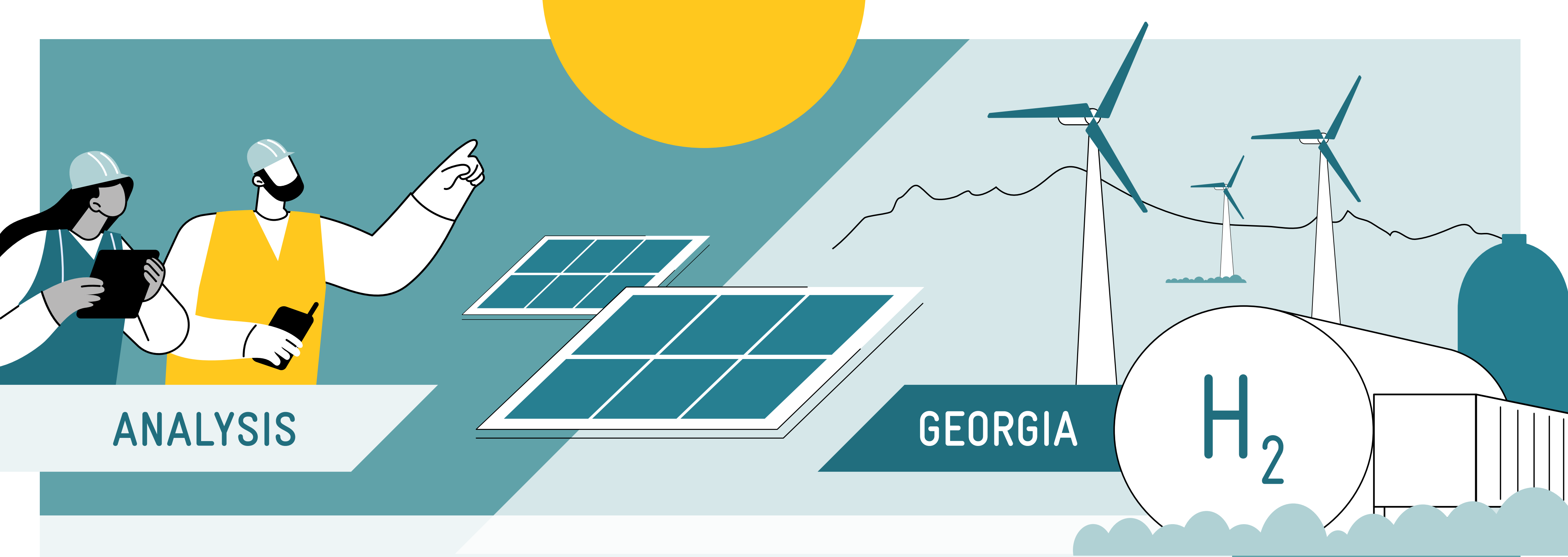


Sector Analysis Georgia

Green Hydrogen for the C&I Sector

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

This publication was commissioned by the German
Energy Solutions Initiative of the German Federal
Ministry for Economic Affairs and Energy (BMWE)

TABLE OF CONTENTS

TABLE OF CONTENTS

List of figures

List of tables

Currency units

GEL	Georgian lari
USD	United States dollar

Currency units and conversion rate as of 05.09.2024

EUR 1 = GEL 0.3348
GEL 1 = EUR 2.9871

EUR 1 = USD 0.92275
USD 1 = EUR 1.0838

Source: Exchange-Rates.org, 2024

Technical units

bbl	Barrels (plural)
GW	Gigawatt
GWh	Gigawatt hour
kTPA	Thousand tonnes per annum
Mt	Million tonnes
MTPA	Million tonnes per annum
MW	Megawatt
MWh	Megawatt hour
PJ	Petajoule (10^3 TJ)
TJ	Terajoule (10^12 joule)

Abbreviations/acronyms

AEC	Alkaline electrolysis
AEMEC	Anion exchange membrane electrolysis cell
AN	Ammonium nitrate
ASU	Air separation unit
BMWE	Bundesministerium für Wirtschaft und Energie (German Federal Ministry for Economic Affairs and Energy (BMWE))
BT	Benzyl toluene
BTC	Baku-Tbilisi-Ceyhan
CAN	Calcium ammonium nitrate
CCS	Carbon capture and storage
CCU	Carbon capture and usage
CHP	Combined heat and power
CO_2	Carbon dioxide
DAC	Direct air capture
DAP	Diammonium phosphate
DME	Dimethyl ether
DRI	Direct reduced iron
ETS	Emission trading scheme
EU	European Union
GEDF	Georgian Energy Development Fund
GNERC	Georgian National Energy and Water Supply Regulatory Commission
GH_2	Green hydrogen
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GOGC	Georgian Oil and Gas Corporation
H_2	Hydrogen
HB	Haber-Bosch
HESC	Hydrogen Energy Development Support Committee
IEA	International Energy Agency
LCOH	Levelised cost of hydrogen
MAP	Monoammonium phosphate
MCA	Multi-criteria assessment
MCH	Methylcyclohexane
MeOH	Methanol
MEPA	Ministry of Environmental Protection and Agriculture
MoESD	Ministry of Economy and Sustainable Development
MoU	Memorandum of Understanding
MTBE	Methyl tertiary butyl ether
MTG	Methanol-to-gasoline
MTO	Methanol-to-olefins
NDC	Nationally Determined Contribution
NH_3	Ammonia
NHA	National Hydrogen Association
NPV	Net present value
PDP	Project Development Programme
PEMEC	Proton exchange membrane electrolysis cell
PPA	Power purchase agreement
PPP	Public-private partnership
PSA	Pressure swing adsorption
PtX	Power-to-X (anything)
PV	Photovoltaics
R&D	Research and development
RED	Renewable Energy Directive
SCP	South Caucasus Pipeline
SME	Small and medium-sized enterprise
SMR	Steam methane reforming
SOEC	Solid oxide electrolysis cell
UAN	Urea ammonium nitrate
VAT	Value-added tax
WACC	Weighted average cost of capital

ENERGY SOLUTIONS – MADE IN GERMANY

The German Energy Solutions Initiative

The German Energy Solutions Initiative of the German Federal Ministry for Economic Affairs and Energy (BMWE) aims to globalise German technologies and expertise in climate-friendly energy solutions.

Years of promoting smart and sustainable energy solutions in Germany have led to a thriving industry known for world-class technologies. Thousands of specialised small and medium-sized enterprises (SMEs) focus on developing renewable energy systems, energy efficiency solutions, smart grids, and storage technologies. Cutting-edge energy solutions are also built on emerging technologies such as power-to-gas, fuel cells, and green hydrogen. The initiative's strategy is shaped around ongoing collaboration with the German business community.

The initiative creates benefits for Germany and the partner countries by:

- boosting global interest in sustainable energy solutions
- encouraging the use of renewables, energy efficiency technologies, smart grids, and storage technologies, while facilitating knowledge exchange and capacity building
- enhancing economic, technical and business cooperation between Germany and partner countries

THE PROJECT DEVELOPMENT PROGRAMME (PDP)

PDP is a key pillar of the German Energy Solutions Initiative and is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It connects development cooperation with private-sector engagement and supports climate-friendly energy solutions in selected developing and emerging countries, enabling local businesses to adopt solutions in energy efficiency, electricity and heat supply, and hydrogen, while facilitating market access for German solution providers.

Developing and emerging economies offer promising business potential for climate-friendly energy solutions but also pose challenges for international business partners. The PDP team works closely with local industries to develop financially viable projects by providing technical expertise, financial guidance, and networking opportunities.

It identifies project leads, collects and analyses energy consumption data, and assesses projects from both a technical and economic perspective. This includes outlining the business case, calculating payback periods, and evaluating profitability. Companies can then choose to finance projects using their own funds or explore leasing and other financing options. PDP provides cost-free advice to local companies and connects them with German solution providers for project implementation.

Additionally, by offering training, organising reference project visits, and publishing studies on the potential of climate-friendly solutions and on navigating regulatory frameworks, the programme supports market development and fosters private-sector cooperation.

Executive summary

GREEN HYDROGEN FOR GEORGIA'S C&I SECTOR

The H_2 sector analysis for Georgia aims to lay the groundwork for potential green hydrogen projects in the country. This study is part of a series, which provides market insights and supports pre-development efforts to generate interest in the green hydrogen economy across multiple countries.

The analysis focuses on assessing the potential for transitioning from grey to green hydrogen in Georgia's commercial and industrial sectors. It evaluates specific use cases, offering techno-economic estimates that will help inform both local and international stakeholders, particularly companies based in Germany. The goal is to identify realistic opportunities, address key challenges, and outline potential pathways for integrating green hydrogen into Georgia's energy and industrial landscape.

Georgia is a key transit hub between Europe and Asia and possesses substantial renewable energy resources. The country already generates over 70% of its electricity from hydropower, with growing investments in solar and wind energy. These resources provide a solid basis for electrolysis-based hydrogen production. While local demand for green hydrogen is currently limited, there are potential applications.

Zusammenfassung

GRÜNER WASSERSTOFF FÜR DEN C&I-SEKTOR GEORGIENS

Die vorliegende H_2-Sektoranalyse bildet die Grundlage für potenzielle Projekte mit grünem Wasserstoff in Georgien. Die Analyse selbst ist Teil einer Serie, die Markteinblicke liefert und Vorentwicklungsprozesse unterstützt. Ziel dieser Initiative ist es, das Interesse an einer Grüner-Wasserstoff-Wirtschaft in verschiedenen Ländern zu fördern.

Im Zentrum der H_2-Sektoranalyse für Georgien steht die Bewertung des Potenzials eines Übergangs von grauem zu grünem Wasserstoff im georgischen Industrie- und Gewerbesektor. Analysiert werden konkrete Anwendungsfälle, und es werden technoökonomische Einschätzungen bereitgestellt, die sowohl lokale als auch internationale Akteure – insbesondere Unternehmen mit Sitz in Deutschland – bei ihren Entscheidungen unterstützen sollen. Ziel ist es, realistische Chancen zu identifizieren, zentrale Herausforderungen zu benennen und mögliche Wege zur Integration grünen Wasserstoffs in Georgiens Energie- und Industriestruktur aufzuzeigen.

Georgien ist ein wichtiger Transitknotenpunkt zwischen Europa und Asien. Das Land verfügt über erhebliche Potenziale im Bereich der erneuerbaren Energien. Bereits heute stammen über 70 Prozent des Stroms aus Wasserkraft, ergänzt durch Solar- und Windenergie, in die zunehmend investiert wird. Diese Ressourcen sind eine solide Grundlage für die elektrolysebasierte Produktion grünen Wasserstoffs.

Additionally, Georgia's ambition to expand key ports like Poti and Batumi, as part of the Middle Corridor infrastructure, enhances its potential as an export hub for green hydrogen and its derivatives.

BUSINESS OPPORTUNITIES FOR GERMAN SOLUTION PROVIDERS

The Georgian hydrogen market, while still in its early stages, presents several opportunities for German companies, particularly SMEs in renewable energy, electrolysis technology, industrial applications, and sustainable infrastructure development.

Key advantages for SMEs:

- **Access to renewable energy resources:** Georgia's hydropower dominance, combined with increasing solar and wind capacity, creates favourable conditions for green hydrogen production. Companies specialising in electrolysers, hydrogen storage, and energy integration can play a role in scaling up these technologies.
- **Strategic trade position:** As a transit corridor linking Europe and Asia, Georgia offers logistical advantages for hydrogen export. German businesses in logistics, port infrastructure, and hydrogen transportation can benefit from early engagement.
- **Industrial integration potential:** While local demand remains limited, green hydrogen could be integrated into industries such as fertiliser production, oil refining, and eventually transport. Companies with expertise in these areas can contribute to pilot projects and long-term developments.

Auch wenn die lokale Nachfrage nach grünem Wasserstoff derzeit noch begrenzt ist: In Georgien bestehen potenzielle Einsatzmöglichkeiten. Darüber hinaus stärkt Georgiens Ziel, zentrale Häfen wie Poti und Batumi im Rahmen der Middle-Corridor-Infrastruktur auszubauen, das Potenzial des Landes als Exportdrehscheibe für grünen Wasserstoff und seine Derivate.

GESCHÄFTSMÖGLICHKEITEN FÜR DEUTSCHE LÖSUNGSANBIETER

Der georgische Wasserstoffmarkt befindet sich zwar noch in einer frühen Phase, bietet jedoch vielfältige Chancen für deutsche Unternehmen – insbesondere für KMU aus den Bereichen erneuerbare Energien, Elektrolysetechnologie, industrielle Anwendungen und nachhaltige Infrastrukturentwicklung.

Zentrale Vorteile für KMU:

- **Zugang zu erneuerbaren Energieressourcen:** Georgiens starke Wasserkrafterzeugung kombiniert mit dem Ausbau von Solar- und Windenergie schafft günstige Voraussetzungen für die Produktion grünen Wasserstoffs. Unternehmen mit Spezialisierung auf Elektrolyseure, Wasserstoffspeicherung und Energieintegration können bei der Hochskalierung dieser Technologien eine wichtige Rolle übernehmen.
- **Strategisch günstige Handelslage:** Als Transitkorridor zwischen Europa und Asien bietet Georgien logistische Vorteile für den Export von Wasserstoff. Deutsche Firmen aus den Bereichen Logistik, Hafeninfrastruktur und Wasserstofftransport können von einem frühen Engagement profitieren.
- **Potenzial für die industrielle Integration:** Auch wenn die lokale Nachfrage derzeit begrenzt ist, lässt sich grüner Wasserstoff perspektivisch in Branchen wie der Düngemittelproduktion, Ölraffination und langfristig auch im Transportsektor einsetzen. Unternehmen, die hier über Expertise verfügen, können dazu beitragen, dass Pilotprojekte umgesetzt und entsprechende Anwendungen weiterentwickeln werden.

CHALLENGES ON THE PATH TO A HYDROGEN ECONOMY

Despite these opportunities, economic and technical challenges remain:

- **High production costs & limited domestic demand:** The current cost of green hydrogen is a barrier to large-scale adoption. German companies can support cost reduction through innovation, investment partnerships, and engagement in policy discussions on subsidies and incentives.
- **Technology development & knowledge transfer**: Adapting hydrogen technologies to Georgia's industrial and energy sectors – such as blending hydrogen with natural gas or introducing hydrogen-based solutions in oil refining, transport, and logistics – requires further innovation and expertise, areas where German companies can provide valuable support.

OPPORTUNITIES FOR GREEN HYDROGEN PROJECTS

Georgia's renewable energy potential, strategic location, and early-stage hydrogen market present an opportunity for German SMEs to engage in pilot projects, infrastructure development, and policy discussions. While challenges remain, targeted investment and collaboration can help establish Georgia as a future player in the hydrogen economy. German companies that position themselves early can contribute to shaping this market while benefiting from its long-term growth potential.

HERAUSFORDERUNGEN AUF DEM WEG ZUR WASSERSTOFFWIRTSCHAFT

Trotz dieser Chancen bestehen weiterhin wirtschaftliche und technische Herausforderungen:

- **Hohe Produktionskosten und begrenzte Inlandsnachfrage:** Die derzeitigen Kosten für grünen Wasserstoff erschweren dessen großflächige Einführung. Deutsche Unternehmen können durch technologische Innovationen, Investitionspartnerschaften und die Mitgestaltung politischer Rahmenbedingungen – etwa im Hinblick auf Fördermechanismen – zur Senkung der Kosten beitragen.
- **Technologieentwicklung und Wissenstransfer:** Die Anpassung von Wasserstofftechnologien an die georgischen Energie- und Industriesektoren – beispielsweise durch die Beimischung von Wasserstoff ins Erdgasnetz oder wasserstoffbasierte Anwendungen in Raffinerien, im Transport- und Logistiksektor – erfordert weitere Innovationen und Fachwissen. In diesen Bereichen können deutsche Unternehmen gezielt unterstützen und einen wichtigen Beitrag zur Marktentwicklung leisten.

POTENZIALE FÜR GRÜNE WASSERSTOFFPROJEKTE

Georgiens Potenzial im Bereich der erneuerbaren Energien, die strategische Lage des Landes und der noch junge Wasserstoffmarkt eröffnen deutsche KMU die Chance, sich frühzeitig in Pilotprojekte, Infrastrukturentwicklung und politische Dialoge einzubringen. Auch wenn Herausforderungen bestehen, können gezielte Investition und Zusammenarbeit dazu beitragen, Georgien als künftigen Akteur in der Wasserstoffwirtschaft zu etablieren. Deutsche Unternehmen, die sich frühzeitig positionieren, tragen nicht nur zur Gestaltung dieses neuen Marktes bei, sondern profitieren auch vom langfristigen Wachstumspotenzial.

1

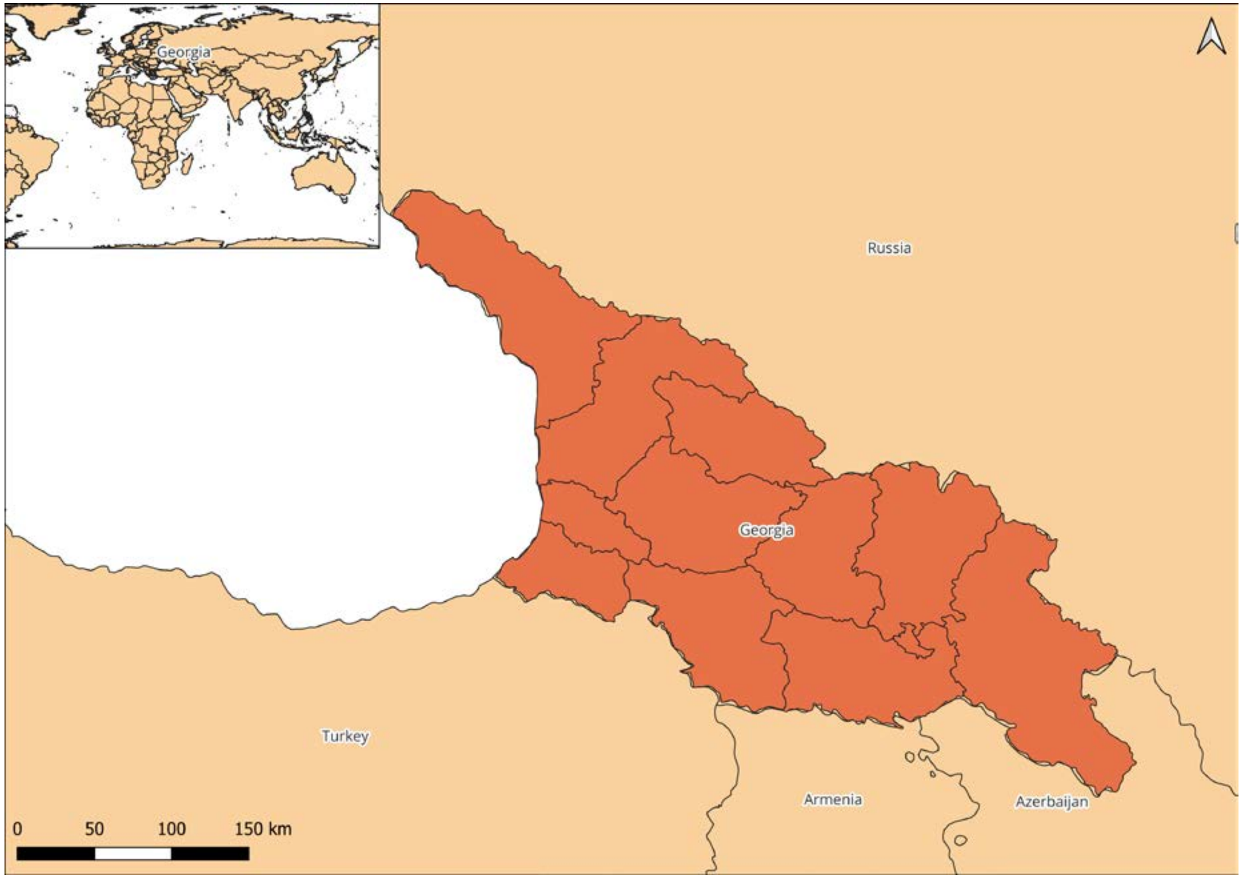
Outline of the current context

1.1 General country information

Georgia is located at the intersection of Eastern Europe and Western Asia (see Figure 1), covering an area of approximately 69,490 km². It has access to the Black Sea. The country has a population of about 3.8 million as of 2023 (World Bank, 2024). Georgia's economy is primarily driven by services, agriculture, and tourism, with notable contributions from wine production and natural resources. Georgia's GDP reached USD 30.5 billion in 2023, equating to USD 8,120 per capita (World Bank, 2024).

