bank (2023)	Referent scenario: → 194 MW wind by 2030, 404 MW by 2040 → 1031 MW solar by 2030, 1499 MW by 2040 High VRES scenario: → 350 MW wind by 2030, 750 MW by 2040 → 1250 MW solar by 2030, 1750 MW by 2040
Armenia's Energy Independence Roadmap (2024)	Accelerated scenario: → 900.38 MW solar by 2030, same in 2040, 1300.38 MW by 2050 → 6.5 MW wind by 2030, 455 MW by 2040, 721.5 MW by 2050 Aggressive scenario: → 2050 numbers from the Accelerated scenario brought to 2040

* The latter figure is provided in an amendment to the national law from 26 October 2023 https://www.arlis.am/hy/acts/184420/latest

The Armenian government has been planning to enhance self-reliance by increasing the share of renewables in the electricity sector as well as by extending Metsamor NPP's life until 2036, by which time a new nuclear power plant would start operating. In terms of energy generation potential, costs and grid integration capacity are the primary constraints on solar and wind resources, as opposed to natural endowment. Here are some examples of projected capacities (see Table 1).

While most hydropower capacity is utilised, a certain potential remains untapped, including three spots for pumped hydropower storage, each with 150 MW output and a total storage capacity of approximately 3,800 MWh.[6] Geothermal potential is estimated at 150 MW,[7] while the potential for power generation from biogas is estimated at 174 MW.[8] With regard to the new nuclear power plant, no planned capacity has been put forward, although the Prime Minister has come out in favour of modular nuclear power plants.[9]

Aging grid infrastructure is one of the obstacles to greater integration of variable energy sources; the enhancement of the Armenia-Iran interconnection would provide a much-needed source for grid regulation. The grid has limited sources of flexibility, and the two-tier day-night tariffication (with a lower electricity tariff at night) does not reflect the growing contribution of daytime solar power generation. These are among the reasons that the rapidly growing share of solar (from virtually 0% a few years ago to over 8% of electricity generation in 2024) is now causing problems for the grid. Spurred by net metering and power purchase agreements, the solar PV sector has grown without being subject to sufficient norms and regulations.

Armenian Energy Policy

Being a member of the Eurasian Economic Union, Armenia has to align its energy regulation with Union standards. At the same time, Armenia's Comprehensive Eastern Partnership Agreement (CEPA) with the EU also provides a framework for energy policy development. The general framework is laid down in the country's 2001 Law on Energy, which is periodically amended;[10] a separate law covers nuclear energy.[11] By 2029 at the latest, Armenia has to align

6 https://ace.aua.am/files/2017/08/AUA-Nov-SEA-.pdf

7 https://www.german-economic-team.com/wp-content/uploads/2024/07/GET_ARM_PB_02_2024_EN.pdf

8 Renew Energy Denmark. (2025). Pre-Feasibility Study on Biogas Infrastructure Development in Armenia. Completed as part of the Sweden-funded program Waste Policy Armenia at the AUA Acopian Center for the Environment, American University of Armenia (AUA), Yerevan.

9 https://armenpress.am/en/article/1200141

10 http://www.parliament.am/legislation.php?sel=show&ID=1291&lang=arm&enc=utf8 (amendments available only in Armenian)

11 http://www.parliament.am/law_docs/010399HO285eng.pdf. Overview can be found at https://www-pub.iaea.org/MTCD/Publications/PDF/CNPP-2021/countryprofiles/Armenia/Armenia.htm

its regulation more closely to EU directives and regulations,[12] including:

- → Directive 2009/72/EC on the Electricity Market;
- → Regulation 714/2009 on Cross-border Trade in Electricity;
- → Directive 2005/89/EC on Security of Electricity Supply;
- → Directive 2009/28/EC on Renewable Energy;
- → Directive 2012/27/EU on Energy Efficiency;
- → Directive 2010/31/EU on Energy Efficiency in Buildings;
- → Directive 2009/119/EC of 14 September 2009 Imposing an Obligation on Member States to Maintain Minimum Stocks of Crude Oil and/or Petroleum Products;
- → Regulation (EU) No 256/2014 of the European Parliament and of the Council of 26 February 2014 Concerning the Notification to the Commission of Investment Projects in Energy Infrastructure within the European Union.

The country's 2040 Energy Strategy,[13] adopted in 2021, highlights five main priorities – maximum use of renewable energy potential, possible realisation of energy efficiency potential, extension of the Metsamor nuclear power plant's life, North-South road corridor construction, and liberalisation of electricity markets. In particular, as part of its regional energy cooperation, Armenia is looking to extend cooperation with four different parties – the EAEU, EU, Georgia, and Iran. While such an approach reflects the country's efforts at diversification, it requires more careful balancing of regulation and management of various energy agreements and cooperations.

Nuclear energy has traditionally been supported in Armenia, regardless of the respective government. The 1990s energy blockade experience, when the nuclear power plant was not functioning, highlighted its role in national energy security. With its capital expenses paid off by the Soviet Union, the Metsamor power plant provides cheap electricity for a reliable baseload. Feed-in tariffs were introduced in 2007, spurring the development of largely post-Soviet small hydropower plant capacity,[14] In the past few years, the rise in autonomous solar consumers has likely been accelerated by a combination of falling costs and the 2015 net metering law, while tenders have been used to accelerate large-scale solar projects.[15] However, the variability of solar generation and the pronounced seasonality of small hydropower plants make these fall short of baseline generation. To firm up capacity, Vorotan Cascade and major thermal power plants receive capacity remuneration in addition to payments for electricity sold.[16] Though these various policies have been successful in promoting the specific technologies that they aimed at, it is harder to determine the extent to which the system has moved towards a more optimal configuration as a result. Lack of market-based approaches with free price formation, both internally and with regard to electricity trade with neighbours, has resulted in more centralised approaches to the development of the power sector. Electricity market liberalisation, launched in 2022, constitutes a more systematic attempt at reforming the electricity sector, though many power plants will continue providing electricity through long-term agreements in the near future, rather than bidding their generation capacities on spot electricity markets or through bilateral contracts with consumers. Additional policy measures for promoting renewable energy and energy efficiency are set out in the Program on Energy Savings and Renewable Energy for 2022–2030.[17] Among other things, the program outlines battery storage technologies, both stand-alone and in combination with large solar power plants, as directions for further energy development.