In 2022 Georgia's main exports included ores, slag and ash; cars, tractors, trucks and parts thereof; fertilisers, beverages, spirits and vinegar, and iron and steel. The main imports included mineral fuels, mineral oils and products of their distillation; cars, tractors, trucks and parts thereof; machinery, mechanical appliances, and electrical machinery and electronics. The total export and import volumes in 2022 reached USD 6.8 billion and USD 14.7 billion respectively.

FIGURE 1. Location of Georgia



Source: Authors' own compilation, Fichtner (2025) based on (OpenStreetMap, 2024)

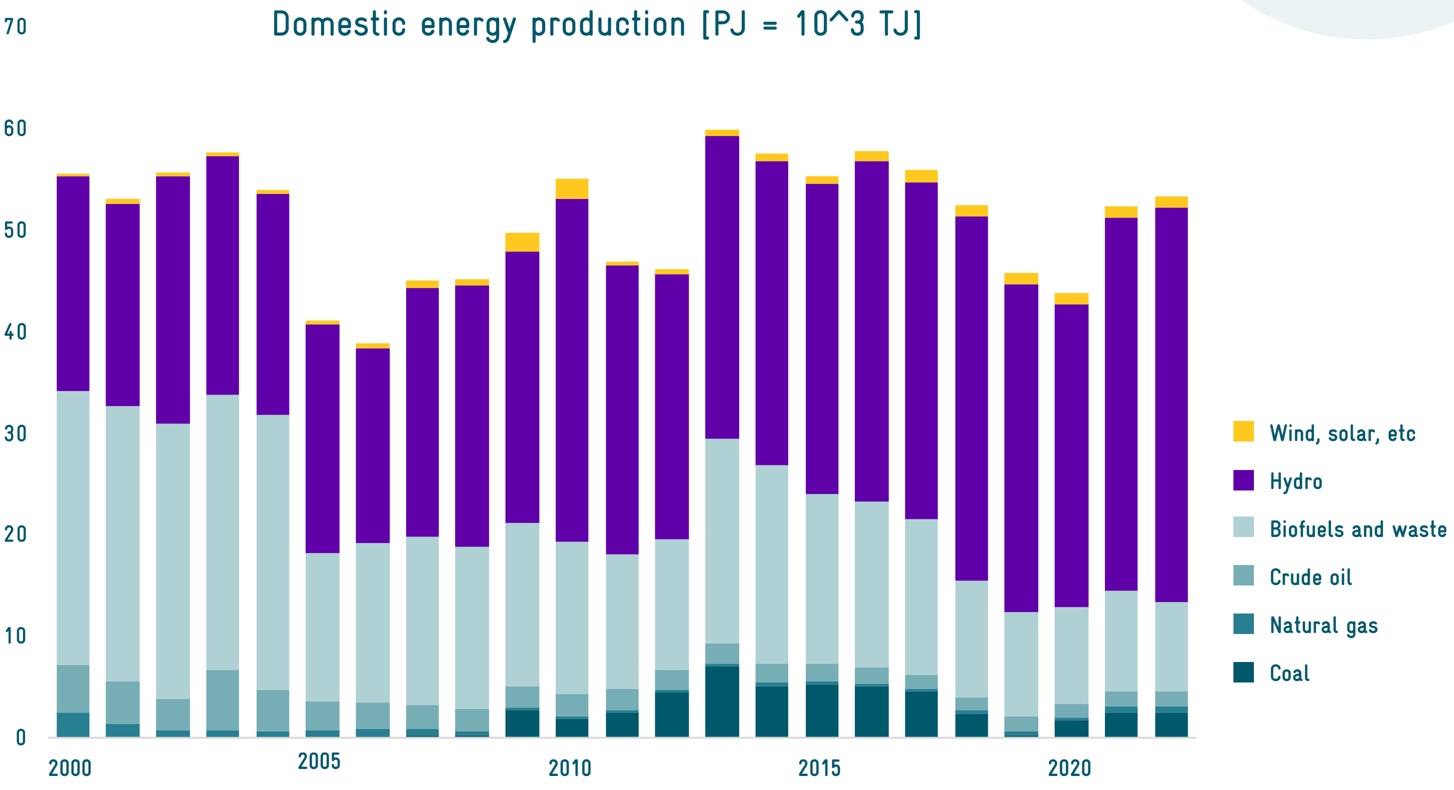
1.2 National energy sector analysis

1.2.1 Evolution of the energy sector to the present

Georgia's domestic energy production has fluctuated over the years but has been between 40 and 60 petajoules (PJ) since 2000. Domestic energy production is dominated by hydropower (73%), as shown in Figure 2 (in PJ = 10^3 terajoule TJ). Hydropower production has almost doubled since 2000. The traditional use of biomass has sharply declined since 2000, but it still reached almost half a million households in 2020, which represents 40% of all households in the country (IEA, 2020) and makes up around 16% of domestic energy production. Other fossil primary sources such as coal, oil, and natural gas account for around 9% of Georgian energy production, while other renewable sources represent a much lower share of 2% and include geothermal sources, which are currently mainly used directly as a hot water source.

Of the total electricity generation of 14,245 gigawatt hours (GWh) in 2022, hydropower represented almost 76%, followed by natural gas at around 24%. Electricity from wind started to be generated in 2016 and currently accounts for only 0.6% of total electricity generation. Due to the heavy reliance on hydro, electricity generation is subject to seasonal fluctuations, with high production during the dry season.

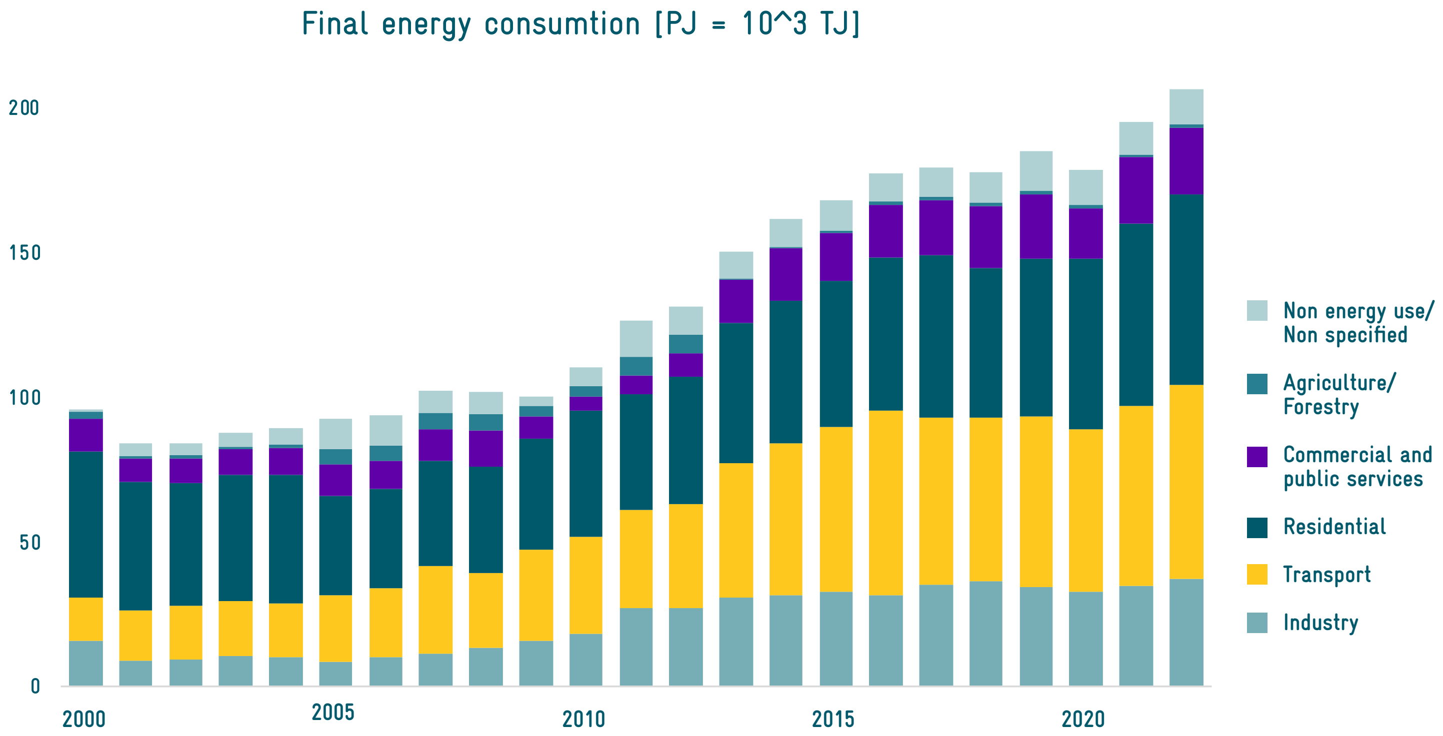
FIGURE 2. Evolution of domestic energy production in Georgia since 2000 (in PJ)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

Regarding final energy consumption, Figure 3 shows that it has more than doubled since 2000, reaching about 206 PJ in 2022, with residential and transport as the main consumption sectors, constituting 32% each. Industry accounts for 18% of final energy consumption, followed by commercial and public services with 11%. Mainly the industry and transport sectors show a strong increase since 2000; industry more than doubled its final energy consumption, while the transport sector quadrupled. Other sectors such as agriculture and forestry and non-specified or non-energy use together make up some 6% of final energy consumption.

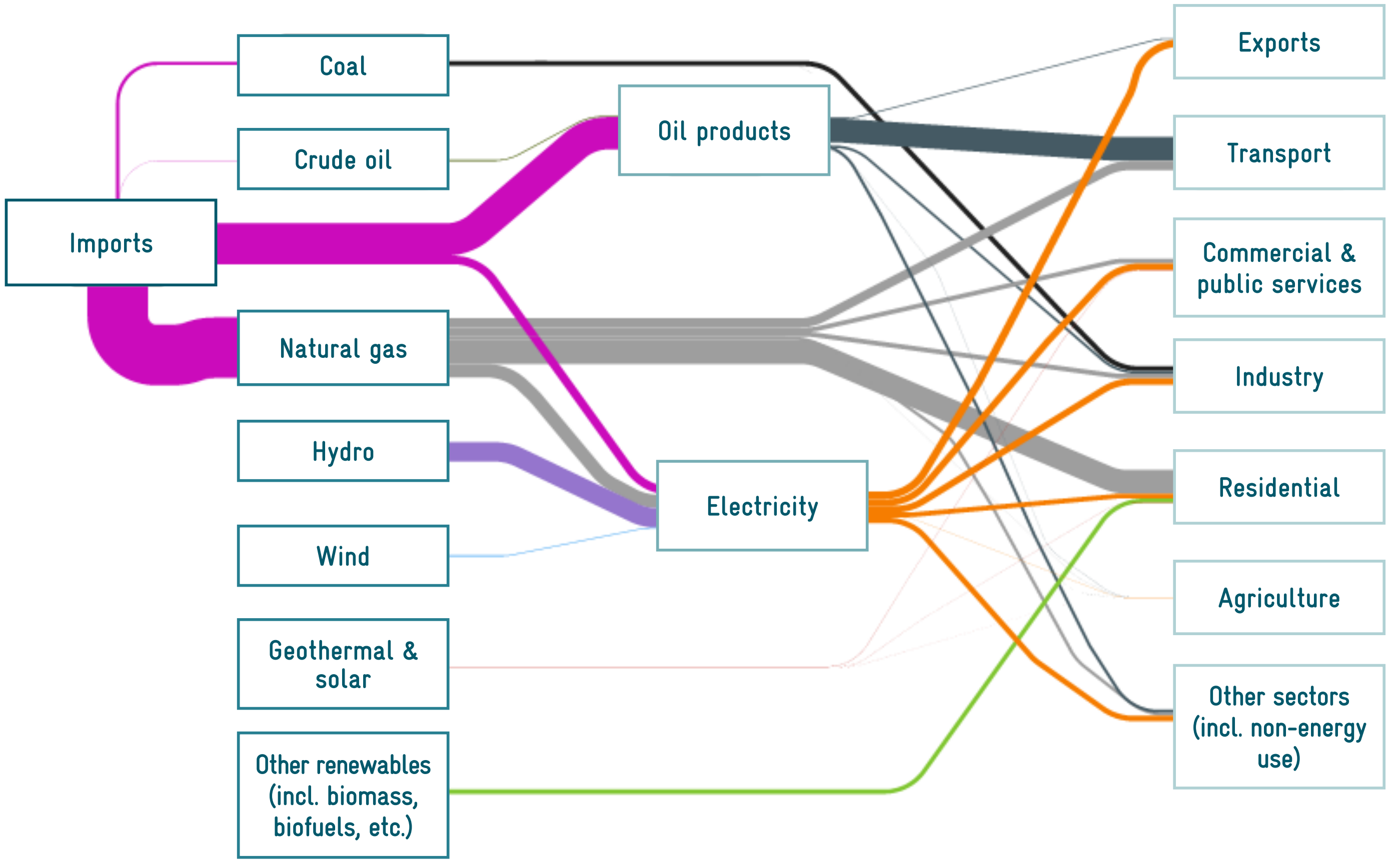
FIGURE 3. Evolution of final energy consumption by sector in Georgia since 2000 (in PJ)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

The Sankey diagram in Figure 4 is based on Georgia's energy balance (National Statistics of Georgia, 2023) and summarises the energy flows from primary energy sources to secondary energy sources and to different end users' sectors for 2022. Georgia depends almost completely on imports for primary energy sources such as natural gas and coal, due to its own lack of resources. Total primary energy available was 180 PJ. The main primary energy sources were natural gas (67%) and hydro (21%). Secondary energy sources such as oil products are also imported, while the electricity trade (imports vs. exports) rather balances out. Domestic final energy consumption is led by the residential sector with 31%, which relies mainly on natural gas with smaller shares of electricity and biomass. The transport sector (30%) heavily relies on imported oil products and natural gas. The industry (17%) and commercial and public services (11%) sectors follow, with industry using a mix of energy sources that include coal, oil products, natural gas, and electricity, while the commercial and public services sector is mainly reliant on natural gas and electricity.

FIGURE 4. Energy flow in Georgia in 2022



Source: Authors' own compilation, Fichtner (2025) based on (National Statistics of Georgia, 2023)

As also indicated in the previous Sankey diagram, despite having low to non-existent fossil fuel reserves and production levels, the country greatly relies on natural gas and oil products. Domestic natural gas production represented only 0.4% of the total gas supply in 2022, while 3% of the oil products were refined in the country. The remaining consumption was covered by imports. Even though Georgia exports some of the generated electricity to neighbouring countries, primarily Turkey, in total the country is a net importer of energy, and the quantity of energy imported has more than tripled since 2000 (IEA, 2024a).

Energy prices

Indicative energy prices for the main energy sources are listed in Annex 4. Natural gas prices vary depending on the supply company. The prices shown are those of Tbilisi Energy, by way of example. Electricity tariffs, on the other hand, are regulated by the Georgian National Energy and Water Supply Regulatory Commission (GNERC) for different end users depending on their consumption level. GNERC reviews and adjusts regulated electricity tariffs once a year. For large commercial and industrial consumers who participate in the deregulated electricity market, prices are not fixed and can fluctuate more frequently (e.g. monthly), also reflecting seasonal variations (lower prices during summer when hydropower is abundant and higher prices in winter with increased reliance on thermal generation or imports). Annex 4 includes minimum and maximum tariffs for each group of consumers for the Tbilisi Electricity Supply Company. In Georgia neither a carbon tax nor an emission trading scheme (ETS) is in place. The prices serve only as an indication of current levels and will vary over time and for different supply companies.

1.2.2 Current infrastructure

Georgia's transportation infrastructure reflects its strategic location and diverse geography, combining modern highways with older, sometimes less-developed rural roads. Major cities such as Tbilisi and Batumi benefit from well-maintained road networks that facilitate efficient transport, while rural areas often struggle with unpaved roads that can become challenging to navigate, especially in winter conditions. The railway system is also significant, connecting key regions and serving both passenger and freight needs, particularly for agricultural products and minerals. Georgia's ports, including Batumi, Poti, Supsa, Kulevi, and Anaklia (under development), play a vital role in facilitating trade and logistics in the region, providing access to the Black Sea for exports and imports. The national electricity grid is reliable in urban areas but faces challenges in remote regions, where access to consistent power supply can be limited. Many rural communities utilise decentralised energy solutions, such as solar panels and diesel generators, to meet their needs. While urban areas like Tbilisi, Batumi, Kutaisi, and Rustavi generally have well-developed natural gas networks, rural areas often lack access due to the high costs related to infrastructure extension to these regions. Water resources are a critical issue, particularly in the eastern regions, where seasonal variations can affect availability. While many urban areas have access to potable water, rural communities often encounter difficulties due to aging infrastructure and pollution from agricultural runoff. Flooding during heavy rains can also pose risks to infrastructure and local populations, highlighting the need for improved water management strategies.

It should be noted that on a regional level, Georgia's oil and gas pipeline network includes key transit routes like the Baku-Tbilisi-Ceyhan oil pipeline and the South Caucasus gas pipeline, making it a key energy corridor connecting the Caspian region to European and global markets. This infrastructure not only supports regional energy security but also provides Georgia with significant economic and geopolitical advantages.

1.2.3 Forecasted evolution of the energy sector

In 2023, Georgia's Ministry of Economy submitted the draft of the National Energy and Climate Plan (Ministry of Economy and Sustainable Development of Georgia, 2023) to the Energy Community Secretariat for its review. The Energy Community is an international organisation which brings together the European Union (EU) and its neighbours to create an integrated pan-European energy market. The key objective of the Energy Community is to extend the EU internal energy market rules and principles to countries in Southeast Europe, the Black Sea region and beyond on the basis of a legally binding framework (Energy Community, 2024). It aims to align Georgia's energy and climate policies with European standards and commitments under international agreements, such as the Paris Agreement. The plan covers the period from 2021 to 2030, establishing clear targets for energy production, consumption, and greenhouse gas (GHG) emissions.

The plan foresees increasing the share of renewable energy sources in the energy mix, targeting at least 50% by 2030, with a focus on hydropower, wind, solar, and biomass. Specific targets on renewable energies by 2030 include 1 GW of wind capacity and 1 GW of solar capacity. Further, the implementation of measures to improve energy efficiency across all sectors aims for a 30% reduction in energy consumption by 2030. One main objective for climate change mitigation is a reduction of 35% in GHG emissions by 2030, compared to 1990 levels. The main target sectors to achieve this reduction are the energy sector, which should transition to renewable energy sources, the transport sector, promoting the use of electric and hybrid vehicles, and agriculture, through the implementation of sustainable practices.

Regarding final energy consumption by 2050, the transport sector is expected to remain the main consumer, while industry is expected to overtake residential as the sector with the second highest consumption. The residential sector is expected to start reducing its consumption in 2025, continuing gradually until 2050. All other sectors are expected to gradually increase consumption until 2050.

The plan is aligned with Georgia's 2030 Climate Change Strategy (Georgia, 2021a). The targets set for renewable energies other than hydro are ambitious, and it might be challenging to achieve them by 2030, with international cooperation being essential. It must be highlighted that Georgia is actively working on multiple energy infrastructure projects, including generation, transmission, and distribution.

Additionally, Georgia's strategic location makes it a key transit country between Europe, the Middle East and Asia. Georgia, Azerbaijan, and Turkey have developed strong energy ties, and the country already serves as a major transit hub for oil and gas pipelines, such as the Baku-Tbilisi-Ceyhan (BTC) oil pipeline and the South Caucasus Pipeline (SCP), which transports natural gas from Azerbaijan to Turkey and Europe. Further expansion and enhancement of these pipeline networks and regional partnerships would strengthen its position in the regional energy market, allowing it to develop alternative sources of energy and import routes and improving energy security across the Caucasus. With regard to the electricity market, the Black Sea Transmission Network is an ongoing project to enhance electricity trade between Georgia and Turkey. Cross-border electricity trade allows Georgia to leverage its extensive hydropower resources during peak production times. This is one of the focus areas of the ten-year network development plan for 2023-2033, in which specific projects are considered for the development and upgrading of national transmission lines as well as for the enhancement of interconnections with Turkey, Armenia, and Azerbaijan to facilitate the cross-border electricity trade.

1.3 Legislative and regulatory framework

Over the past decades, Georgia's energy sector has continued to undergo significant transformation. Consequently, the country's energy laws are in a state of continuous reform and transition. The regulatory framework for the energy sector and for renewable energy in Georgia is designed to harmonise with EU legislation, reflecting its principles. Furthermore, by promoting energy efficiency and electrification, this framework creates an enabling environment for emerging sectors such as green hydrogen (GH_2). A detailed overview of the relevant legislative and regulatory framework is listed in Annex 2.

2

Industrial applications of hydrogen

Global hydrogen demand reached 97 million tonnes per annum (MTPA) in 2023 and remains concentrated in traditional uses such as refining and industry applications, mainly ammonia and methanol production and steel manufacturing (IEA, 2024b). Considering current (or traditional) and potential new uses of hydrogen as a decarbonisation solution, this demand is expected to increase significantly to 200-600 MTPA by 2050, depending on the analysis and scenario selected, which should be covered primarily by clean hydrogen (produced either by electrolysis powered by renewable energies, so-called green hydrogen, or by reforming of fossil fuels combined with carbon capture and storage (CCS), referred to as blue hydrogen).

2.1 Hydrogen production methods

Hydrogen can be produced through different processes according to the energy source and technology used, as summarised in the following table. The hydrogen used to meet current demand comes almost exclusively from the processing of fossil fuels (natural gas and coal) within methane reforming and coal gasification.

TABLE 1. Production methods of hydrogen

Production process	Energy source	Technology options	Products	CO_2 emissions
Methane reforming	Natural gas	• Steam methane reforming (SMR) • Autothermal reforming (ATR)	H_2, CO, CO_2, N_2	• High CO_2 emissions • Potential combination with CCS to reduce CO_2 emissions
Coal gasification	Coal	• Gasification/reaction with O_2 and steam at high pressure and temperatures	H_2, CO, CO_2, N_2	
Methane pyrolysis	Natural gas	• Thermal decomposition at high temperatures without O_2	H_2, CO, CO_2	
Biomass gasification	Biomass	• Heating with limited oxygen	H_2, CO, CO_2	• Low to zero CO_2 emissions
Electrolysis	Electricity	• Electrolysis (AEC, PEMEC, SOEC, AEMEC)	H_2, O_2	• CO_2 emissions depend on electricity source • Low to zero for renewable energy sources

CCS	carbon capture and storage
AEC	alkaline electrolysis cell
PEMEC	proton exchange membrane electrolysis cell
SOEC	solid oxide electrolysis cell
AEMEC	anion exchange membrane electrolysis cell

Source: Authors' own compilation, Fichtner (2025)

2.2 Hydrogen uses

Hydrogen is a key component of the global energy and industrial landscape, with similar applications worldwide. The data presented in this section reflects the global context of hydrogen and is location independent.

Hydrogen demand reached 97 MTPA in 2023, with the largest consumers of hydrogen being refining (44%), ammonia production (33%), and methanol production (17%). Some 5% of hydrogen is used for direct reduced iron (DRI) in the iron and steel sector and small amounts are used in other segments such as glassmaking, electronics, and metal processing, accounting for 1 MTPA or 1% of current global hydrogen demand (IEA, 2024b).

Other minor current uses of hydrogen include aerospace, as a propellant, and energy storage for balancing renewable energy supply and demand.

1 In refineries, hydrogen is required for hydrocracking and hydrotreating, but it is also generated, mainly during catalytic reformulation: 18 kg of hydrogen/tonne of crude oil (Fuel Cells and Hydrogen Observatory, 2021).

TABLE 2. Current uses of hydrogen

Current uses	Main processes/products	Specific requirements
Refining[1]	• Hydrocracking, hydrotreating and desulphurisation	• Depends on refinery complexity and oil quality: 8–14 kg H_2/tonne refined product
Ammonia	• Fertiliser production • Chemical production: e.g. nitric acid, amines, explosives • Refrigeration	• Stochiometric: 178 kg H_2/tonne ammonia
Methanol	• Fuel: methyl tertiary butyl ether (MTBE) • Solvent • Antifreeze • Chemical feedstock: e.g. formaldehyde, acetic acid	• Stochiometric: CO_2 hydrogenation: 189 kg H_2/tonne methanol CO hydrogenation: 126 kg H_2/tonne methanol
Chemical industry	• Oxo alcohols	• Depends on olefin, process and product, stoichiometrically between 10–30 kg H_2/ tonne oxo alcohol
	• Fatty alcohols	• Depends on production process and product, stoichiometrically between 10–20 kg H_2/ tonne fatty alcohol
	• Hydrogen peroxide (H_2O_2)	• Stochiometric: 59 kg H_2/tonne H_2O_2
	• Cyclohexane (C_6H_{12})	• Stochiometric: 71 kg H_2/tonne cyclohexane
	• Hydrochloric acid (HCl)	• Stochiometric: 55 kg H_2/tonne HCl
	• Caprolactam	• Depends on the production process, between 30–50 kg H_2/tonne caprolactam

Current uses	Main processes/products	Specific requirements
Chemical industry	• Phenol production*	• Depends on the production process, between 10–30 kg H_2/tonne phenol
	• Acetone production* via hydrogenation of isopropyl alcohol	• Stochiometric: 34 kg H_2/tonne acetone
	• 1,4-Butanediol (BDO)	• Stochiometric: 23 kg H_2/tonne BDO
	• Fine chemicals and pharmaceuticals as reducing agent	• Depends on processes and products
Iron and steel	• As reducing agent in direct reduced iron (DRI) • As reducing atmosphere in annealing process in steel roll mills	• Depends on iron ore quality: ~60 kg H_2/tonne steel
Glass	• Glass melting as reducing agent to improve quality • Specialty glasses to control optical properties • Alternative fuel or furnaces to replace e.g. natural gas	• As reducing agent: 0.4 kg H_2/tonne float glass
Electronics	• Chemical vapour deposition, mainly e.g. for semiconductor manufacturing and LED production • Reduction agent	• 45–90 kg H_2/tonne semiconductor
Food industry	• Hydrogenation of oils (fats) and fatty acids	• Depends on oil/fat, required product and process: 5–100 kg H_2/tonne unsaturated fat processed
Metal processing	• Pure or in a mixture as shielding gas for welding processes	• Depends on process

Source: Authors' own compilation, Fichtner (2025) based on (Bressan, L. et all, 2009), (Fuel Cells and Hydrogen Observatory, 2021), (Wasserstoff Kompass, 2022), (Semiconductor Digest, 2018)

* The most common production process for phenol and acetone is the cumene process. This process does not require hydrogen directly, but it can be required for refining acetone (removal of impurities).

Additionally, hydrogen is produced within different production processes as a by-product.

In 2023, some 25% of hydrogen was produced as a by-product in refineries and petrochemicals production (IEA, 2024b). The main products that generate hydrogen as a by-product are listed in Table 3.

TABLE 3. Hydrogen generation as a by-product

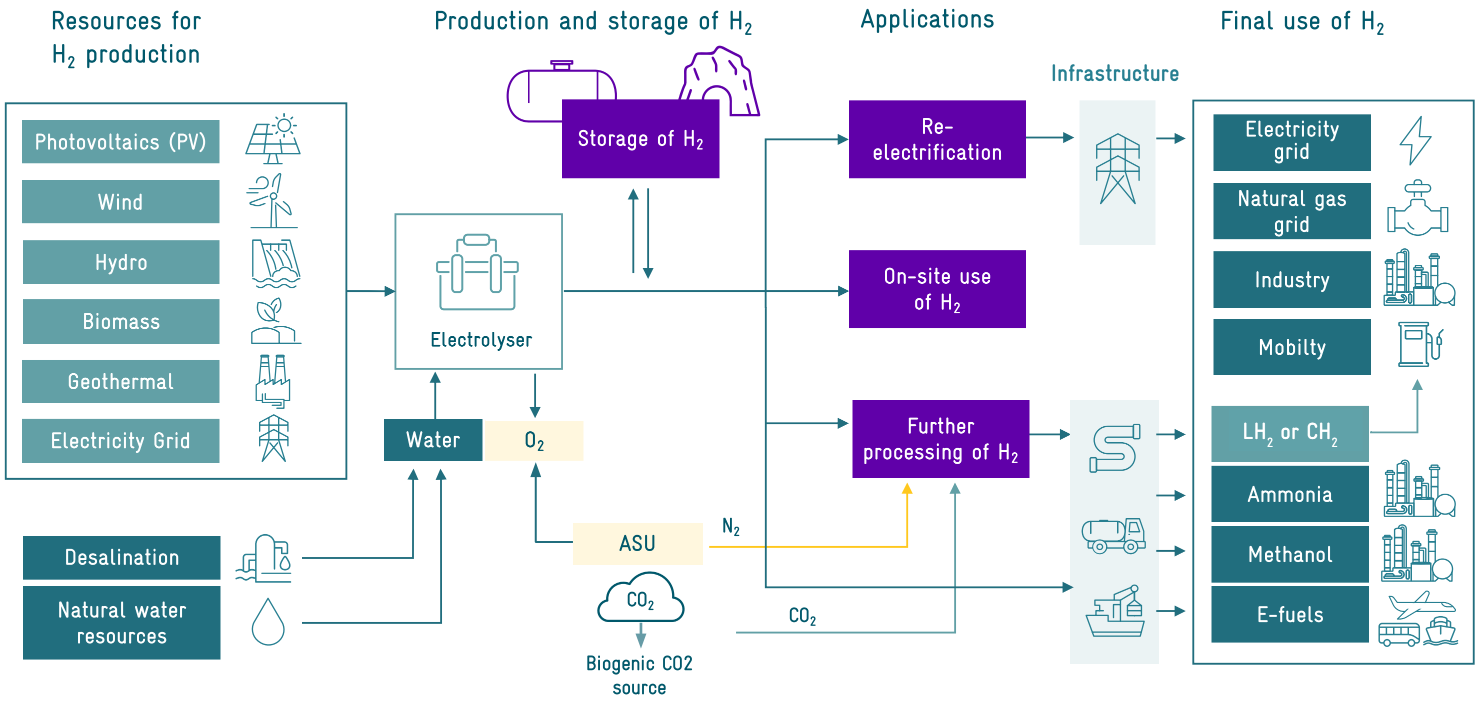
Final product	Typical use of H_2 by-product	Specific H_2 generation
Ethylene	• On site as feedstock for other processes	190 Nm³ H_2/tonne ethylene (11 kg H_2/tonne ethylene)
Styrene		220 Nm³ H_2/tonne styrene (20 kg H_2/tonne styrene)
Chlorine (via chlor-alkali process)	• Fuel for heat boilers and/or combined heat and power (CHP) units • Chemical feedstock: e.g. formaldehyde, acetic acid	270–300 Nm³ H_2/tonne chlorine (24–27 kg H_2/tonne chlorine)
Acetylene	• On site as feedstock for other processes	3,400–3,740 Nm³ H_2/tonne acetylene (305–336 kg H_2/tonne acetylene)
Cyanide		2,470 Nm³ H_2/tonne cyanide (222 kg H_2/tonne cyanide)

Source: Authors' own compilation, Fichtner (2025) based on (Fuel Cells and Hydrogen Observatory, 2021)

Demand for hydrogen has been concentrated in refining and some industrial applications, but the adoption of clean hydrogen in new applications will play a key role in the energy transition. This will include the replacement of current hydrogen demand with green hydrogen produced via electrolysis (as shown in Figure 5), for example, but also new areas of use such as mobility (road, air, and maritime transport), electricity generation, production of synthetic fuels (e-fuels), and high-temperature heat generation, among others. The switch from conventional production processes to electrolysis for hydrogen generation will require additional feedstocks for derivatives production, including a nitrogen source for ammonia production and a sustainable CO_2 source for methanol and synthetic fuel production.

These applications provide a first indication of how green hydrogen might be used in the future. Which applications gain traction will largely depend on possible alternative technologies with which hydrogen will have to compete, on national and international decarbonisation targets and commitments, and on available energy sources in the individual countries.

FIGURE 5. Value chain of potential applications of green hydrogen



H_2	Hydrogen
LH_2	Liquefied hydrogen
CH_2	Compressed hydrogen
ASU	Air separation unit

Storage: In tanks or geological.

Source: Authors' own compilation, Fichtner (2025)

Furthermore, the production of hydrogen by electrolysis generates 8 kg oxygen (O_2)/kg H_2 as a by-product. Some typical applications of high-purity liquified oxygen include water treatment, medical purposes, and industry (metallurgy, pulp & paper, chemical, etc.). Nonetheless, taking into consideration that current technologies for oxygen production (air separation unit (ASU), pressure swing adsorption (PSA)) are mature, easily scalable, and applicable to on-site oxygen generation, the use of oxygen generated by electrolysis in an economic feasible way is quite restricted and very location dependent.

2.3 Most common hydrogen downstream products

2.3.1 Ammonia and fertilisers

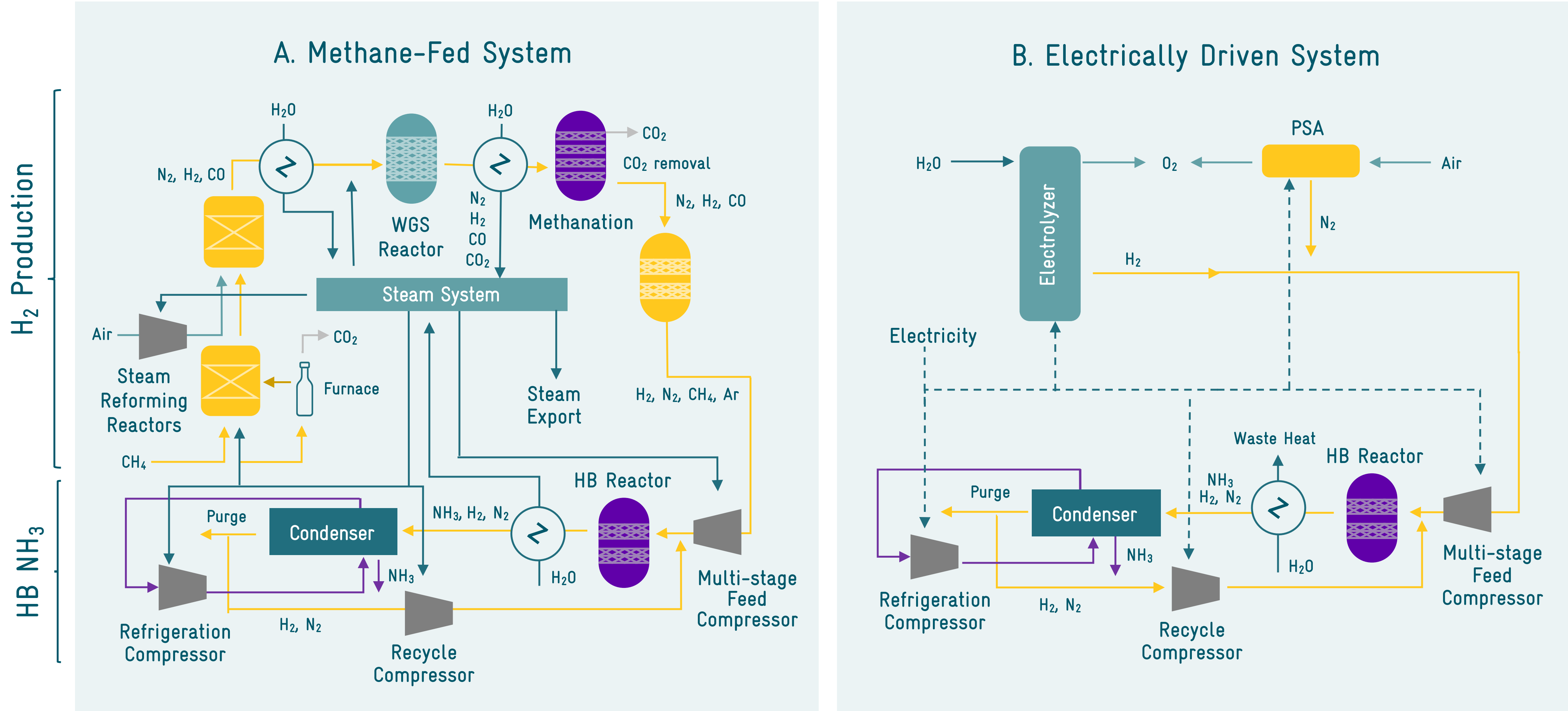
Ammonia production is the second-largest current use of hydrogen, accounting for 33% of total hydrogen demand. Ammonia is a key precursor in industry and is mainly used for nitrogen-based fertilisers (around 70-80%), and other industrial applications such as plastic and explosive production.