The government has recently been taking steps towards diversification of energy partners, as the sector has been traditionally dominated by the Russian-Armenian relationship, including ownership and operation of gas pipelines by a subsidiary of Gazprom, Russian supply of uranium fuel as well as the vast majority of natural gas and oil, ownership of major electricity production facilities – Hrazdan TPP and Sevan-Hrazdan Cascade – by the Russian-based Tashir Group, as well as the latter's ownership and operation of electricity distribution networks.[18] In addition to the Armenian-EU cooperation outlined further below,[19] Armenia has expanded its cooperation in the energy field with such countries as the United States (US) (nuclear energy)[20] and the United Arab Emirates (UAE) (solar energy).[21]

At the same time, as the country remains committed to aligning its energy standards both with the EU (through CEPA) and the Eurasian Economic Union (EAEU) (of which it is a member), this requires additional administra-

12 Armenia 2022 Energy Policy Review

13 Republic of Armenia Energy Sector Development Strategic Program to 2040

14 Armenia 2022 Energy Policy Review

15 Armenia 2022 Energy Policy Review

16 Էլեկտրաէներգետիկական համակարգի 2025թ. սակագների վերանայում (psrc.am, 2025)

17 Annex1. Program on ES&RE for 2022-2030_eng.pdf

18 Armenia 2022 Energy Policy Review. As of the time this article was being written (July 2025), the question of ownership of electricity distribution networks had become a salient issue in national politics, with the government seeking to take ownership away from Tashir networks (Pashinyan Moves to Nationalize Energy Grid – EVN Report).

19 For an overview of Armenia-EU cooperation up to 2020, see Armenia's Precarious Balance: The European Union (EU) and the Eurasian Economic Union (EAEU)

20 The United States of America and the Republic of Armenia Sign a Memorandum of Understanding Concerning Civil Nuclear Cooperation

21 Construction of largest solar power plant in Armenia jointly with Emirati company MASDAR will start in early 2026

tive resources, although the two frameworks are complementary to an extent.[22] Of particular relevance in this article are obligations relating to energy efficiency standards under the EAEU[23] and the agreement on common electricity markets.[24] While the former can be more complementary to CEPA obligations, the latter would require further legal analysis if Armenia were to trade electricity both with the EU and EAEU. An important nuance is that the country shares no border with any member of the two organisations. All trade will physically take place through a third party, unless a neighbouring country joins one of those organisations as well (as, for instance, both Turkey and Georgia have candidate status in the EU). The potential difficulty is not the trade itself, as multiple countries, e. g., Finland and the Baltic countries, have traded electricity with the EAEU while themselves being members of the EU. Rather, it is the question of regulations – whether the sale of electricity to the EU or the EAEU will take place for purely economic reasons (i. e., whoever offers higher prices), or whether there will be restrictions imposed due to Armenia being a member of the EAEU. Another potential question is the role of an intermediary in these regulations; in particular, Georgia, which likewise can have electricity trade with the EAEU (Russia) and, if the Black Sea cable is constructed, with the EU as well. These questions require a legal analysis of electricity market regulations and the potential impact on the management of electricity regimes in Georgia.

Georgia

Current Energy Mix and Renewable Energy Potential

Georgia's energy mix is characterised by a high dependence on fossil fuel imports and a notable, though underutilised, potential for renewable energy. In 2023, natural gas dominated Georgia's total energy supply, accounting for 51%, followed by oil products at 25% and hydropower at 16.5%[25]. Renewable energy sources, including hydropower, biofuels, and a small contribution from wind and solar, made up approximately 21% of the total supply. Domestic energy production is limited, covering only about 23% of Georgia's total energy demand, with the rest being met through imports – especially of natural gas from Azerbaijan and Russia and oil products from various sources.

22 Armenia 2022 Energy Policy Review

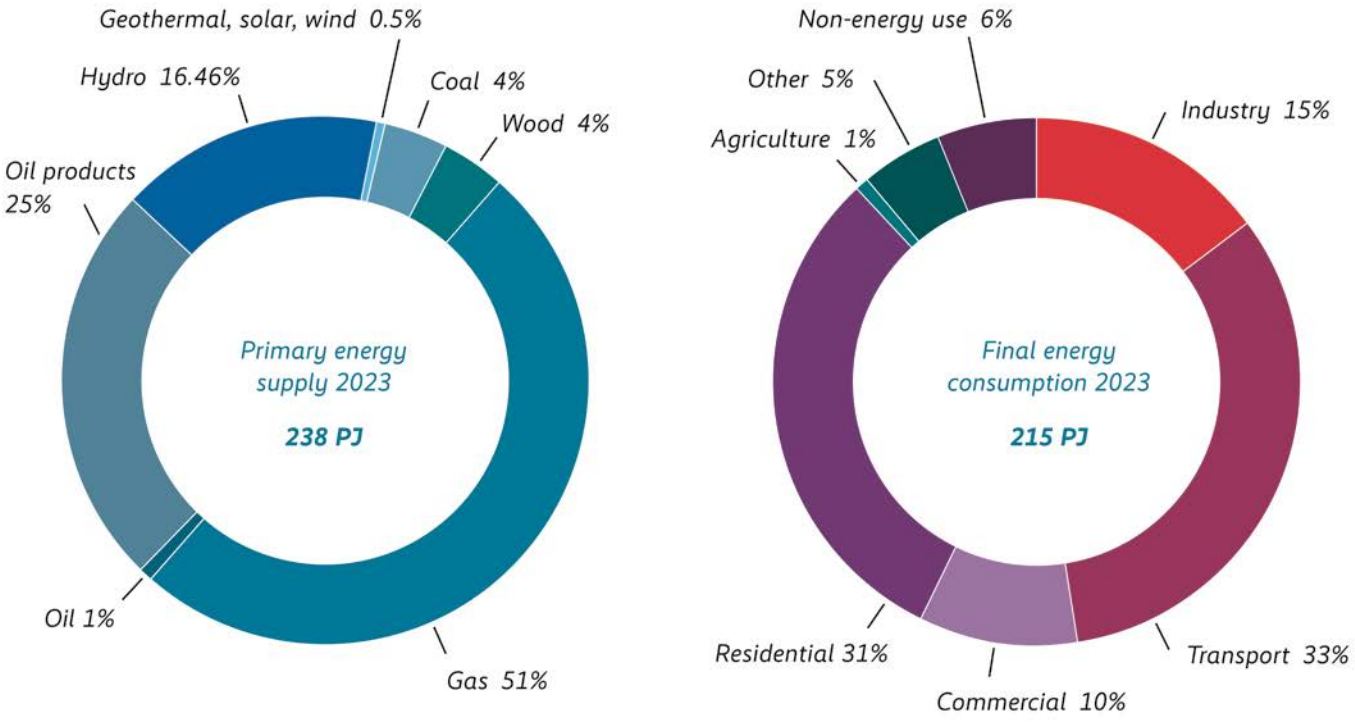
23 https://docs.eaeunion.org/upload/iblock/63d/nxgms5og4fb1pouovwz3h9c76d2qzsv9/cncd_24122019_114_doc.pdf