Ammonia is synthetised via the Haber-Bosch (HB) process, in which hydrogen (H_2) reacts with nitrogen (N_2) to form ammonia (NH_3) under high pressures and high temperatures. A schematic of the conventional HB process as well as a green hydrogen-based process is shown in Figure 6. The conventional process combines hydrogen - typically obtained through SMR of natural gas - with nitrogen, sourced from air. In the green ammonia option, an electrically driven system, an external source of nitrogen is required (e.g. from air through an air separation unit, ASU) and the compressors that are steam-driven in the conventional process are mainly electrically driven. Little to no steam is used in the green ammonia production process.

Ammonia is a key ingredient in nitrogen fertilisers and as such is critical for crop growth. Annex 3 presents an overview of some commonly used fertilisers.

It should be noted that the production processes of some of the fertilisers require a carbon source, which needs to be sustainable in order to obtain green fertilisers. Possible solutions are direct air capture (DAC), carbon capture and usage (CCU) from unavoidable industrial sources, or biomass treatment processes. Globally, only few industrial or commercial-scale projects are currently available for sustainable carbon sourcing.

FIGURE 6. Schematic of conventional (A) and green (B) Haber-Bosch process



Source: Smith, 2019

2.3.2 Methanol

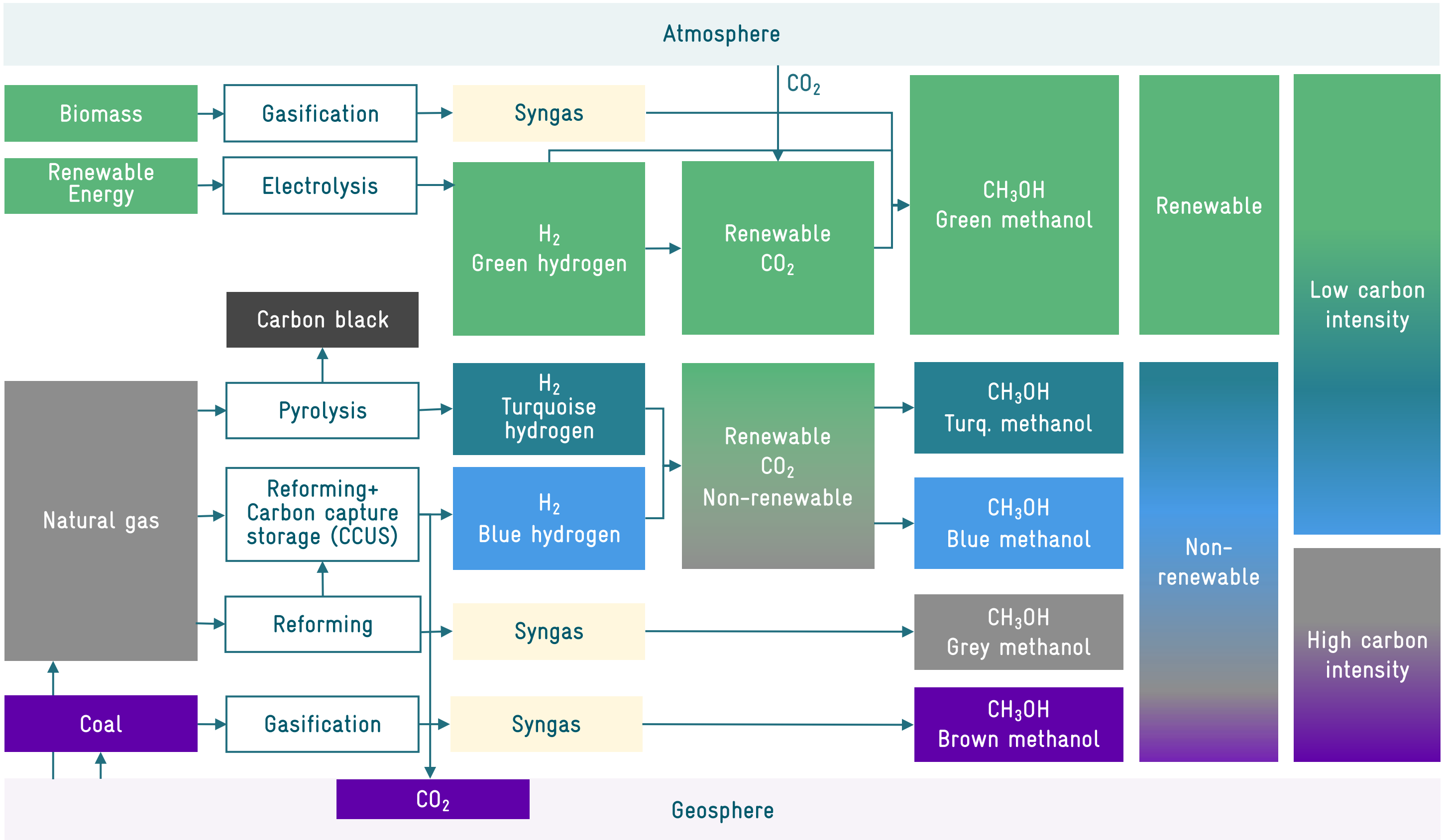
Methanol production is another major current use of hydrogen, amounting to 17% of hydrogen demand. Methanol is a widely used chemical, with its main uses including the production of basic chemicals (e.g. formaldehyde, acetic acid; 52%), olefins (e.g. polyethylene; 31%) and fuels/fuel additives (e.g. dimethyl ether (DME); 17%) (Methanol Institute, 2024).

Today's methanol production depends mainly on natural gas consumption to produce hydrogen as well as the necessary CO_2 (see Figure 7). The mixture of hydrogen, CO_2, and CO generated in a steam methane reforming (SMR) reactor is passed over a catalyst at high pressure and moderate temperatures, with two key reactions:

$CO + 2H_2 \rightarrow CH_3OH$ and
$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

In the case of green methanol, the hydrogen is generated by electrolysis and an additional source of carbon is required for the synthesis process. The sourcing of sustainable carbon and the deployment of technologies such as DAC or CCU at large scale might be limiting factors. The following table offers an overview of the main uses of methanol.

FIGURE 7. Pathways of methanol production



Source: Authors' own compilation, Fichtner (2025) based on (IRENA, 2021)

TABLE 4. Key methanol uses

Application	Precursors
Fuel	As a fuel, either directly or blended with gasoline. Methanol fuel cells are a promising technology.
Solvent	As a solvent in various industrial processes, including paint thinners and adhesives.
Formaldehyde	Formaldehyde production, which is used in resins, plastics, and textiles.
Acetic acid	Acetic acid production, which is used in the production of vinegar, plastics, and synthetic fibres.
Methyl tertiary butyl ether (MTBE)	MTBE production, which is used as oxygenate added to gasoline to reduce emissions.
Biodiesel	Used in the transesterification process to produce biodiesel from vegetable oils or animal fats as a substitute for conventional diesel.
Methanol-to-olefins (MTO)	Conversion into light olefins such as ethylene and propylene, for the production of plastics and synthetic fibres.
Methanol-to-gasoline (MTG)	Transformation into high-octane gasoline through a series of catalytic reactions.
Dimethyl ether (DME)	Dehydration to form DME, which can be used as a substitute for diesel.

Source: Authors' own compilation, Fichtner (2025)

2.4 The hydrogen industry in Georgia

2.4.1 Overview of the national industry

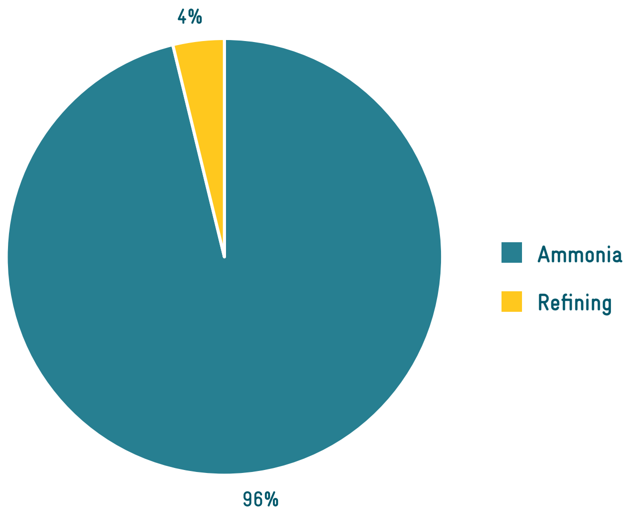
The hydrogen industry in Georgia mainly focuses on its use for fertiliser production. The country does not have large refining facilities in operation, nor DRI furnaces.

Since hydrogen is typically produced on site, no hydrogen trading takes place currently. As for main derivatives, Georgia exported about USD 728 million of nitrogen-based fertilisers in 2022, while it imported small amounts of mineral fertilisers and methanol (OEC, 2024).

Hydrogen statistics in Georgia are not available. Considering that hydrogen is currently used for the production of ammonia and nitrogen-based fertilisers, current demand has been estimated on the basis of ammonia production capacity and the demand for a small-scale oil refinery. The resulting hydrogen demand is shown in Figure 8 and Table 5. Further details are provided in the following sections.

The estimated current hydrogen demand for large applications is about 37 kTPA. This demand is likely to increase in future, e.g. as a result of increasing local oil refining capacity. Even if demand in small consumer sectors has not been considered for this estimation, total hydrogen demand in the country is mostly determined by large applications and is therefore expected to remain in the same order of magnitude.

FIGURE 8. Estimated local hydrogen demand in Georgia



Source: Authors' own compilation, Fichtner (2025)

TABLE 5. Estimated local hydrogen demand

Product	Specific H_2 demand [t_{H2}/t product]	Local capacity [kTPA]	Potential H_2 demand [kTPA]
Oil refining	0.008	175	1.4
Fertilisers (ammonia)	0.177	200	35.4
Total	-	-	36.8

Source: Authors' own compilation, Fichtner (2025)

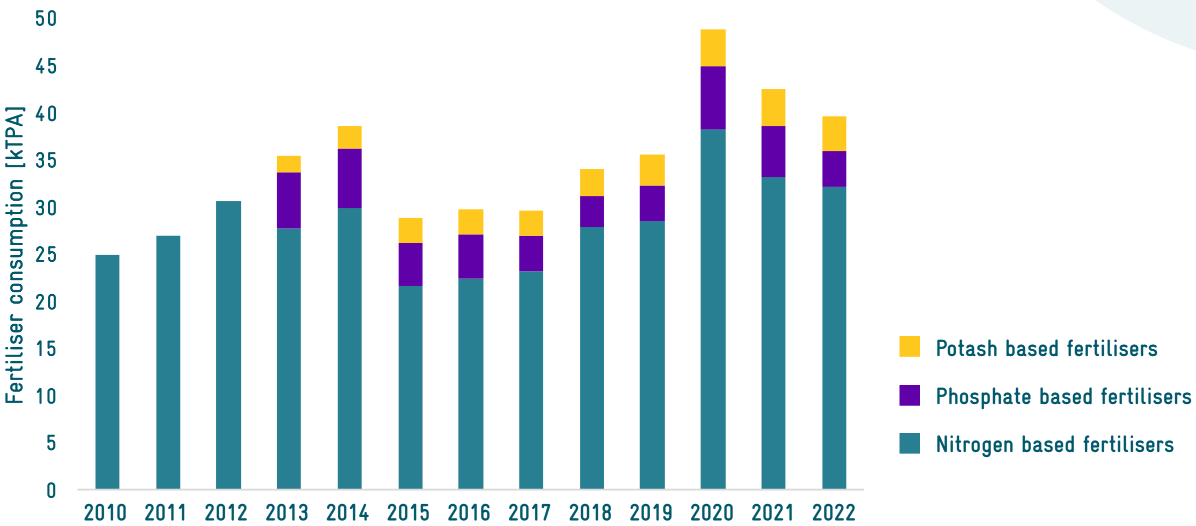
2.4.2 The fertiliser industry

Georgia's fertiliser industry is primarily focused on producing mineral and chemical fertilisers, taking advantage of local resources such as phosphates and sulphur. Georgia's fertiliser consumption is subject to annual fluctuations, as shown in Figure 9, lately between 30 and 40 kTPA.

The main producer of fertilisers is Rustavi Azot, producing ammonium nitrate, urea, and ammonia, as depicted in Table 6. The company was bought by Indorama in 2023.

In 2023 Georgia imported 18 kTPA and exported 0.23 kTPA of nitrogen-based, phosphate-based and potash-based fertiliser (WITS, 2024a), indicating that local production capacity is not sufficient to cover the country's demand.

FIGURE 9. Fertiliser consumption in Georgia



Source: Authors' own compilation, Fichtner (2025) based on (IFA, 2024)

TABLE 6. Main fertiliser production companies in Georgia

Company	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA][2]
Rustavi Azot	Rustavi	NH_3: 200 Fertilisers: 450	35.4

2 The hydrogen requirement is estimated for the ammonia production capacity (it is assumed that ammonia is then further processed to other fertilisers) with a specific requirement of 0.177 t_{H2}/t_{NH3}.

Source: Authors' own compilation, Fichtner (2025) based on (Rustavi Azot, 2024)

2.4.3 The chemical industry

The chemical industry in Georgia supports various economic segments, including healthcare, packaging, and manufacturing. Some of the main players in the Georgian chemical industry include LLC GM Pharmaceuticals with local pharmaceutical production, and MN Medical Georgia as a provider of medical equipment. Additionally, there are some companies active in the production of PET materials for packaging, such as JSC Caucasian PET Company. Table 7 gives an overview of these main companies, including their location.

Manufacturing companies in the pharmaceutical sector might require hydrogen, depending on the type of processes and products, but no detailed information is currently available on this. Considering the current limited production of chemical products in the country, the potential hydrogen demand related to these processes and products is expected to be very low.

In recent years, Georgia has become a notable importer and consumer of caustic soda (Chemkraft, 2024). The country does not have any production plants for this chemical, so the demand is met through imports, which amounted to 27 kTPA in 2023 (including both solid and lye forms). The majority of this caustic soda supply comes from Russia (WITS, 2025a).

Georgia is still highly dependent on the import of chemical products to meet local demand. In 2022 the country imported USD 1.9 billion in chemical products (including rubber and plastics) (OEC, 2024). Local demand, including that from chemical companies, is mostly covered by imports. Imports of hydrogen peroxide reached 11 kTPA in 2023 (WITS, 2025b). With regard to methanol, there are currently no production facilities in Georgia. Imports reached around 200 tonnes in 2023 (WITS, 2024b).

TABLE 7. Main chemical companies in Georgia

Company	Location	Capacity
LLC GM Pharmaceuticals	Tbilisi	127 million bulk units
Chemicals Coating Trading LLC	Rustavi	Unknown (paint and coating products)

Source: Authors' own compilation, Fichtner (2025) based on (GM Pharma, 2024) and (dun & bradstreet, 2024)

2.4.4 The steel and metallurgy industry

The steel industry in Georgia is represented by two key players, Rustavi Steel and GeoSteel, both located near the capital city, Tbilisi. Chiaturmanganum Georgia LLC also operates in Georgia; the company was founded in 2008 and produces and exports ferroalloys. It owns raw material deposits, mining licenses and manganese ore enrichment plants. Zestaponi Ferroalloy Factory is one of the largest ferrous metallurgy factories in Georgia. Since 2006 the factory has been owned by Georgian Manganese.

In 2023, total production of crude steel reached 128 kTPA (World Steel Association, 2024). While there might still be some hydrogen requirement for specific processes, currently no DRI furnace is found to be operational in Georgia. Refurbishment and expansion plans of the key companies might offer an opportunity for a technological transition in the sector. If the 128 kTPA of crude steel produced in 2023 were to be produced via DRI, the corresponding hydrogen demand would be approximately 7.7 kTPA.

TABLE 8. Main steel and metallurgy companies in Georgia

Company	Location	Capacity [kTPA]
GeoSteel	Rustavi	Steel rebars: 215* Wirerod: 150
Rustavi Steel	Rustavi	Pipes: 350 Steel melting: 200 Cast iron: 650
Chiaturmanganum Georgia	Chiatura	Ferroalloys: 40
Zestaponi Ferroalloy Factory	Zestaponi	Unknown**

* Plans to expand to 300 kTPA.
** Inactive since November 2024.

Source: Authors' own compilation, Fichtner (2025) based on (GeoSteel, 2024), (Chmg, 2024), (RustaviSteel, 2024), and (JamNews, 2024)

2.4.5 The oil and mining industry

Georgia does not have large-scale oil refineries for processing crude oil domestically. Instead, it relies on imported refined petroleum products, such as gasoline, diesel, and jet fuel, to meet its energy needs. Currently, the main refinery in Georgia is the Batumi Oil Refinery, nonetheless its primary purpose is storage and logistics rather than refining. A small refinery named ZD Oil Company is located in Martkopi and has a refining capacity of 480 tonnes per day (~175 kTPA) (Trans Logistic, 2024). However, construction of Georgia's first full-cycle oil refinery by Black Sea Petroleum recently started. The refinery is scheduled to begin operations in March 2025. It will initially process 1.2 million tonnes of crude oil annually, with plans to increase capacity to four million tonnes by 2028 (BSP, 2022). Table 9 summarises these oil refineries, including location, production capacity, and estimated hydrogen demand. Hydrogen demand has been estimated on the assumption of operation throughout the year at full capacity and a specific requirement of 8 kg of hydrogen per tonne of oil.

The estimated hydrogen demand for refineries should give a first indication of the order of magnitude, but it must be borne in mind that it would be highly dependent on the complexity of the refinery, the quality of the processed oil, and the required products.

Mining has been conducted in Georgia for centuries. Georgia has more than 300 explored mineral deposits, only about half of which have been brought into production. The mining sector in Georgia includes copper (Sadaqari and Madnueli mines), gold (Sakdrisi mine, in Bolnisi Municipality, near Kazreti), manganese and minerals such as limestone, clay, and marble, and some iron ore on a rather small scale. Relevant players include Georgian Manganese, RMG Copper, RMG Gold, and RMG Auramine Georgian Mining Corporation, among others. The Georgian Manganese LLC owns the Zestaponi Ferroalloy Plant in Zestaponi (through JSC Ferro) and the Chiatura mine in Chiatura (through JSC Manganumi) (RMG, 2022).

Most mining and industrial explosives require ammonia-based ammonium nitrate (AN), resulting in a demand for hydrogen that could be covered by green hydrogen. The hydrogen demand depends on the explosive; taking ammonium nitrate as the precursor, the specific requirement would be between 0.25 - 0.94 tonnes of AN per tonne of explosive, resulting in 10 - 38 kg of hydrogen per tonne of explosive.

TABLE 9. Main oil refineries in Georgia

Company	Location	Capacity [kTPA]	Estimated H_2 demand [kTPA]
Batumi Oil Refinery*	Batumi	1,200	9.6
ZD Oil Company	Martkopi	175	1.4

* Under construction.

Source: Authors' own compilation, Fichtner (2025) based on (Trans Logistic, 2024), (BSP, 2022)

2.4.6 The food industry

The food industry in Georgia is a vital part of the national economy, encompassing a range of sectors from beverage manufacturing to sugar processing. While the industry includes both domestic production and export-oriented operations, local manufacturing is primarily concentrated in beverages, particularly wine, mineral water, and spirits. Georgia has a deep-rooted winemaking tradition and is also well known for its high-quality mineral waters. Additionally, beer and spirits production are well developed.

However, food processing beyond the beverage sector remains relatively underdeveloped. There is some domestic production of dairy products, meat processing, confectionery, and flour-based goods, but key ingredients such as vegetable oils, fats, and other staples continue to be heavily imported. Efforts are emerging to expand local agricultural processing, particularly in nuts, fruit preserves, and dairy.

According to Georgia's statistical office, the country imports significant volumes of vegetable oils and margarines. In 2023, vegetable oil imports totalled 47.3 kTPA, while margarine imports stood at 17.8 kTPA (geostat, 2025). However, there is a growing trend towards local production. Companies like Vaziscremli have begun producing sunflower and hazelnut oils, leveraging regional resources such as sunflower plantations in Kakheti and hazelnut orchards in Samegrelo (Vaziscremli, 2025). However, further processing, such as hydrogenation, is not currently implemented. Another key player, Greenville, produces vegetable oils, fats, butter, and margarine under the brand name ODA, but explicitly states that all its products use non-hydrogenated palm oil (ODA, 2025).

While the current food industry landscape does not indicate direct hydrogen demand, the potential for hydrogen applications – such as in hydrogenation processes – may emerge as local production expands and processing capabilities develop.

2.4.7 The glass industry

The glass industry in Georgia primarily focuses on the production of glass containers. While companies like Georgian Glass Market or Geo-glass are key players in the industry, they primarily act as importers of glass products. Sisecam stands out as the only domestic manufacturer, specialising in glass packaging (Glass International, 2023). At present, there are no known producers of float glass in Georgia, and the country relies on imports to meet its float glass requirements. In 2022, Georgia imported roughly USD 18 million worth of float glass, mainly from Iran, Russia, Azerbaijan, and Turkey (OEC, 2025).

Although there is no local production of float glass at the moment, continued industrial development in the future may create opportunities for integrating green hydrogen into the manufacturing processes.

2.4.8 Other industries

Hydrogen is increasingly recognised as a critical enabler for decarbonising industries that are challenging to electrify, particularly those requiring high-temperature processes. In the cement industry, green hydrogen could replace fossil fuels in high-temperature processes (e.g. for kilns), where typically coal, petcoke, or natural gas are used.

The cement industry in Georgia plays a crucial role in supporting the nation's construction and infrastructure development. One major player in the sector is Hunnewell Cement, with several cement plants in Rustavi and Kaspi and a combined production capacity of 2 MTPA of cement and 1.4 MTPA of clinker (HeidelbergCement, 2025). Another relevant player is the Georgian Cement Company with a production capacity of 250-300 kTPA (Georgia Today, 2015). Table 10 presents an overview of current cement companies in Georgia including their locations and production capacities.

As the global push for decarbonisation grows, Georgia's cement industry could benefit in future from integrating green hydrogen into its processes. This transition could help reduce the industry's reliance on fossil fuels, lower carbon emissions, and contribute to a more sustainable future.

TABLE 10. Main cement companies in Georgia

Company	Location	Capacity [kTPA]
Hunnewell Cement	Rustavi/Kaspi	Cement: 2,000 Clinker: 1,400
Georgian Cement Company	Mtskheta/Kaspi/Poti	300

Source: Authors' own compilation, Fichtner (2025) based on (HeidelbergCement, 2025) and (Georgia Today, 2015)

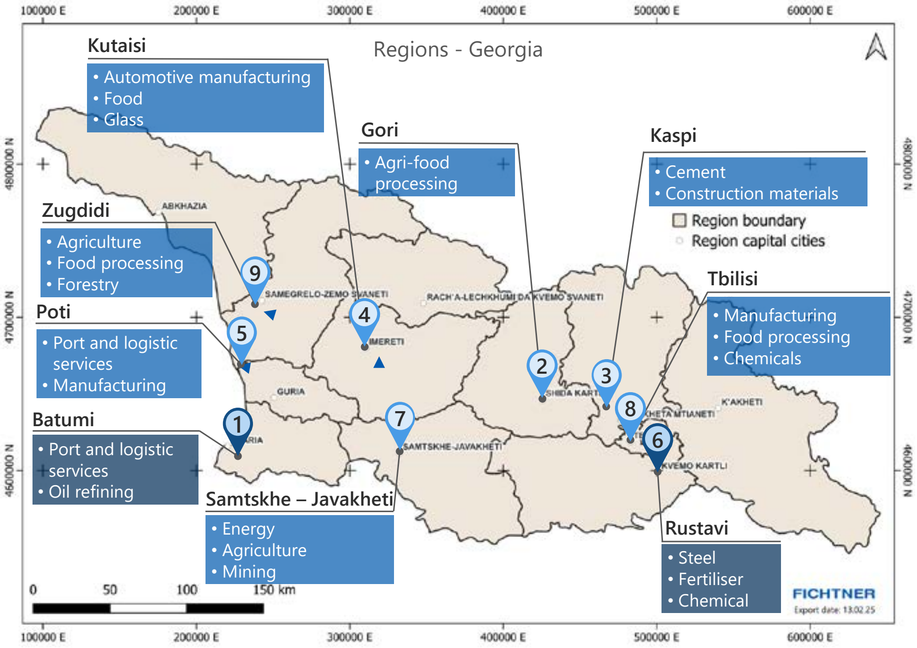
2.5 Industrial clusters and enabling infrastructure

The main existing industrial clusters in Georgia are depicted in Figure 10. Of the nine identified industrial clusters, two have been prioritised based on their higher likelihood of hydrogen use, with potential for transitioning from grey to green hydrogen. Further details on the industrial clusters are given in Annex 1.

In cluster 6 in Rustavi, hydrogen demand is related to the production of ammonia and nitrogen-based fertilisers. Additionally, cluster 1 in Batumi has been identified as a cluster with potential hydrogen demand in the short term, largely due to Batumi's role as a logistics hub with its strategic position by the Black Sea. Cluster 4 in Kutaisi might see hydrogen demand for certain welding processes related to automobile manufacturing. Clusters with other products and processes might still have or develop hydrogen demand, such as iron and steel or cement.

FIGURE 10. Main industrial clusters in Georgia

Industrial Clusters



Key Companies

	Company	[kTPA]
1	**Batumi Oil Refinery** (Oil)	1,200
3	**Hunnewell Cement** (Cement)	2,000
6	**Rustavi Azot** (Fertilizer/NH_3)	450/200
	GeoSteel (Steel rebars/Wire rood)	215/150
	RustaviSteel (Pipes/Iron)	350/650
8	**LLC GM Pharmaceuticals** (Chemical)	-

Prioritized clusters

Other clusters

Source: Authors' own compilation, Fichtner (2025)

Existing industrial clusters already have at least basic infrastructure in place. This, together with the size of the country and numerous ongoing projects in e.g. renewable electricity generation and transmission and distribution lines, facilitates the implementation of a green hydrogen economy in the country. The main features of enabling infrastructure to be considered include:

- **Electricity infrastructure:** Georgia already has a stable and clean electricity matrix. Nonetheless, its heavy reliance on hydropower is challenging. This reliance on hydro could be diminished by implementing other forms of renewable energy such as wind and solar photovoltaic (PV), decreasing the effects of seasonal fluctuations. Rustavi and Batumi are connected to the Georgian electricity grid. Moreover, large-scale GH_2 projects might be implemented isolated from the electricity grid with dedicated renewable energy generation, which would facilitate implementation as they do not overburden the transmission network. However, if it is intended that the projects should be allowed to connect to the grid, transmission and distribution networks will have to be expanded accordingly.
- **Water infrastructure:** Water supply systems are in place in Rustavi and Batumi, and both clusters have access to rivers. Nonetheless, considering the requirements for green hydrogen production (in this case, sustainability criteria for water), it might be necessary to extend the current water network or to start considering and evaluating the feasibility of water desalination projects along the Black Sea coastline of the country and the distribution of desalinated water to the project sites.
- **Transport infrastructure:** Road conditions influence transport capacities and related costs, being a key driver of competitiveness for the clusters. In general, the road networks for both clusters are well developed. The expansion of capacities in both road and railway networks also aligns with the requirements of the Middle Corridor (or Trans-Caspian International Transport Route), which starts in Southeast Asia and runs through Kazakhstan, the Caspian Sea, Azerbaijan, and Georgia to connect with European countries.
- **Ports:** Georgia's access to the Black Sea provides access to maritime trade routes relevant for technology imports in early phases of project implementation and for product exports in later phases (either of hydrogen or derivatives). Within the Middle Corridor, the ports of Poti and Batumi are considered key for the connection to Europe. While large ports are already established, the capacity of the ports will most likely have to increase and additional facilities for loading, unloading, and storage of e.g. GH_2, ammonia, and methanol will have to be installed. Moreover, Georgia is currently developing a dry port in Tbilisi as an extension of the Batumi and Poti ports as part of the Middle Corridor infrastructure for rail and road container shipments (Agenda.ge, 2024), which will also benefit project developers in the GH_2 sector.
- **Gas and oil infrastructure:** Further development of current networks would allow the connection of more regions and a potential reallocation of these networks to green hydrogen and derivatives at later stages of deployment. In early phases, blending of green hydrogen in the natural gas network can also be considered as a means towards decarbonising the Georgian economy and diminishing its reliance on energy imports.

2.6 Pilot projects

Currently, no specific pilot projects have been officially announced in Georgia. However, in its Hydrogen in Georgia document (Ministry of Economy and Sustainable Development of Georgia, 2024), the Ministry of Economy and Sustainable Development outlined four potential pilot projects for the near future. No concrete plans have been revealed thus far, but these proposed projects include:

- Production of GH_2 and injection in Rustavi Azot in the Haber-Bosch process to produce green ammonia and green fertilisers. The use of green ammonia for export or for maritime transport could also be developed.
- Production of GH_2 for use in metallurgy or future oil refining with a further test of market opportunities for green products.
- Hydrogen blending in the gas network to study the effects and the operation of equipment in selected applications.
- Use of hydrogen electrolysers in conjunction with hydropower plants for balancing of medium- or large-sized variable solar and wind power variations in the power system.

The country is working on the development of the hydrogen strategy of Georgia, which is expected to provide a clear and concrete list of pilot projects.

3

Green hydrogen potential in Georgia and use cases

Georgia stands at an early stage in terms of establishing a green hydrogen economy. Although the country's current hydrogen demand is relatively modest – primarily driven by the fertiliser industry – it benefits from abundant hydropower resources, growing wind and solar investments, and strategic access to the Black Sea for potential exports. By capitalising on these resources and addressing infrastructure gaps, Georgia can support both domestic hydrogen consumption and eventually tap into export opportunities, contributing to its broader sustainable development goals.

3.1 Renewable resource potential within Georgia

Georgia's renewable energy profile is dominated by hydropower, which accounts for a significant share of the national electricity mix. Large- and medium-scale hydropower plants supply low-carbon electricity, especially during periods of sufficient water flow. However, seasonal fluctuations in river flow can challenge year-round electricity generation stability.

Alongside hydropower, the country is increasingly exploring wind and solar projects:

- **Wind resources:** Georgia's mountainous terrain and coastal areas near the Black Sea offer substantial wind potential, although actual capacity factors vary significantly across regions. Ongoing and planned wind farm developments (e.g. near Kutaisi or in eastern parts of the country) highlight growing investor interest.
- **Solar resources:** While not as globally competitive as some desert regions, Georgia's solar irradiation in the southeastern and western areas is sufficient for utility-scale PV projects. Solar can complement hydropower and wind by providing daytime generation, partially smoothing the country's supply profile.

The solar and wind resources are shown in Figure 11.

Water availability for electrolysis is also a critical factor for hydrogen production. Georgia generally has adequate freshwater resources due to its mountainous rivers; nevertheless, local supply constraints or environmental concerns might necessitate desalination in coastal areas like Batumi. Given that desalination costs remain a small fraction of the total levelised cost of hydrogen (LCOH), water access is unlikely to be a major barrier, provided environmental regulations and best practices are observed.

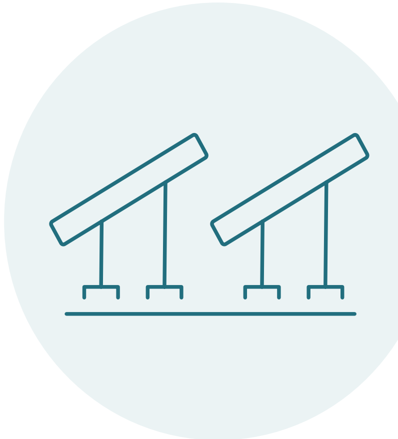
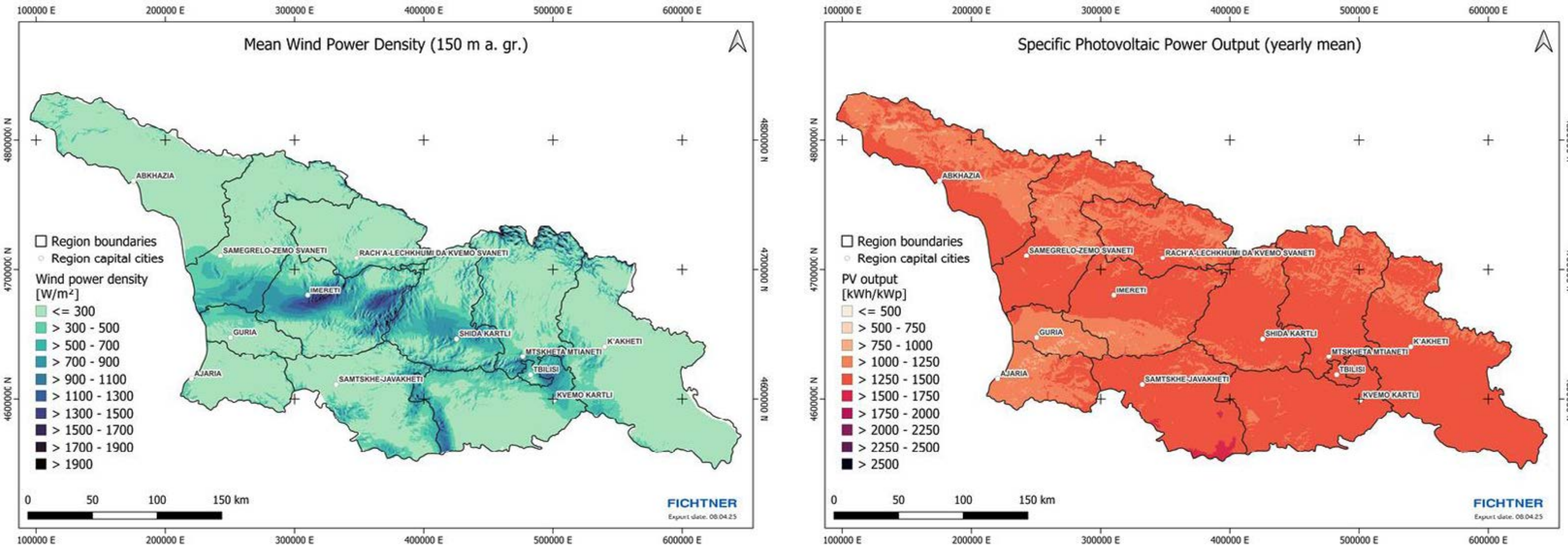


FIGURE 11. Mean wind power density and specific photovoltaic power output



Source: Authors' own compilation, Fichtner (2025) based on (Neil N. Davis, 2024)[3]

Source: Authors' own compilation, Fichtner (2025) based on (Global Solar Atlas, 2024)[4]

3 Data obtained from the Global Wind Atlas version 3.3, a free, web-based application developed, owned, and operated by the Technical University of Denmark (DTU). The Global Wind Atlas version 3.3 is released in partnership with the World Bank Group, utilising data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

4 Data obtained from the Global Solar Atlas 2.0, a free, web-based application developed and operated by Solargis s.r.o. on behalf of the World Bank Group, utilising Solargis data, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalsolaratlas.info

3.2 Potential use cases

Georgia's existing industries present several opportunities for integrating green hydrogen – particularly fertilisers, potential future oil refining, and small-scale industrial applications. These use cases can be broadly segmented into **small-scale** and **large-scale** projects, mirroring global trends in early hydrogen market development.

Small-scale use cases (electrolyser capacity: 1+ MW)

Small-scale green hydrogen projects serve industries with moderate hydrogen demand or decentralised production needs. These setups prioritise on-site or near-site generation to minimise logistics costs and seamlessly integrate with existing processes.

Electrolysers will then typically be powered by local wind or solar PV plants, supported by battery energy storage or hydrogen storage to manage fluctuations in electricity supply and hydrogen demand. In most cases, the hydrogen is consumed directly on site, ensuring efficiency and reliability.

Typical small-scale applications include electronics, specialty glass production, welding processes, and the food industry – either for hydrogenation or as protective gas in food packaging. In Georgia, no existing applications at small scale have been identified as part of this study, but potential applications that could be developed in the future include:

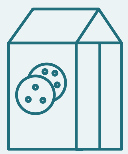
1. Food industry

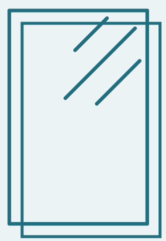
In the food industry, hydrogen is required for e.g. the hydrogenation of oils and fatty acids. This process serves multiple purposes, such as enhancing shelf life and stability of the products or modifying fats for industrial applications.