24 https://eec.eaeunion.org/upload/medialibrary/c0d/prilozhenie_21_k_dogovoru_o_eaes.pdf

25 Energy Balance of Georgia 2023 – National Statistics Office of Georgia

Figure 4

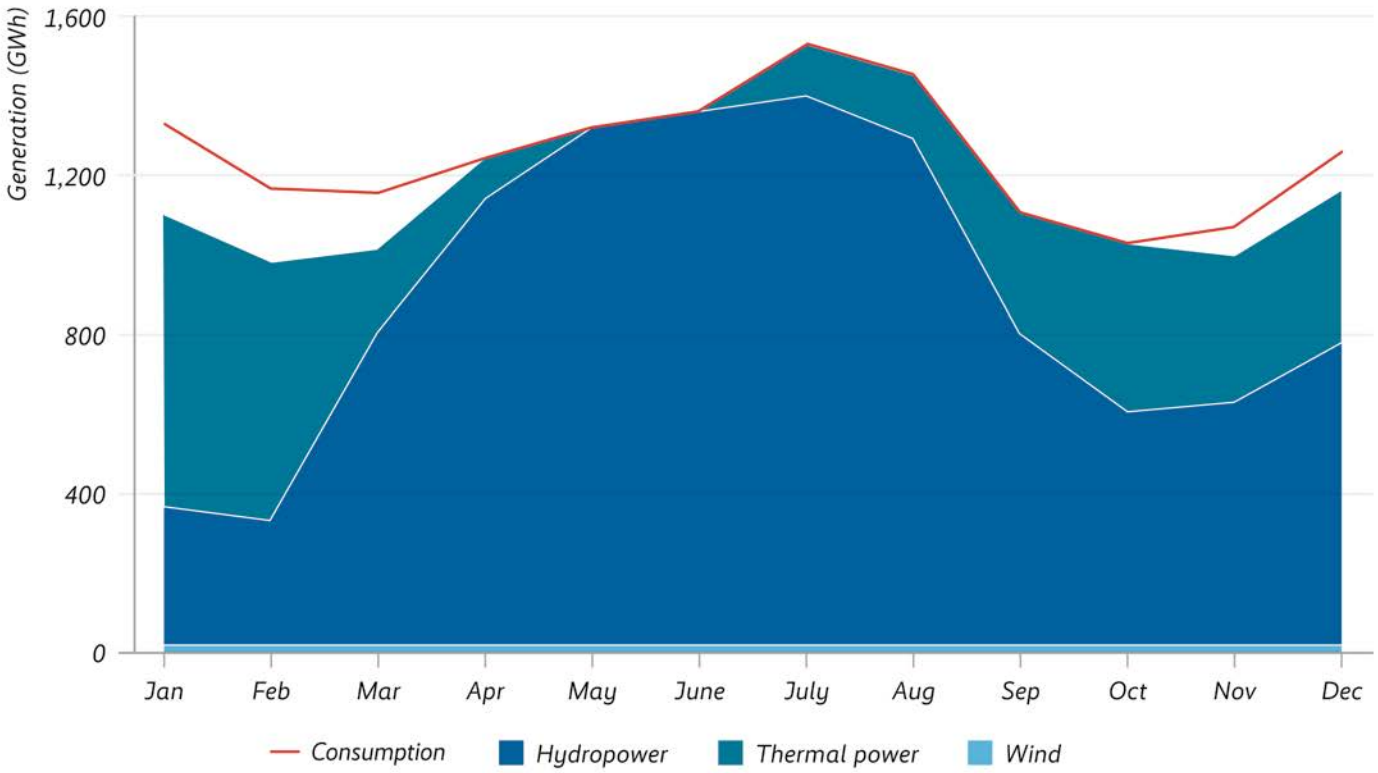
Georgia's primary energy supply and final energy consumption, 2023



Source: GEOSTAT

Figure 5

Georgia's electricity monthly production and consumption, 2023



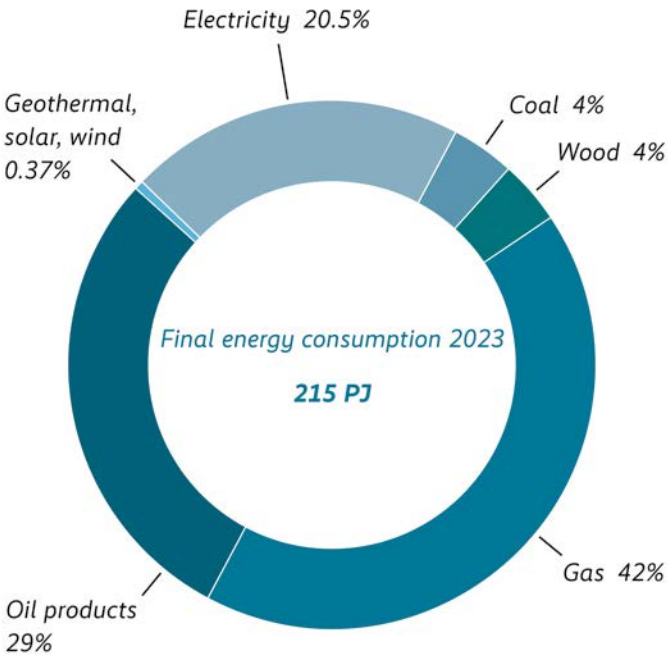
Source: GNERC

Georgia's electricity sector is dominated by hydropower. In 2023, the installed capacity of the Georgian power system accounted for 4,596 MW, of which hydropower plants (3,394 MW) constituted the largest share, followed by thermal power plants (1,181 MW) and a single wind power plant (20.7 MW). Solar power is gradually emerging as a part of Georgia's renewable energy mix, although its role remains relatively modest (160 MW, by 2025) compared to hydropower. Hydropower contributed over 75% of the 14,396 GWh generated in 2023, followed by thermal power (24%) and wind (0.6%)[26]. However, because of the strong reliance on intermittent renewables, electricity production is highly dependent on weather conditions and is characterised by seasonal variations. The seasonal variability of hydropower and increasing electricity demand – partially driven by cryptocurrency mining – require Georgia to import electricity during winter months.