- Unlike countries with large vegetable oil hydrogenation needs, Georgia's food industry does not currently appear to have significant hydrogen requirements. However, smaller niches – such as the potential use of hydrogen in specialty processes (e.g. protective gas or minor hydrogenation steps) – may emerge over time.
- Producers of beverages, sugar, or other food items may eventually consider green hydrogen (e.g. for process heat generation) to align with sustainability goals, although immediate demand appears limited.
- These smaller plants often require reliable, locally produced hydrogen to limit transport costs and ensure supply security.

2. Glass and specialty chemical processes

- Georgia's glass production is limited to a few key players (e.g. Sisecam) manufacturing glass containers, and specialty chemicals remain a small market segment. However, where hydrogen is needed, on-site or near-site electrolysers can supply these niche demands reliably without the complexities of large-scale infrastructure.
- Georgia's chemical sector remains relatively small, relying on imports for many raw materials (e.g. methanol, hydrogen peroxide, and caustic soda). Should local production expand, small-scale on-site hydrogen could support specialised processes, such as hydrogenation in pharmaceutical or specialty chemical applications.





Large-scale use cases (electrolyser capacity: 10 MW and above)

Large-scale green hydrogen projects serve industries with high and continuous hydrogen demand, maximising economies of scale through larger electrolyser installations and the utilisation of optimal wind and solar resources.

These projects typically feature large renewable energy facilities paired with nearby large-scale electrolysers, supported by infrastructure for electricity transmission, water supply, wastewater management, and hydrogen storage and transport to off-takers or ports. Extensive hydrogen storage is essential either to balance production fluctuations without disrupting downstream processes or to accommodate the periodic nature of maritime transport for export-oriented projects.

Unlike smaller-scale projects, large electrolysers are housed in dedicated buildings, as containerised solutions are more common for smaller installations. In some cases, desalination units may be required to ensure a sustainable water supply, depending on local availability.

Typical large-scale applications include ammonia and fertiliser production, chemicals (including methanol), and crude oil refining. In the future, iron & steel and cement may also emerge as major hydrogen consumers.

In Georgia, existing large applications are limited to the local production of ammonia and fertilisers by Rustavi Azot. Nonetheless, the availability of low-cost natural gas might hinder the transition to green hydrogen in the short term.

The following primary opportunities at large scale offer potential for green hydrogen use in the future:

1. **Ammonia and fertiliser production**

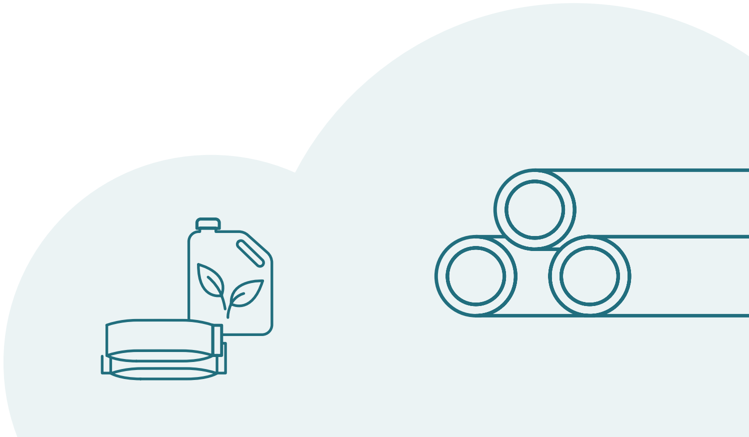
- Fertiliser production – especially ammonia-based fertilisers – currently constitutes Georgia's largest hydrogen consumer (e.g. at Rustavi Azot). Transitioning from natural gas-based hydrogen to electrolytic green hydrogen could reduce overall emissions and align with global sustainability mandates.
- Georgian ammonia and fertiliser production is already exported to neighbouring markets; adopting green hydrogen could open premium 'green product' segments internationally.

2. **Oil refining (future growth)**

- Although Georgia's refining capacity is minimal today, planned refinery projects, such as the Kulevi Oil Refinery under construction, may demand significant hydrogen for hydrotreating and hydrocracking.
- Retrofitting or designing new refineries to utilise green hydrogen could significantly cut operational carbon footprints, given the country's increasing renewables capacity.

3. **Steel and metallurgy**

- Current steel production in Georgia (e.g. Rustavi Steel, GeoSteel) does not rely on direct reduced iron (DRI) technology. Should these facilities upgrade to hydrogen-based DRI in the future, the potential hydrogen demand could be considerable.
- Demonstration or pilot projects in hydrogen-based metallurgy would align Georgia with the global shift towards low-carbon steel.
- Other industries, such as mining or metallurgy, could likewise adopt hydrogen for heat, explosives, or chemical processes, but large-scale demand is not anticipated in the near term without major technological and regulatory shifts.



Techno-economic calculations of the use cases

Based on the previous analysis, potential use cases for hydrogen in Georgia will primarily focus on small-scale applications or ammonia production for fertilisers.

To provide a preliminary indication of techno-economic feasibility for projects of varying scales, three different scenarios have been assessed for direct hydrogen use at the Rustavi Azot location, where fertilisers are currently produced. Here, a transition to green hydrogen could be considered in the short term. For these selected cases, the analysis examined the optimal renewable energy mix, including PV and wind, necessary to meet the given annual hydrogen demand using different electrolyser sizes (1 MW for small scale and 10 MW for large scale). The main results of these three cases are summarised in the following table. These results are based on model renewable profiles in southeast Georgia (41°31'50.5"N; 45°03'05.5"E). It is important to note that the results can vary considerably if industries in other regions of the country with better wind resources are selected, or if utility-scale projects with significantly larger component sizes are considered, as these can take better advantage of economies of scale.

TABLE 11. Techno-economic calculations for direct hydrogen use cases

Case	Small-scale H_2 (wind & PV)	Small-scale H_2 (PV only)	Large-scale H_2 (wind & PV)
Demand (H_2) in tonnes/a	45	45	450
Installed RE (capacity) in MW	PV: 3.9 Wind: 0.5	PV: 3.75	PV: 29 Wind: 2
Electrolyser size in MW	1	1	9.8
Weighted average cost of capital (WACC) (%)	9.1	9.1	9.1
Total investment in million USD	6.1	5.4	43.4
Oxygen sales in million kg	0.36	0.36	3.4
Excess RE sales/ consumed in GWh[5]	2.5	2.1	13
LCOH grey (USD/kg)	8.00	8.00	8.00
LCOH proposed case/ green (USD/kg)	13.46	11.99	10.87
Project IRR (%)	2.9	3.7	4.4
Net present value (NPV) in million USD	−2.2	−1.6	−11.9
Finance gap (USD/kg)	5.46	3.99	2.87

5 Excess RE is calculated for the value chain including ammonia. If only H_2 is to be produced, the amount of excess renewables can be increased by ~5%.

Source: Analyses performed by GIZ (2025)

Based on the results presented in the table above, the following can be concluded:

- **Resource utilisation and cost analysis:** The analysis reveals that wind resources at the selected location are insufficient for effective electricity generation[6], as indicated by the lower LCOH for green hydrogen in the 'small-scale H_2 (PV only)' case compared to the 'small-scale H_2 (wind & PV)' case. The green LCOH for the 'small-scale H_2 (PV only)' and 'large-scale H_2 (wind & PV)' cases is approximately 50% and 35% higher than the current grey hydrogen costs, respectively.
- **Financial viability:** With a LCOH for grey hydrogen of USD 8.00 per kg, which results from taking an external supply from a third party (no production of its own), among the analysed scenarios the 'large-scale H_2 (wind & PV)' case shows the lowest finance gap at USD 2.65 per kg of hydrogen and the highest IRR (4.4%), suggesting that it is the most financially feasible option for implementation based on these estimates. Lower LCOHs for grey hydrogen will correspondingly increase the finance gap[7]. By leveraging a single funding source or a mix of the funding sources described further in section 4.3, the finance gap might be closed to make the project economically feasible.

Given that current hydrogen use in Georgia is directly linked to ammonia-based fertiliser production, a complementary techno-economic analysis was conducted for three ammonia use cases that align with the hydrogen use cases presented above. The results are summarised in the following table.

TABLE 12. Techno-economic calculations for ammonia use cases

Case	Small-scale NH_3 (wind & PV)	Small-scale NH_3 (PV only)	Large-scale NH_3 (wind & PV)
Demand (NH_3) in tonnes/a	270	270	2,700
Installed RE (capacity) in MW	PV: 3.86 Wind: 0.5	PV: 3.75	PV: 29 Wind: 2
Electrolyser size in MW	1.0	1.0	9.8
WACC (%)	9.1	9.1	9.1
Total investment in million USD	6.83	6.07	47.69
LCOA grey (USD/kg)	1.21	1.21	1.21
LCOA proposed case (USD/kg)	2.88	2.63	2.33
Excess RE sales/consumed in GWh	2.5	2.1	13
Oxygen sales in million kg	0.36	0.36	3.4
Project IRR (%)	−0.1	0.5	1.3
NPV in million USD	−3.36	−2.93	−20.59
Finance gap (USD/kg)	1.67	1.42	1.12

6 Capacity factors of wind: 5% for small scale and 9% for large scale.
7 Defining the finance gap as the difference between LCOH for green hydrogen and LCOH for grey hydrogen.

Source: Analyses performed by GIZ (2025)

Based on these results, the following can be concluded:

- **Cost competitiveness:** Among the cases, the 'large-scale NH_3 (wind & PV)' scenario presents the lowest green LCOA at USD 2.33 per kg, making it more competitive relative to the alternatives.
- **Financial feasibility:** Despite having large financial gaps and negative net present values in all scenarios, the 'large-scale NH_3 (wind & PV)' case has the smallest financial gap at USD 1.12 per kg of ammonia, highlighting its potential for large-scale implementation. As with hydrogen, the remaining gap might be closed by leveraging funding mechanisms.
- **Investment returns:** Although the project IRR is modest across all cases, the 'large-scale NH_3 (wind & PV)' scenario offers the highest return at 1.3%.

Overall, and under current assumptions, the results show the general rationale of larger projects being more cost efficient than small-scale projects. Nevertheless, they also require higher initial investment and the lower LCOH is still not enough to compensate for it and to reach a positive net present value (NPV). It is therefore clear that these projects are not economically feasible in the short term without intensive funding. From a funding perspective it might be more feasible to go for small-scale projects as the funding required to set up these projects is lower in terms of absolute value, but this is heavily dependent on the funding scheme that is to be used.

It is important to note that the aforementioned options provide an estimate of potential green hydrogen and ammonia costs; however, cost evaluations should be conducted on a project-by-project basis as factors such as the local renewable profile and the required industry's offtake profile (the analysis above is based on a constant profile) can significantly influence the levelised cost, particularly due to their impact on the sizing of the electrolyser and storage system required. This effect is smaller for ammonia than hydrogen as the former has significantly lower storage costs. The calculation further assumes that the full amount of renewable electricity generated can be sold to the industry attached for a price of USD 42.3/MWh. It is likely that the industries will be interested in purchasing the otherwise curtailed renewable electricity, but this might not always be the case, and without the sale of excess renewables, implementation of battery storage might become an option. In certain scenarios, it may be further feasible to derive additional benefits from using the electrolyser's waste heat for applications such as district heating or industrial pre-heating processes and to conclude a power purchase agreement (PPA) with other renewable sources, for instance to make use of the constant renewable profile of existing hydropower assets.

3.3 Analysis of hydrogen production potential

For large-scale hydrogen production, the alignment of renewable energy resources, water availability, export infrastructure, and regulatory frameworks is essential. In Georgia, the combination of abundant hydropower, wind potential in select regions, and mountainous terrain with plentiful water resources lays a solid foundation for green hydrogen production. Moreover, the relatively low density of population in certain mountainous or semi-rural areas can reduce land-use conflicts, potentially lowering project development costs. These factors can position Georgia as a green hydrogen producer in the Caucasus region.

Conversely, small-scale hydrogen projects require proximity to industrial end-users to minimise transportation costs and ensure economic viability. Industrial centres such as Rustavi and the greater Tbilisi area offer strategic locations for pilot or smaller-scale hydrogen initiatives. These locations benefit from existing energy and water infrastructure, as well as direct access to industries – such as steel manufacturing and chemicals – that could integrate hydrogen into their processes. Leveraging these established clusters can reduce capital expenditure (CAPEX) and accelerate project deployment.

Georgia's existing export and transport infrastructure further strengthens its potential role in a regional hydrogen economy. With direct access to the Black Sea through ports like Poti and Batumi, and a strategic position as a transit route between Europe and Asia, Georgia is well placed to export hydrogen or its derivatives to neighbouring markets. In the long term, the nation's existing natural gas pipelines and possible new corridors could be repurposed or adapted to carry hydrogen, reducing the need for entirely new infrastructure and facilitating both domestic and international transport routes.

Nevertheless, Georgia's relatively small domestic market and ongoing regional political uncertainties could hinder the large-scale investments needed for major hydrogen projects. Additionally, competition from larger, more established energy exporters may limit Georgia's ability to position itself as a leading global hydrogen hub.

3.4 Multi-criteria assessment for small-scale hydrogen projects

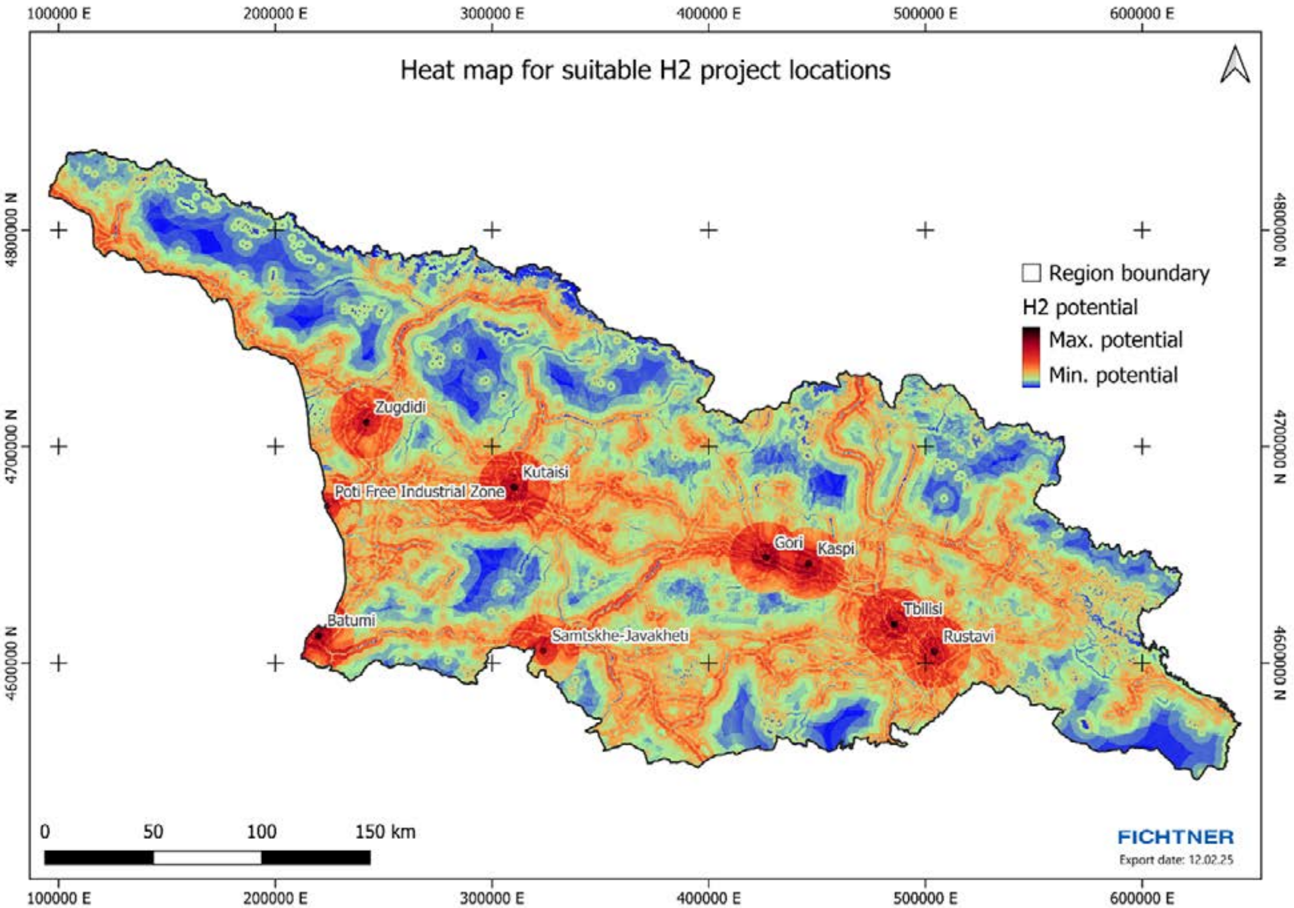
A multi-criteria assessment (MCA) was carried out in order to identify optimal locations for small-scale hydrogen projects. The evaluation considered:

- Renewable energy availability (wind and solar potential)
- Proximity to industrial clusters (potential off-takers)
- Access to water resources (for electrolysis)
- Connection to existing energy and transport infrastructure

Each criterion was assigned specific scoring thresholds based on factors such as distance to off-takers, high-voltage grid connections, water sources, roads, and port facilities. Industrial proximity received the highest weighting, followed by grid access, renewable resource quality, and water availability. Transportation infrastructure (roads and ports) was also factored in to assess export feasibility.

The results of the MCA are visually represented in Figure 12, highlighting high-potential areas in red as prime locations for engaging industrial off-takers and initiating project development. Areas with less favourable conditions are marked in blue, indicating higher development challenges.

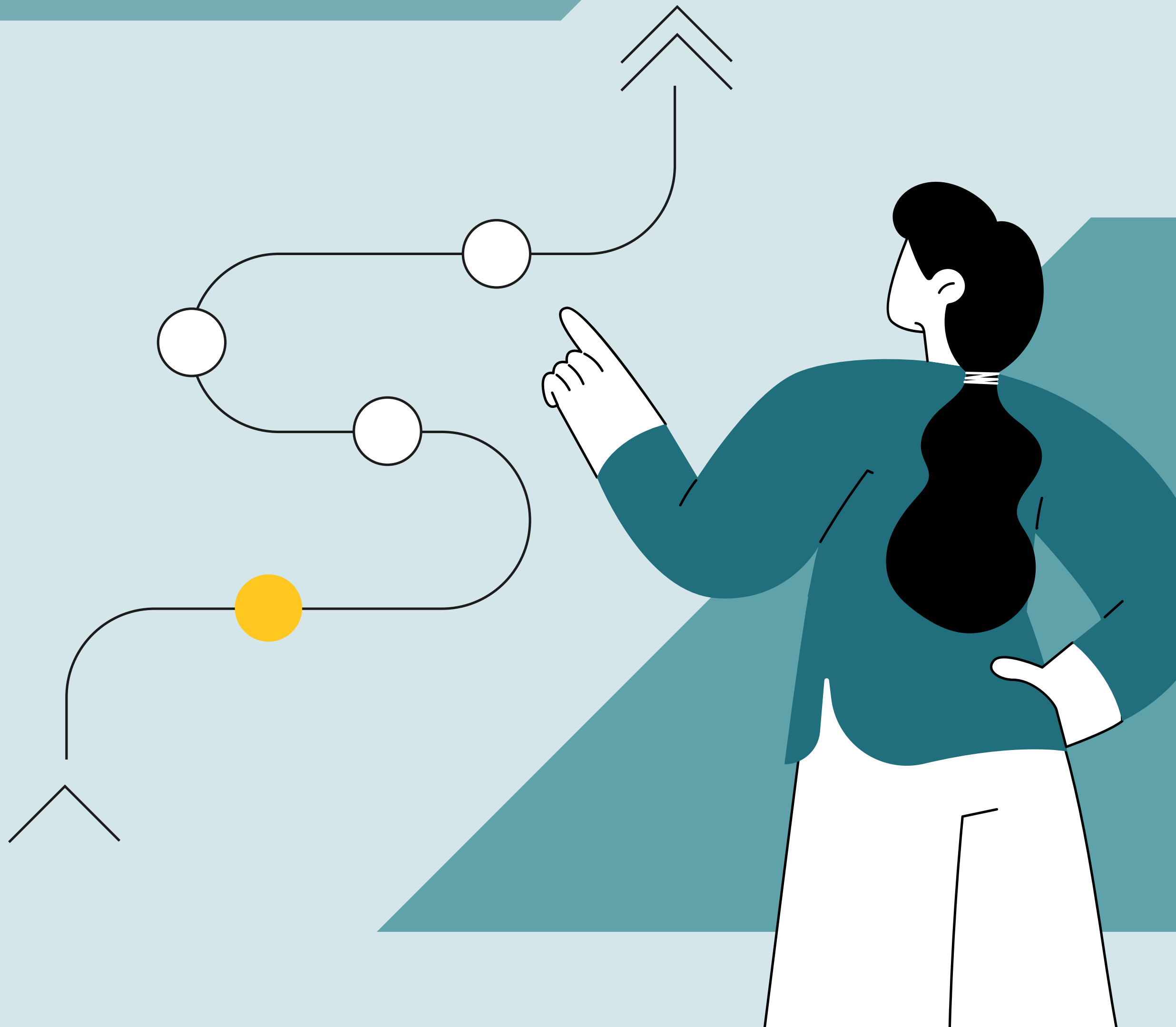
FIGURE 12. Country heat map indicating potential locations for green hydrogen pilot projects



Source: Authors' own compilation, Fichtner (2025)

4

The way forward



The analysis presented in the previous sections regarding Georgia's energy sector and the potential for green hydrogen adoption in industry reveals both opportunities and challenges in developing a sustainable hydrogen economy. While Georgia's strategic location and abundant hydropower resources provide a solid foundation for green hydrogen development, barriers such as policy gaps, infrastructure limitations, and economic constraints must be addressed.

This section outlines the key opportunities available for Georgia in the hydrogen sector, including its renewable energy potential, strategic export position, and industrial integration prospects. It also examines the challenges that need to be overcome – ranging from high production costs and limited domestic demand to regulatory hurdles – to ensure the successful development of a competitive hydrogen market.

4.1 Opportunities and supporting frameworks

Georgia's strategic position between Europe and Asia, combined with its abundant renewable energy resources, creates a strong foundation for the development of a hydrogen economy. Although local demand for hydrogen remains limited, Georgia has the potential to become a regional producer and exporter by leveraging its natural advantages and expanding infrastructure.

- **Renewable energy potential for green hydrogen production:** Georgia already generates over 70% of its electricity from hydropower, complemented by increasing wind and solar capacity, providing a stable renewable energy source for electrolysis-based hydrogen production.
- **Strategic location for hydrogen exports**: Georgia's geographic position as a gateway between Asia and Europe makes it an ideal hub for hydrogen exports to both European and neighbouring countries. Expansion of main ports in the Black Sea (Poti and Batumi) is being planned as part of the Middle Corridor infrastructure, facilitating the export of GH_2 and derivatives.
- **Industrial and energy sector integration:** Green hydrogen could be initially blended with natural gas, benefiting from existing infrastructure while reducing import dependence. Over time, industries such as ammonia and fertiliser, steel, and oil refining could emerge as large consumers of green hydrogen, alongside hydrogen-powered transport and logistics.
- **Energy security:** The adoption of green hydrogen could enhance energy independence by offering a domestic alternative while also reducing emissions. Additionally, hydrogen could be used for energy storage and seasonal energy balancing using excess hydropower during the rainy season.

To fully capitalise on these opportunities, Georgia needs a well-defined supporting framework that includes policy, regulatory, and technological measures:

- **Policy framework:** Defining the role of green hydrogen within Georgia's national energy mix, supported by a detailed scenario analysis, would allow for targeted investments and infrastructure development. Policies should focus on providing clear incentives for large renewable energy projects, which can supply the necessary energy for green hydrogen production. A detailed hydrogen action plan and/or roadmap (potentially as a follow-up to the Hydrogen Strategy) should define hydrogen's role in Georgia's energy mix, set clear production and usage targets, and establish financial incentives for large-scale projects. Additionally, introducing a carbon pricing mechanism, such as a carbon tax or cap-and-trade system, would incentivise hydrogen production by placing a price on carbon emissions and making green hydrogen a more competitive alternative.
- **Regulatory framework:** Existing energy laws, including the Law on Energy and Water Supply and the Law on Renewable Energy, should be amended to explicitly recognise hydrogen as an energy resource. Additionally, specific regulations on hydrogen production, storage, transport, and quality should be established, aligned with inter-

national and EU standards to enable cross-border trade. Tax incentives, such as VAT exemptions for green hydrogen and tax breaks for production facilities, could further drive investment.

- **Technology framework:** Georgia should assess pipeline compatibility for hydrogen blending with natural gas, identify necessary upgrades, and outline modifications required for safe and efficient hydrogen transport. Pilot projects in various sectors should be introduced to test hydrogen technologies at a smaller scale before large-scale deployment, ensuring safe integration into existing systems. Additionally, technical handbooks and regulatory guidelines should be developed to standardise infrastructure deployment.

4.2 Challenges and considerations

While Georgia has significant potential for hydrogen development, it also faces economic, technical, and regulatory challenges that need to be addressed to ensure successful market adoption. A coordinated approach involving financial incentives, regulatory reforms, infrastructure development, and capacity-building efforts is essential.

- **Economic challenges:** High production costs pose a major challenge, especially given the country's limited domestic hydrogen demand. Without large-scale industrial consumers, it will be difficult to achieve economies of scale. The lack of targeted subsidies and strategic investment incentives, such as hydrogen purchase guarantees and industrial decarbonisation grants, further hinders market development. Early adoption in sectors like municipal transport would require significant investment in refuelling infrastructure and fuel cell vehicle deployment.
- **Technical challenges:** While hydrogen adoption in established industries like fertiliser production and oil refining does not present major technological challenges, the lack of existing production capacity limits immediate off-take opportunities. Blending hydrogen into the natural gas grid requires an infrastructure assessment to determine feasibility and necessary upgrades. The use of green hydrogen in industries like steel and cement will only become viable as new technologies and cost-effective production processes emerge.
- **Regulatory challenges:** Georgia currently lacks a comprehensive regulatory framework to support hydrogen development. The absence of clear legislative recognition in key areas, such as energy, climate, and renewable energy laws, creates uncertainty and prevents hydrogen from being fully integrated into the national energy strategy. The partial implementation of the EU Clean Energy Package and the lack of a long-term vision for hydrogen deployment further complicate regulatory progress. Although Georgia has drafted a Strategy for Green Hydrogen, which aims to position the country as a regional leader, its final approval is still pending.

Addressing these challenges through coordinated policy efforts, infrastructure investment, and regulatory alignment with international standards will be essential for Georgia to unlock the full potential of its hydrogen sector and establish itself as a key player in the regional hydrogen market.

4.3 Green hydrogen financing opportunities for German companies

The green hydrogen sector requires substantial financial investments to overcome high initial costs and infrastructure challenges. To address this, several funding mechanisms exist, as described in the following with selected examples:

German instruments for investment in the international market

- **H_2Global** (H_2Global Stiftung, 2025): A reverse auction-based mechanism to support green hydrogen market development, offering 10-year purchase agreements. No project size or investment limitations; non-EU hydrogen producers can participate, meeting EU sustainability standards.
- **Power-to-X (PtX) Development Fund** (KfW, 2025): Set up by the German Government and KfW Group. Provides non-reimbursable grants for large-scale projects in emerging economies, with no specific investment thresholds. Eligible countries include Brazil, Colombia, Egypt, India, Kenya, Morocco, and South Africa (PtX Development Fund, 2025). As of now, Georgia is not listed among the eligible countries. However, eligibility criteria and target countries may evolve in future funding rounds.
- **International Hydrogen Ramp-up Programme (H_2Upp)** (BMWK, 2025): Supports early-stage public-private partnerships for pilot projects, with a minimum public contribution of EUR 100,000 and total project costs of at least EUR 200,000. Companies must contribute at least 50%. Applications are currently open until March 2025 (PtX Hub, 2025), though the overall programme is expected to continue until 2026 (BMWK, 2024).
- **UFK Untied Loan Guarantees** (UFK-Garantien.de, 2025): Provides loan guarantees to reduce political and economic risks in target countries. Green hydrogen projects may be eligible if they align with Germany's energy strategy.

European instruments for investment in the international market

- **Green Hydrogen Trust Fund (GHF)** (European Investment Bank, 2025): The European Investment Bank (EIB) established this fund to support large-scale green hydrogen infrastructure projects with substantial investments (millions USD), requiring a 30-40% contribution from applicants. Countries outside the EU, like Georgia, may be eligible, provided they meet the specific requirements of the fund at the time of application.
- **Clean Hydrogen Partnership** (European Union, 2025) (CHP) primarily supports the development and commercialisation of clean hydrogen technologies. No fixed limitations on project size or investment, but large, impactful projects are prioritised. Third countries may participate through specific agreements.
- **Green for Growth Fund** (GGF, 2025): Launched by the European Investment Bank and KfW Development Bank, and supported by the European Commission and Germany's Federal Ministry for Economic Cooperation and Development (BMZ), this finances renewable energy and climate projects in Southeast Europe and the Caucasus, offering loans, equity investments, and technical assistance. In 2024, it signed a EUR 7 million agreement with JSC Isbank Georgia to support corporate and small and medium-sized enterprise (SME) clients (EU NeighboursEast, 2024).
- **Green Transition for Georgia** (KfW, 2024): Launched in 2023, this multi-year green reform programme is a joint initiative of KfW, the French Development Agency (AFD), BMZ, the EU, and the Georgian government. It supports renewable energy, green hydrogen, carbon pricing, smart mobility, and sustainable finance, aligning Georgia with EU policies. The programme provides concessional budget financing based on successful policy implementation (policy-based lending).

Multilateral instruments

- **MIGA (Multilateral Investment Guarantee Agency)** (MIGA, 2025): Offers political risk insurance and credit guarantees for hydrogen investments in developing countries, with a focus on projects with significant developmental impact. There is no strict minimum investment amount, but larger projects, especially those aligned with national development priorities, are likely to be prioritised.
- **Global Environment Facility (GEF)** (Green Climate Fund, 2025): Provides grants and concessional loans for renewable energy projects, including green hydrogen, to achieve decarbonisation and environmental goals.
- **World Bank Loans:** The World Bank promotes the implementation of renewable energies including hydrogen through various programmes and initiatives. In 2023, for example, the bank stated that it had approved USD 1.6 billion in funding for renewable hydrogen loans in that year (World Bank Group, 2023).
- **International Finance Corporation** is a member of the World Bank Group and is the largest global development institution focused on the private sector in emerging markets. In 2024, IFC signed a new loan agreement with Isbank Georgia for a financing package of USD 10 million, 20% of which will be for climate finance projects (energy efficiency and renewable energies), enabling the bank to increase its lending to SMEs (IFC, 2024).

Private finance

- **Hydrogen One Capital** (HydrogenOne, 2025): A private venture fund specialising in direct or indirect investments in hydrogen infrastructure and technology.
- **Breakthrough Energy Ventures** (Breakthrough Energy, 2022): Through various programmes, Breakthrough Energy supports cutting-edge research and development by investing in companies with clean products to accelerate the clear energy transition.
- **Green Bonds:** These bonds are fixed-income financial instruments designed to fund sustainable projects such as renewable energy or clean transportation. There are different standards that can be applied, two of the most common being the Green Bond Principles issued by the International Capital Market Association (ICMA, 2025) and the Climate Bond Standards (Climate Bonds, 2025).

4.4 Stakeholder mapping and institutional overview for green hydrogen development

The development of Georgia's green hydrogen sector involves a diverse network of stakeholders, including government ministries, regulatory agencies, academia, non-governmental organisations, and international partners. Each plays a crucial role in shaping policy frameworks, advancing pilot projects, and establishing regulations to support hydrogen adoption. The following provides an overview of key stakeholders as of today.

Government bodies

- **Ministry of Economy and Sustainable Development (MoESD)**: As the main policy-making body responsible for hydrogen development, MoESD coordinates efforts to establish and implement the Green Hydrogen Strategy. This includes approving the Hydrogen Action Plan, Roadmap, and legislative updates needed to integrate hydrogen into Georgia's energy policy. MoESD ensures that human and financial resources are allocated appropriately for effective implementation.
- **Georgian Energy Development Fund (GEDF)**: Operating under MoESD, the GEDF is tasked with overseeing the development of hydrogen policies and projects. Its role includes facilitating the mobilisation of funds and promoting the realisation of the country's hydrogen potential, working closely with various stakeholders to drive hydrogen-related initiatives.
- **Hydrogen Energy Development Support Committee (HESC)**: Established in July 2022 by MoESD, HESC brings together government representatives, private entities, and field experts. Its primary goal is to support the development of a national hydrogen vision, assess Georgia's hydrogen potential, and develop legal frameworks, feasibility studies, and cost-benefit analyses. The committee has thematic working groups in key areas, including technical, policy, legal, and economic domains, ensuring a comprehensive approach to hydrogen development.
- **Georgian National Energy and Water Supply Regulatory Commission (GNERC)**: Responsible for regulating the energy and water supply sectors, it ensures fairness and transparency. In the context of hydrogen, GNERC's role involves developing transportation rules for hydrogen and creating mechanisms for hydrogen grid connection exemptions, which will be essential to facilitate the integration of hydrogen into existing infrastructure.
- **Ministry of Environmental Protection and Agriculture (MEPA)**: The ministry oversees environmental protection, including the development of carbon pricing mechanisms and measurement, reporting, and verification (MRV). These systems are crucial for incentivising green hydrogen projects by providing transparency and ensuring the environmental integrity of hydrogen production.

Non-governmental organisations and academia

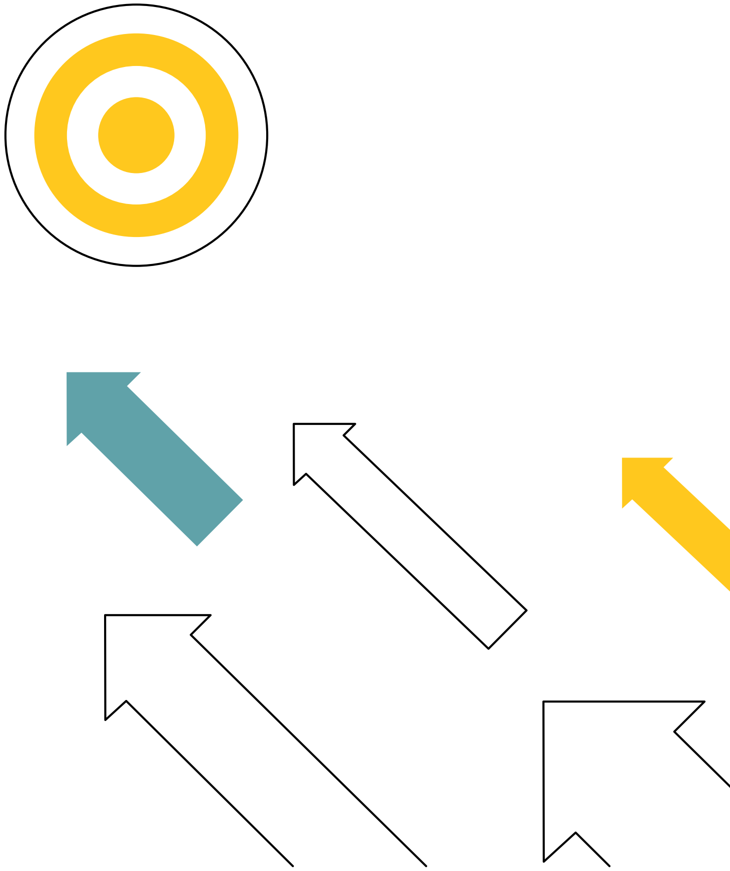
- **National Hydrogen Association (NHA):** The Association is a Georgian NGO dedicated to advancing the hydrogen sector. It fosters connections between local and international actors, conducts research, raises awareness, and supports partnerships. With 34 members from diverse sectors such as renewable energy, chemicals, and academia, the NHA plays a pivotal role in organising working groups and promoting hydrogen projects.
- **Academic institutions:** Institutions like Georgian Technical University and Ilia State University (both state universities) are engaged in hydrogen-related research, particularly focusing on green hydrogen production and technological innovation.