Based on Georgia's 2023 aggregated energy balance, different energy sources are dominated by distinct sectors. Oil products are overwhelmingly consumed by the transport sector, which accounts for over 82% of total oil use (around 51,128.8 TJ). This reflects the sector's heavy reliance on petroleum for mobility and freight. In contrast,

Figure 6

Georgia's final energy consumption by energy carrier, 2023



Source: GEOSTAT

26 https://data.gnerc.org/

natural gas consumption is more evenly distributed, with significant use in the residential (39%), power generation (22%), and industrial sectors (7%), commercial, and public services (8%) – indicating its broad role in heating and industrial processes. Electricity consumption is also evenly distributed in all sectors of the economy, underscoring its critical importance. Geothermal and solar energy remain marginal, with minimal consumption confined mostly to the residential and service sectors.

If Georgia is to increase its energy security and reduce its reliance on energy imports, there is an urgent need to explore indigenous sources of energy supply, and take advantage of its abundant renewable energy resource potential.

Georgia possesses a diverse and substantial **renewable energy potential** that remains largely untapped. Hydropower dominates the landscape, with over 300 rivers offering hydropower opportunities and a **total estimated capacity of 15 GW with an annual production potential of 50 TWh**, of which less than a quarter has been developed. The majority of this potential is located in the western regions, where water runoff is highest.[27]

Wind and solar resources are still in the early stages of development, but offer substantial untapped capacity. According to IRENA, Georgia's **wind energy potential has been roughly estimated at 4 GW**, with integration of up to 750 MW into the national grid by 2028 being considered feasible under current conditions. Average wind speeds vary significantly across the country, with zones characterised by speeds exceeding 7 m/s at 100 m hub height being viewed as particularly favourable.

In terms of solar energy, the country benefits from global horizontal irradiation levels ranging from 1,100 to 1,600 kWh/m²/year, especially in the southern and central regions. The **technical potential for solar photovoltaic (PV) capacity is estimated at 4.5 GW**, though no large-scale solar PV facilities are operational at present. Grid constraints allow only 500 MW of solar PV to be integrated by 2028. Nonetheless, this highlights a clear opportunity for targeted investment and infrastructure development to support solar deployment.[28]

Together, these resources provide Georgia with a strong foundation for transitioning to a more sustainable and secure energy system. **The rationale for Georgia's energy transition** is grounded in the country's urgent need to enhance **energy security** and reduce its overwhelming dependence on fossil fuel imports. The heavy reliance on external energy sources makes Georgia vulnerable to international **price volatility and supply disruptions**. As the country lacks significant fossil fuel reserves of its own, transitioning to indigenous renewable energy sources – such as hydropower, wind, and solar – is essential to build a secure, resilient, and self-sufficient energy system.

Additionally, the energy transition presents an opportunity to **boost Georgia's economic competitiveness** and **fulfill its international climate commitments**. The falling costs of renewable energy technologies, particularly solar and wind, offer a cost-effective alternative to fossil fuels. By decarbonising its energy mix, Georgia can **align with EU climate policies**, including the Carbon Border Adjustment Mechanism, thereby safeguarding the competitiveness of export-oriented industries like steel. At the same time, expanding renewables can **reduce the country's energy trade deficit, alleviate energy poverty** through modern and affordable energy solutions, and **stimulate local value chains and job creation**. In essence, the energy transition is not only an environmental imperative, but also a strategic driver of sustainable economic development.

Despite Georgia's significant renewable energy potential, the country faces several critical **challenges in any efforts to accelerate the deployment of renewables**. One of the foremost issues is the **lack of grid flexibility and modernisation**. Georgia's power system, originally designed within the Soviet-era framework, **struggles to accommodate variable renewable energy sources such as wind and solar**. **Seasonal dependence on hydropower** also contributes to grid instability, particularly during the winter months, when electricity demand peaks and hydropower output declines. These fluctuations necessitate reliance on electricity imports and thermal generation, highlighting the urgent need for enhanced **energy storage systems, demand-side management**, and the integration of **flexible technologies like battery energy storage and pumped hydro**.

In addition, **regulatory and institutional limitations** hinder the growth of renewable energy. **Delays in the implementation of electricity market reforms**, such as full activation of day-ahead and intra-day markets, have complicated the use of effective support mechanisms like contracts for difference (CfD). Moreover, **policy uncertainty and abrupt** shifts – such as halting further renewable energy auctions – undermine investor confidence and reduce the bankability of projects. The **lack of comprehensive geospatial planning, insufficient capacity for long-term energy scenario modelling**, and **limited municipal engagement** further constrain coordinated development efforts. Without targeted regulatory reform, institutional strengthening, and capacity-building, Georgia risks underutilising its renewable energy resources despite clear long-term economic and environmental benefits.

27 IRENA (2025), Energy transition assessment: Georgia, International Renewable Energy Agency, Abu Dhabi.

28 IRENA (2025), Energy transition assessment: Georgia, International Renewable Energy Agency, Abu Dhabi.

Georgia's Energy Policy

Georgia's policy and regulatory framework for renewable energy has evolved significantly in recent years, particularly with the adoption of key legislative acts such as **the Law on Energy and Water Supply (2019)**[29]**, the Law on Promoting the Generation and Consumption of Energy from Renewable Sources (2019)**[30]**, and the Law on Energy Efficiency (2020)**[31]. The cornerstone of Georgia's strategic planning is **the National Energy and Climate Plan (NECP)**[32], adopted in 2024, which sets national targets for greenhouse gas reductions, renewable energy development, and energy efficiency through 2030. The NECP complements the country's commitments under the Energy Community and the Paris Agreement, aiming for a **27.4% share of renewables in gross final energy consumption by 2030**.

To support renewable energy development, Georgia introduced incentive schemes such as **net metering** [33](in 2016) for small-scale producers (up to 500 kW) and contracts for difference (CfD) for larger projects. Two competitive auctions held in 2023 and 2024 allocated 1.1 GW of renewable capacity. However, the policy environment remains in flux: further auctions have been suspended in favour of direct contracting at pre-determined median prices, raising concerns about market transparency and investor confidence. Moreover, while the regulatory framework has provisions for promoting the use of renewables in electricity generation, there are no comparable incentives in heating and cooling. Delays in electricity market liberalisation and challenges in aligning the NECP with Georgia's Nationally Determined Contribution (NDC) highlight the need for stronger institutional coordination, improved planning capacity, and a more stable, investor-friendly policy environment. **The government is planning to double generation capacity by 2034**, prioritising hydropower, but also targeting modest expansions in wind and solar.[34] By 2034, the total installed capacity of the Georgian power system is projected to reach 10,336 MW. Of this capacity, 4,314 MW will be derived from regulating hydropower plants (HPPs), 2,908 MW from seasonal HPPs, 1,291 MW from wind power plants, 232 MW from solar power plants, 110 MW from gas turbines, and 1,480 MW from high-efficiency combined-cycle thermal power plants (TPPs) and legacy Gardabani TPP units Nos. 3, 4, and 9. Nonetheless, electricity imports comprised 5% of consumption in 2023, highlighting the system's seasonal vulnerabilities.

Looking ahead, Georgia's energy policy aims to enhance energy security by diversifying energy sources, scaling up renewables, improving energy efficiency, and strengthening the national grid. The country has significant untapped potential in wind, solar, biomass, and geothermal resources, but challenges such as grid bottlenecks and seasonal hydropower variability, while public opposition to large-scale projects persists. With strategic investments, particularly in infrastructure and renewables, Georgia could reduce its reliance on imports and become a regional electricity exporter, especially if the planned Black Sea Submarine Electricity Cable linking Georgia to the EU market materialises.

29 ენერგეტიკისა და წყალმომარაგების შესახებ | სსიპ "საქართველოს საკანონმდებლო მაცნე"

30 განახლებადი წყაროებიდან ენერგიის წარმოებისა და გამოყენების წახალისების შესახებ | სსიპ "საქართველოს საკანონმდებლო მაცნე"

31 საქართველოს კანონი ენერგოეფექტურობის შესახებ, 2020

32 sakartvelos_energetikisa_da_klimatis_erovnuli_integrirebuli_gegma_damtkicebuli_.pdf

33 GNERC – ნეტოაღრიცხვა

34 Ten-Year Network Development Plan of Georgia 2024–2034

3
Regional and Extra-Regional Energy Cooperation: Strategic Perspectives from Armenia and Georgia

Armenia

Having been isolated from much regional energy development to date, Armenia plans to expand its electricity exports not only to Iran, but also to other markets, potentially via Georgia. Given Armenia's lack of electricity trade with neighboring Turkey and Azerbaijan, the country would benefit significantly from becoming a member of regional and extra-regional electricity trade. The expansion of variable renewable sources requires a higher level of integration, exporting surplus electricity in periods of high renewable generation and importing it when it is low.

The Energy Sector Development Strategic Program outlines a general plan to develop transmission and distribution networks, as well as to digitise and modernise the infrastructure. In terms of regional integration, the country has a 350 MW interconnection capacity with Iran, planned to increase to 1,200 MW through the construction of a 400 kV substation. With Georgia, the current 200 MW interconnection capacity is to increase to 350 MW, an amount which would potentially be doubled and tripled later on[35] through a 500/400 kV back-to-back connection (as the two systems are asynchronous). These developments would not only strengthen Armenia's position as a regional energy transit hub, but also attract investments in renewable energy projects.

Lacking large pumped storage reserves and other storage installations, Armenia would benefit significantly from the added flexibility of interconnections in any effort to mitigate daily fluctuations of wind and solar, as well as seasonal variability of hydropower. Emergency situations may also be better managed as a result, given that Armenia and Georgia have had a bilateral agreement on emergency electricity provision since 2012.[36]

Georgia

Georgia's strategic location at the crossroads of Europe and Asia positions it as a **key player in regional energy connectivity and cross-border electricity trade**. Already interconnected with the energy systems of Turkey, Armenia, Azerbaijan, and Russia, Georgia holds increasing potential to become a **renewable electricity transit hub between the South Caucasus and the European Union**. With the EU's increasing interest in diversifying energy sources and securing green electricity imports – particularly under initiatives such as **the European Green Deal and REPowerEU** – Georgia's abundant hydropower, wind, and solar resources make it a valuable partner in supporting Europe's decarbonisation goals.

To understand the prospects for regional integration, it is essential to examine **the specific characteristics and priorities of Georgia's domestic power sector**. The **Ten-Year Network Development Plan (2024–2034)**[37] outlines Georgia's strategic goals, emphasising supply reliability, energy security, and long-term system resilience. Among its main drivers are the integration of renewable energy (especially hydropower), the replacement of outdated thermal plants with efficient combined-cycle gas turbines, and the reinforcement of infrastructure to meet increasing domestic demand.

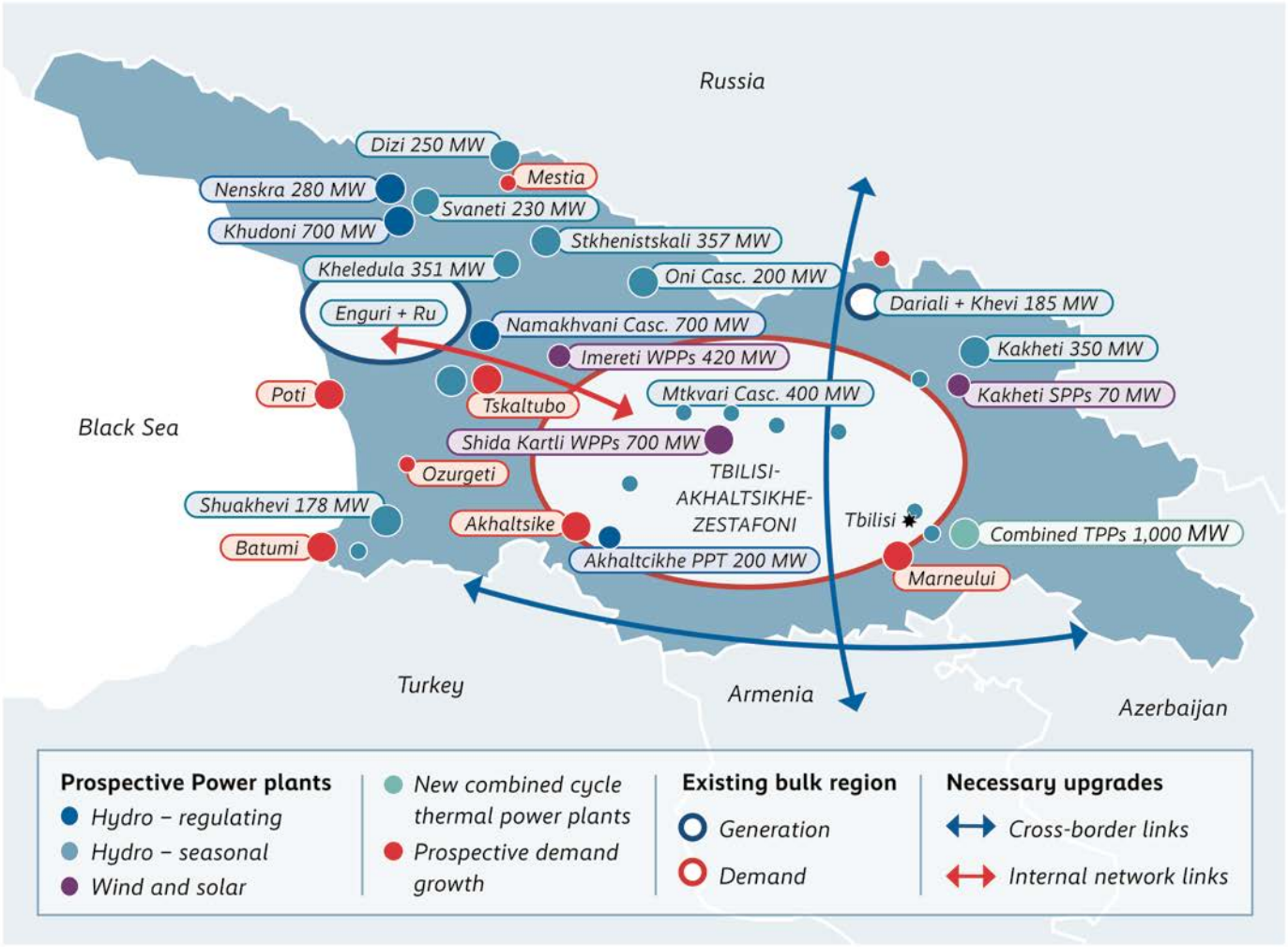
Georgia's internal transmission structure reflects legacy imbalances. The power system is predominantly west-to-east oriented, with much of its hydroelectric generation concentrated in the western region, while consumption hubs – such as Tbilisi and Rustavi – are in the east. This imbalance, especially acute in spring and summer when river flows are high, results in eastward flows that stress key substations. Moreover, significant portions of the infrastructure – especially hydro and thermal power plants – are aging or deteriorated, leading to reliability challenges and insufficient operational reserves. Without N-1 compliance at critical substations, outages could necessitate load shedding, thereby compromising system security.[38]

In this context, regional integration emerges not merely as a policy objective, but as a practical necessity. According to Georgia's **Integrated National Energy and Climate Plan (NECP)**, **cross-border electricity integration offers multiple benefits: enhanced system flexibility, stronger energy security, and improved integration of variable renewable energy sources**. Strategic initiatives – such as devel

35 Republic of Armenia Energy Sector Development Strategic Program to 2040
36 Energy security – Armenia energy profile – Analysis – IEA
37 Ten-Year Network Development Plan of Georgia 2024–2034
38 Ten-Year Network Development Plan of Georgia 2024–2034

Map Illustrating Development Drivers of Georgian Electric Power Network

Figure 7



Source: GSE

oping new AC and DC transmission lines with Azerbaijan, Armenia, and Turkey – are central to this vision. These projects aim to enable Georgia to export surplus hydropower during the summer and import it during winter shortages, thereby mitigating the seasonal volatility of renewable generation.

Concrete infrastructure developments are already supporting this integration. The Akhaltsikhe HVDC back-to-back station enables electricity exchange with Turkey despite differences in grid regulation. Likewise, the Marneuli–Ayrum 500 kV interconnection with Armenia, scheduled for completion in 2025, will facilitate power transfers of up to 1,050 MW and connect with Armenia's planned 700 MW HVDC station. These projects will enhance regional grid flexibility and reliability, particularly as both Georgia and Armenia rely on renewable sources and lack significant fossil fuel reserves. Coupled power systems could optimise the use of hydro, solar, wind, and Armenia's nuclear energy, facilitating cleaner and more efficient electricity-balancing across borders.

Black Sea interconnection

The **Georgia-Romania Black Sea submarine interconnection project** represents a transformative initiative that seeks to connect Georgia and the South Caucasus region with the continental European grid. The project aims to enhance energy security, enable electricity trade with the EU, and create the technical conditions necessary to scale up investments in renewable energy. Infrastructure components include a 500 kV double-circuit line from the Jvari substation to a new Anaklia substation, a two-pole DC submarine cable to Constanta, Romania, and a 500/500 kV converter station with 2x500 MW capacity. The project is currently in its development phase following the successful completion of a feasibility study in 2024.

Despite its strategic promise, the submarine cable project also faces major uncertainties. The lack of market coupling and limited market liberalisation in the region make it difficult to determine whether electricity price differentials are sufficient to support commercial investment. Broader liber

alisation of South Caucasus regional electricity markets would allow for spot price comparisons with the EU, aiding in feasibility assessments. While non-commercial benefits such as energy security and frequency regulation are also significant, commercial viability remains a primary concern.

Stakeholder perspective

Beyond technical and economic considerations, the region continues to face broader structural challenges. These include discrepancies in national regulatory frameworks, market structures, and technical standards which hinder harmonisation. Infrastructure limitations and geopolitical uncertainties add further complexity to long-term energy planning and sustained regional cooperation. Moreover, variations in energy pricing, tariffs, and subsidies discourage private investment and undermine regional trade incentives.

Addressing these challenges requires a shift toward identifying mutual drivers and potential synergies across regional power systems. Georgia, Armenia, and Azerbaijan each possess distinct yet complementary characteristics in their generation profiles and resource availability. For instance, Georgia's hydro potential, Armenia's nuclear and solar capacity, and Azerbaijan's fossil fuel resources provide a strong basis for balancing and reserve-sharing. A coupled electricity market between Armenia and Georgia would allow for more efficient management of surplus clean energy, reduce resource curtailment, and create a more resilient power system.

By leveraging these complementarities, the South Caucasus region can collectively enhance reliability, improve power quality, and accelerate the transition toward low-carbon energy systems. A coordinated development strategy – focused on clean energy, operational reserve-sharing, and grid interconnection – should be paired with institutional market integration. This would enable deeper alignment with European Union energy markets and policy objectives, particularly in the areas of decarbonisation, diversification, and market liberalisation.

In summary, cross-border energy cooperation offers Georgia and Armenia not only a pathway to greater energy security and system reliability, but also a platform for aligning with broader European energy frameworks. For Armenia in particular, it is an opportunity to move out of its semi-isolated status towards higher regional integration and cooperation with the EU, as the EU Commission has offered support to involve Armenia in the Black Sea interconnection project.[39] While internal infrastructure and regulatory challenges persist, strategic planning, policy harmonisation, and investment in interconnection capacity will be essential to unlocking the full benefits of regional and extra-regional energy integration.

As a result of greater regional system integration, solar energy suppliers in Armenia are likely to gain, as excess solar electricity can be sold abroad; since Georgia has limited solar development so far, autocorrelation (producing solar surplus in both countries at the same time) may not be an issue. However, such a risk grows the longer one waits for integration, and the more the two countries' power systems develop in a semi-isolated mode. The benefit to solar suppliers may come at the expense of more costly electricity suppliers in Georgia (thermal power), who would otherwise have met the growing afternoon demand. Similar issues may be mirrored in Armenia, where cheaper Georgian wind power could undermine local electricity; this would depend on wind generation patterns and hours. In both countries, hydropower is well-developed, and low-cost hydropower can benefit as well, once again at the expense of more costly producers, as is often the case when the system moves towards higher efficiency.

Wholesale suppliers, who would be outbid by low-cost renewables, may be particularly hurt, as opposed to generators with long-term guaranteed power purchase agreements. Consumers would benefit from a more efficient and secure system, though at some point the growing costs of higher renewable deployment due to maintenance of back-up capacity and flexibility have to be considered. Through efficient system development, these costs would be offset up to a certain point by the environmental and security benefits of a growing share of renewables in regional systems.

39 Joint statement by Nikol Pashinyan and Ursula von der Leyen – Press releases – Updates – The Prime Minister of the Republic of Armenia

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The EU's Role and Perspective

The European Union has a critical role to play in supporting energy integration in the South Caucasus and aligning it with broader European decarbonisation, energy security, and diversification goals. Through its cooperation frameworks, such as the Eastern Partnership and the Energy Community, the EU provides institutional and financial support that is vital for regulatory harmonisation, capacity-building, infrastructure modernisation, and market development in the region.

Georgia, as a member of the Energy Community, has benefited from EU-backed technical assistance to align its energy legislation with the EU acquis, advance market liberalisation, and improve environmental standards. This cooperation strengthens Georgia's attractiveness to green investors and supports the development of renewable energy auctions, long-term planning tools, and better grid infrastructure. These actions align Georgia more closely with the EU's internal energy market and long-term climate objectives.

Armenia, while not a full member of the Energy Community, is undertaking energy sector reforms under the EU–Armenia Comprehensive and Enhanced Partnership Agreement. Following recent budget cuts to United States Agency for International Development (USAID's) support programs in Armenia, the EU is well-positioned to step in and expand its assistance, particularly through support for electricity market liberalisation and energy security frameworks. This includes helping Armenia harmonise its policies and institutions with EU energy directives to facilitate future cross-border electricity trade. EU's involvement in Armenia's energy sector has been growing over the past years, including co-financing the largest solar power plant to date – 55 MW Masrik-1,[40] loans and grants for energy efficiency improvements,[41] as well as a range of activities in the area of energy security and decarbonisation.[42] Research cooperation in the energy field is likewise deepening, a recent example being the EU Horizon-funded STREACS projects (Strengthening Research in Armenia for Energy Transition toward Climate Solutions), which is being carried out in cooperation with Armenian and EU universities to develop early-career researchers' skills in Armenia.[43]

The EU can also offer direct investment and co-financing opportunities through mechanisms like the European Investment Bank (EIB), European Bank for Reconstruction and Development (EBRD), and the Eastern Partnership Investment Platform. These financial instruments are essential to de-risking capital-intensive infrastructure projects and enabling private sector involvement in energy investments across the region. Further support through EU Horizon grants could enhance research capacity and encourage joint innovation projects between EU and South Caucasus stakeholders.

Digitalisation and the integration of smart grid technologies offer additional areas for EU-South Caucasus cooperation. By supporting the modernisation of grid operations and the adoption of digital solutions, the EU can help improve the operational efficiency and reliability of regional power systems. Joint investments in smart infrastructure, data platforms, and demand-side management can create a more resilient and future-ready regional energy system. This likewise includes joint training and cooperation in the field of cybersecurity, protecting the energy systems against external attacks and malwares, particularly in light of digitization.

The EU's strategic interest in projects like the Georgia-Romania Black Sea Submarine Electricity Cable underscores its broader vision for integrating neighboring regions into its internal market. This cable not only enhances energy security by diversifying sources and routes – it also supports the European Green Deal and REPowerEU by facilitating the import of renewable electricity from outside the EU. The cable would also create a channel for excess Armenian solar and nuclear electricity (depending on the size of the new nuclear power plant) or excess Georgian hydropower and wind power to reach the EU market, provided sufficient harmonisation and market coupling is achieved.

Beyond infrastructure, the EU's engagement fosters political stability and peace-building through economic cooperation. Energy integration can serve as a vehicle for building trust and interdependence in the South Caucasus, offering a rare platform for positive regional interaction. In this sense, the EU's energy diplomacy is not only about achiev-

40 Armenia's largest photovoltaic plant opens with EU support – EU NEIGHBOURS east

41 Armenia: EIB provides €25 million to support energy efficiency renovations in Yerevan, A resilience and growth plan for Armenia

42 https://eu4armenia.eu/projects/?search=&filter=ongoing&country%5B%5D=1&country%5B%5D=5&topic%5B%5D=13

43 EU-Funded Energy Transition Research Capacity Project Publicly Launched at AUA

ing its internal objectives, but also about shaping a more secure and sustainable neighbourhood. Ultimately, by supporting regulatory harmonisation, infrastructure integration, investment facilitation, and sustainability goals, the EU can play a transformative role in fostering a secure, competitive, and decarbonised energy system in the South Caucasus – one that benefits both the region and the European Union.

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Conclusions and Recommendations

The electricity sectors of Georgia and Armenia are undergoing significant transformations amidst the global shift toward low-carbon energy systems. Georgia, in particular, has substantial untapped renewable energy potential – most notably in hydropower, wind, and solar – which remains underutilised due to grid constraints, seasonal imbalances, and outdated infrastructure. Armenia, while facing its own challenges, has similar ambitions to expand domestic electricity production and strengthen energy security, not only through the expansion of renewables, but also by eventually constructing a new nuclear power plant to replace the current one. Both countries recognise the value of regional collaboration, particularly in enhancing resilience, managing electricity supply variability, and aligning with the European Union's energy and climate goals.

Cross-border cooperation offers significant benefits, including improved access to operational reserves, better utilisation of generation diversity, and facilitation of renewable energy integration. The Black Sea Submarine Electricity Cable project (connecting Georgia with Romania) can be a key enabler of this integration. This infrastructure project supports the transit of clean electricity from the South Caucasus to the EU, opening export opportunities and encouraging investment in renewables and grid modernisation. Furthermore, the Turkish market has become a strategic outlet for Georgian electricity, with infrastructure like the HVDC back-to-back station in Akhaltsikhe strengthening trade links; similarly, Iran has become a major export market for Armenian electricity.

Despite the clear benefits of cross-border energy integration, several challenges persist. Regulatory and market differences between Georgia and its neighbours, particularly Armenia, hinder smooth cooperation. Incompatible technical standards, grid codes, and operational practices further complicate system alignment. Geopolitical tensions and political instability in the South Caucasus add uncertainty, while limited interconnection capacity and outdated infrastructure constrain electricity exchange. Moreover, inconsistencies in energy pricing, tariffs, and subsidies create economic barriers to investment. Overcoming these issues requires coordinated policies and joint strategic efforts to unlock the full potential of regional energy integration; delaying market integration may result in additional costs due to semi-isolated development of electricity mixes.

A key starting point for regional energy integration is identifying common drivers and synergies that can support collaboration among South Caucasus countries. Integration offers strategic benefits, particularly by strengthening energy security, improving system reliability, and enabling mutual support during supply fluctuations. The complementary energy profiles of Georgia, Armenia, and Azerbaijan create opportunities for electricity-balancing and reserve-sharing. Joint development of renewable resources and interconnected infrastructure would facilitate integration with EU markets and advance regional decarbonisation goals. Moreover, energy cooperation can promote peacebuilding and trust, while digitalisation and the green transition add momentum to coordinated regional action. Unlocking these synergies is essential to building a resilient, sustainable, and interconnected energy future.

Policy Recommendations

1. **Electricity Market Integration and Regulatory Harmonisation**

   → Georgia and Armenia should accelerate electricity market reforms by adopting compatible regulatory frameworks and technical standards. Aligning with the EU's electricity market rules, including market liberalisation and the introduction of balancing and day-ahead markets, is essential to enable efficient cross-border trade.

   → Establishment of regional energy coordination bodies or task forces under the auspices of the Energy Community can foster regulatory dialogue and technical alignment.

2. **Infrastructure Development for Cross-Border Trade of Renewable and Clean Electricity**

   → Prioritise the completion of key infrastructure projects such as the Marneuli–Ayrum 500 kV transmission line and Armenia's planned HVDC back-to-back station. These will significantly increase cross-border transfer capacity and grid reliability.

   → Mobilise EU and international financing (e.g., through the EBRD, EIB, or Green Climate Fund) to modernise aging infrastructure and expand interconnections.

→ Georgia and Armenia can establish a formal bilateral cooperation framework to jointly engage in the development and implementation of the Black Sea Submarine Electricity Cable (BSEC) project. While Georgia serves as the physical gateway to the EU through the submarine link to Romania, Armenia can contribute strategically by integrating its renewable and low-carbon electricity – particularly from solar, wind, and nuclear – into the shared export mix. This collaboration would strengthen regional energy interdependence and enable Armenia to benefit indirectly from access to the EU electricity market.

3. Strengthening Regional Energy Security and Sustainability

→ Develop shared contingency plans and operational reserve mechanisms to manage seasonal and demand-related imbalances. This can reduce reliance on imports and increase resilience during emergencies or supply disruptions.

→ Invest in regional digital platforms to enhance forecasting, load management, and integration of variable renewable energy.

4. Enhancing Institutional Capacity and Stakeholder Engagement

→ Support institutional capacity-building through EU-funded training programs and knowledge-sharing platforms, especially targeting grid operators, regulators, and local governments.

→ Foster public awareness and regional trust through joint outreach efforts, emphasising the socio-economic and environmental benefits of regional energy integration.

By implementing these recommendations, Georgia and Armenia can build a more resilient, interconnected, and decarbonised electricity system that contributes to regional stability and advances mutual interests within the framework of the EU's energy transition and climate objectives.

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Green Electricity Transitions in Armenia and Georgia

This study investigates the electricity transitions in Armenia and Georgia, focusing on the challenges and prospects for renewable energy deployment and cross-border cooperation within the South Caucasus region. Both countries face similar structural challenges—overreliance on imported fossil fuels, underutilised renewable energy potential, and aging infrastructure—while navigating divergent regulatory alignments and geopolitical constraints. By means of policy analysis and quantitative data, the report assesses national energy mixes, infrastructure development, and regulatory frameworks. Armenia's focus on solar, nuclear, and strategic interconnections complements Georgia's hydropower-dominated system and emerging wind and solar sectors. The study highlights the transformative potential of regional integration, including key infrastructure such as the Black Sea Submarine Electricity Cable and Armenia–Georgia interconnections. The European Union's role is examined as a strategic enabler of technical harmonisation, investment, and decarbonisation. Policy recommendations emphasise market liberalisation, harmonised regulations, and coordinated infrastructure planning to foster a resilient, secure, and low-carbon regional electricity system aligned with EU climate and energy goals.

Further information on the topic can be found here:
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