4.5 Next steps for German companies

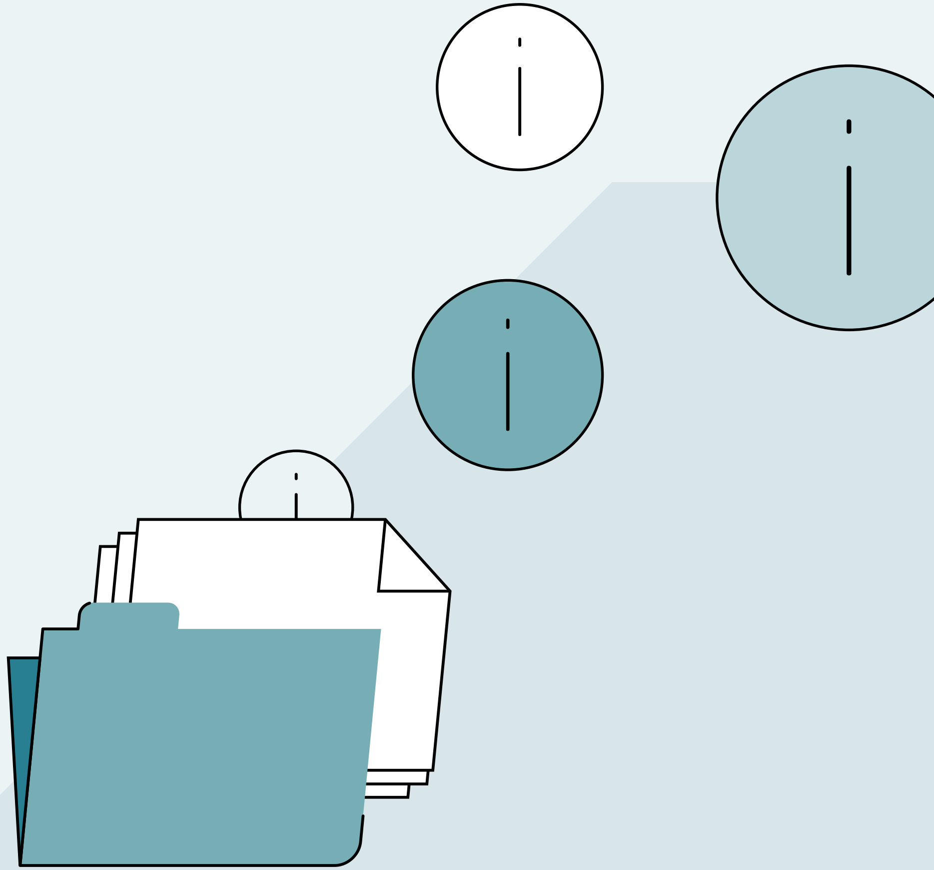
Georgia presents a promising opportunity for green hydrogen development, supported by its abundant renewable energy resources, strategic location, and growing policy interest. While challenges such as high production costs, regulatory gaps, and infrastructure limitations remain, a coordinated approach involving public and private investment, policy alignment, and technological advancements can enable the country to emerge as a key player in the regional hydrogen market.

For German companies interested in green hydrogen projects in Georgia, the following next steps are recommended:

1. Engage with local stakeholders: Establish partnerships with local industry associations to stay informed about regulatory updates and investment opportunities.
2. Leverage European and multilateral funding: Explore available financing mechanisms such as H_2Global, PtX Development Fund, the Clean Hydrogen Partnership, and the Green for Growth Fund (GGF) to secure funding and risk mitigation for green hydrogen projects.
3. Assess infrastructure and market viability: Conduct feasibility studies to evaluate electrolysis production potential, hydrogen blending with natural gas, and export logistics through Black Sea ports. Early-stage pilot projects in ammonia, fertilisers, transport, and steel industries could provide initial demand and scaling-up opportunities.
4. Monitor regulatory developments: Stay updated on Georgia's Hydrogen Strategy, Action Plan, and potential carbon pricing mechanisms, ensuring compliance with emerging standards. Advocacy for hydrogen-specific legislation, tax incentives, and streamlined permitting can further improve market conditions.
5. Participate in pilot and research and development (R&D) projects: Collaborate with Georgian universities, research institutions, and industry associations to develop and test hydrogen technologies, ensuring alignment with EU and international safety and efficiency standards.
6. By taking these steps, German companies can position themselves at the forefront of Georgia's green hydrogen market, capitalising on early-mover advantages while supporting the country's transition to a sustainable energy economy.



Annexes



Annex 1 Details of industrial clusters

Table 13 shows the main existing industrial clusters across the country. The table is ordered alphabetically and includes the location of the clusters, the main sectors, key products, and the main companies in each cluster. The H_2 column indicates clusters with a higher likelihood of hydrogen demand, either currently or in the near future.

TABLE 13. Main industrial clusters in Georgia

Industrial cluster	Location	Main sectors	Key products/main companies	H_2
1 Batumi	Batumi	Port and logistics, oil refining	Oil and gas products, transport and logistics services Batumi Refinery, SOCAR	X*
2 Gori	Gori	Agri-food processing	Grain (wheat, barley, corn), livestock and dairy products, food processing, forestry products Local SMEs	–
3 Kaspi	Kaspi	Cement, construction	Cement, concrete Hunnewell Cement, Georgian Cement Company, Black Sea Group, Evrocement	–
4 Kutaisi	Kutaisi	Automotive manufacturing, food, glass	Automotive** and components, processed food Aigroup, Adjara Group, EuroGlass, KAMP, Onima	–
5 Poti Free Industrial Zone	Poti	Logistics, light manufacturing	Plastics, exports Maqro Construction, Hualing Group, Prime Concrete, Georgian Cement Company	–
6 Rustavi	Rustavi	Steel, fertilisers, chemicals	Steel production, metal processing, industrial machinery, chemical products (fertilisers, paints), cement Rustavi Steel, Rustavi Azot, Geosteel, Ruselois, Hunnewell Cement	X
7 Samtskhe-Javakheti	Akhalkalaki, Borjomi	Energy, agriculture, mining	Hydroelectric power, agricultural products, mineral resources (marble, copper), wine Tsinandali Estate, Paravani HPP, Shuakhevi HPP	–
8 Tbilisi	Tbilisi	Manufacturing, textiles, food processing, chemicals, machinery	Food products (dairy, meat, beverages, canned goods), textiles and garments, pharmaceuticals, machinery and electronics Sante GMT Products, Marnueli Food Factory, Coca-Cola Bottlers Georgia, Industrial Group Tbilisi, KMC Glass, Glass Factory, LG Group, Mart Recycling LLC, MN Medical Georgia LLC, Besti Group, Bright Road	–
9 Zugdidi	Zugdidi	Agriculture, food processing, forestry	Agricultural products (fruit, vegetables, hazelnuts), food products (canned goods), timber products, agribusiness products Meama Tea, Georgian Tea Company, Anka Fair Trade, local SMEs	–

* No current demand but high potential in short term.
** Additional electric car factory announced by Aigroup in 2019

Source: Authors' own compilation, Fichtner (2025)

Annex 2 Legislative and regulatory framework

Law of Georgia on Energy and Water Supply (5646-RS) (Georgia, 2019a)

OVERVIEW:

The law replaces the previous market framework, aligning it with the EU's core energy principles offering an overarching legal framework for the energy sector in Georgia. This law outlines the legal framework for the energy sector, focusing on unbundling, third-party access, and regulatory authority. It aims to ensure the safe and efficient operation of energy systems.

KEY PROVISIONS:

- **Energy conservation and production:** Encourages energy-saving measures and the use of renewables.
- **Authorisation and permits:** Defines processes for energy production and infrastructure.
- **Institutions and governance:** Defines the roles of public institutions, regulatory bodies, or agencies responsible for overseeing the energy, water supply, and natural gas sectors and identifies decision-making processes.
- **EU law integration**: Incorporates key EU directives to ensure non-discriminatory access and secure supply.

Law of Georgia on Promoting the Generation and Consumption of Energy from Renewable Sources (5652-RS) (Georgia, 2019b)

OVERVIEW:

Establishes a legal framework for promoting, facilitating, and using energy from renewable sources, while setting mandatory national targets for the share of renewable energy in the country's gross final energy consumption, including in the transport sector. The law is currently being amended to incorporate the provisions of the Energy Community's adaptation of the Renewable Energy Directive (RED) II.

KEY PROVISIONS:

- **Mandatory renewable energy targets:** Aims for 30% of total energy consumption from renewables by 2030.
- **Policy planning:** Defines the strategic approach to integrating renewable energy into the national energy system. It includes provisions for developing renewable energy plans, setting targets for renewable energy adoption, and outlining the roles of various stakeholders in achieving these goals.
- **Certification:** Establishes certification processes for renewable energy sources and technologies, ensuring that they meet specific standards including green certificates.
- **Data collection and reporting:** Establishes requirements for collecting and reporting data related to renewable energy generation, consumption, and efficiency.

Law of Georgia on Energy Efficiency (5898-SS) (Georgia, 2020)

OVERVIEW:

This law focuses on improving energy efficiency across all sectors, aiming to reduce energy consumption and GHG emissions.

KEY PROVISIONS:

- **Energy performance standards:** Establishes mandatory energy performance standards for buildings and appliances.
- **Energy audits:** Requires energy audits for large enterprises and public buildings to identify opportunities for efficiency improvements.

Georgia's Second Nationally Determined Contribution (NDC) (Georgia, 2021b)

OVERVIEW:

Georgia's updated NDC, submitted in 2021, outlines commitments to reduce GHG emissions, aiming for a 35% reduction below 1990 levels by 2030. Georgia's updated NDC, a key national policy document covering the period from 2021 to 2030, is designed to promote the sustainable and balanced development of the country, while addressing climate change, environmental concerns, and socio-economic challenges. Georgia's NDC aims for climate neutrality by 2050.

KEY PROVISIONS:

- **GHG emissions target:** Georgia is committed to an unconditional target of GHG emissions reduction of 35% below the 1990 level by 2030. Furthermore, Georgia is conditionally committed to a GHG emissions reduction target of 50-57% by 2030 compared to 1990, assuming there is international support.
- **Sectoral mitigation targets:** The following sectoral targets from the reference level have been specified for 2030:
    - GHG reduction in the transport sector by 15%.
    - Support for the development of low-carbon approaches in the building sector, including public and tourist buildings.
    - GHG reduction by 15% from energy generation and transmission sectors.
    - Promotion of low-carbon industrial development, low-carbon development approaches (including climate-smart agriculture and agritourism), low-carbon development in the waste sector through innovative, climate-friendly technologies.
    - Increase in carbon capture capacity through the forestry sector by 10%.

Law of Georgia on Industrial Emissions of 06/2023 (Georgia, 2023)

OVERVIEW:

Legal framework for regulating industrial emissions to reduce air pollution and align with international environmental standards.

KEY PROVISIONS:

- **Emissions limits:** For key industrial sectors (energy generation, manufacturing, waste management) based on best available technology for reducing CO_2, NO_x and particulate matter.
- **Monitoring and reporting:** Obligations for monitoring, reporting, and verifying emissions data.
- **Permits and compliance**: Introduction of a system of environmental permits for industries and compliance with emissions limits.
- **Penalties and enforcement:** Penalties (including fines and potential suspension of operational permit) for exceeding emissions limits and non-compliance with reporting requirements.
- **Incentives for emissions reduction:** Proposal of financial incentives (tax breaks or subsidies) for adoption of cleaner technologies and practices.

In addition to the NDC, Georgia has adopted Georgia's 2030 Climate Change Strategy (Georgia, 2021a), which serves as a comprehensive mechanism for coordinating and implementing efforts to meet the country's climate change mitigation targets. These documents form the core of Georgia's strategic approach to climate action, emphasising the importance of integrated planning and collaboration at all levels of governance.

Draft Green Hydrogen Strategy (June 2024)

OVERVIEW:

Aims for Georgia to become a leader in the regional GH_2 economy by leveraging its strategic location, renewable energy potential, and hydrogen-related industrial experience. The strategy is planned to be aligned with current energy and climate policies.

REMARK:

The Draft Strategy has been prepared and discussed within the National Hydrogen Committee under the coordination of the Georgian Energy Development Fund, but it has not been yet approved by the Government of Georgia.

KEY PROVISIONS:

- **Phased approach: three phases of implementation**
  - **Phase 1 up to 2030:** Focuses on pilot projects and initial hydrogen production.
  - **Phase 2 (2030-2040):** Scales up hydrogen usage with increased production capacity. Electrolyser capacity could reach up to 800 MW, supported by new wind and solar projects.
  - **Phase 3 (2040-2050):** Targets full market implementation with significant hydrogen consumption. Electrolyser capacity envisioned to grow to 1.5 GW.
- Policies and measures: Envisions a comprehensive governance structure, research initiatives and international cooperation.

Georgia's energy regulations reflect a commitment to transitioning towards a more sustainable energy system, enhancing energy security, and promoting renewable energy development. The framework is designed to facilitate investment and align with European Union standards, positioning Georgia as an emerging player in the renewable energy sector. Nonetheless, it should be noted that ongoing political tensions in the country (between a pro-Russian and a pro-Western orientation) may lead to major changes in state policies with currently unforeseeable consequences.

Annex 3 Key nitrogen fertilisers

Fertilisers	Production process	Specific H_2 requirement (stochiometric)	Global production [MTPA]
Ammonia (NH_3)	Haber-Bosch process $N_2 + 3H_2 \rightarrow 2NH_3$	177 kg H_2/t NH_3	145
Urea	NH_3 and CO_2 from HB fed into a high-pressure reactor (or urea reactor) $2NH_3 + CO_2 \rightarrow CH_4N_2O + H_2O$	100 kg H_2/t urea	234
Ammonium nitrate (AN)	Neutralisation process in which NH_3 (gas) is mixed with HNO_3 (liquid) in neutraliser $NH_3 + HNO_3 \rightarrow NH_4NO_3$	40 kg H_2/t AN	45
Calcium ammonium nitrate (CAN)	Blending of AN (solution) with limestone (calcium carbonate) in a mixing unit and granulation of product $NH_4NO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + NH_4 + CO_2 + H_2O$	50 kg H_2/t CAN	13
Urea ammonium nitrate (UAN)	Mixing solutions of urea and AN and dilution with water	7 kg H_2/t UAN	23
Ammonium sulphate (AS)	By-product of caprolactam production (raw material for nylon) $2NH_3 + H_2SO_4 \rightarrow (NH_4)2SO_4$	50 kg H_2/t AS	30
Diammonium phosphate (DAP)	Reaction of NH_3 with phosphoric acid and posterior granulation $H_3PO_4 + 2NH_3 \rightarrow (NH_4)2PO_4$	46 kg H_2/t DAP	28
Monoammonium phosphate (MAP)	Reaction of NH_3 with phosphoric acid and posterior granulation $H_3PO_4 + NH_3 \rightarrow NH_4H_2PO_4$	26 kg H_2/t MAP	29

Source: Authors' own compilation, Fichtner (2025). Global annual production in 2022 based on (Statista, 2024) and (Chemanalyst, 2023)

Annex 4 Indicative energy prices for Georgia

Energy source		Price [GEL]	Price [USD]	Unit	Date
Coal	Steam coal	310.6	112.7	/ t	27.10.2024
Crude oil	Not applicable	–	–	–	–
Natural gas	Households	48.6	17.6	/ MWh	2024
	Business	116.1	35.7	/ MWh	2024
Electricity	Universal supplier	min. 150 max. 299	min. 54 max. 108	/ MWh / MWh	2024
	Public service supplier	min. 244 max. 299	min. 88 max. 108	/ MWh / MWh	2024
	Supplier of last resort	min. 292 max. 339	min. 106 max. 123	/ MWh / MWh	2024
	Other non-residential	min. 274 max. 339	min. 99 max. 123	/ MWh / MWh	2024
ETS/CO_2	Not applicable	–	–	–	–

Source: Authors' own compilation, Fichtner (2025) based on: coal (Coal Price, 2024), natural gas (Tbilisi Energy, 2024), electricity (TBS Capital, 2024)

Bibliography

Agenda.ge. (2024). *Georgian Economy Minister: Tbilisi dry port project signals 'great potential' for Middle Corridor route.* Retrieved November 2024, from https://agenda.ge/en/news/2024/41100#gsc.tab=0

BMWK. (2024). *International Hydrogen Ramp-Up Programme (H2Uppp).* Retrieved January 2025, from https://www.giz.de/en/downloads/giz-2024-en-BMWK-H2uppp-imageflyer-RampUp.pdf

BMWK. (2025). *International Hydrogen Ramp-up Programme H2Uppp.* Retrieved January 2025, from https://www.bmwk.de/Redaktion/EN/Hydrogen/Foerderung-International-Beispiele/10-international-hydrogen-ramp-up-programme-h2uppp.html

Breakthrough Energy. (2022). *The Breakthrough Energy Network.* Retrieved January 2025, from https://www.breakthroughenergy.org/our-work/

Bressan, L. et al. (2009). *Hydrogen generation for modern refineries.* Retrieved November 2024, from https://www.digitalrefining.com/article/1000044/hydrogen-generation-for-modern-refineries

BSP. (2022). *Introducing Black Sea Petroleum.* Retrieved February 2025, from https://bsp.com.ge/

Chemanalyst. (2023). *Decode the Future of Urea Ammonium Nitrate.* Retrieved January 2025, from https://www.chemanalyst.com/industry-report/urea-ammonium-nitrate-market-2985

Chemkraft. (2024). *Exploring the caustic soda flakes market in Georgia.* Retrieved February 2025, from https://chemkraft.ir/en/caustic-soda-flakes-market-in-georgia/

Chmg. (2024). *Chiaturmanganum Georgia.* Retrieved January 2025, from https://chmg.ge/

Climate Bonds. (2025). *The Climate Bond Standards.* Retrieved January 2025, from https://www.climatebonds.net/standard/the-standard

Coal Price. (2024). *Steam Coal Price.* Retrieved October 2024, from Coal Price: https://coal-price.com/

dun & bradstreet. (2024). *Pharmaceutical and Medicine Manufacturing Companies in Tbilisi, Georgia.* Retrieved February 2025, from https://www.dnb.com/business-directory/company-information.pharmaceutical_and_medicine_manufacturing.ge.na.tbilisi.html

Energy Community. (2024). *Who we are.* Retrieved October 2024, from https://www.energy-community.org/aboutus/whoweare.html

EU NeighboursEast. (2024). *Green for Growth Fund commits new financing to Isbank Georgia to boost green investments.* Retrieved February 2025, from https://euneighbourseast.eu/news/latest-news/green-for-growth-fund-commits-new-financing-to-isbank-georgia-to-boost-green-investments/

European Investment Bank. (2025). *Green Hydrogen Fund.* Retrieved January 2025, from https://www.eib.org/en/products/mandates-partnerships/donor-partnerships/trust-funds/green-hydrogen-fund

European Union. (2025). *Clean Hydrogen Partnership.* Retrieved January 2025, from European Partnership for Hydrogen Technologies: https://www.clean-hydrogen.europa.eu/index_en

Exchange-Rates.org. (2024). *Trusted Currency Converter For Accurate Exchange Rates.* Retrieved September 2024, from https://www.exchange-rates.org/

Fuel Cells and Hydrogen Observatory. (2021). *Chapter 2 - 2021 Hydrogen supply and demand.* Retrieved January 2025, from https://observatory.clean-hydrogen.europa.eu/sites/default/files/2023-05/Chapter-2-Hydrogen-Supply-and-Demand-2021.pdf

Georgia. (2019a). *Law of Georgia on Energy and Water Supply (no. 5646-RS).* Retrieved October 2024, from https://gnerc.org/files/Legal%20Acts%20in%20english/Energy%20Law%20-%20English.pdf

Georgia. (2019b). *Law of Georgia on Promoting the Generation and Consumption of Energy from Renewable Sources (No. 5262-RS).* Retrieved October 2024, from https://ppp.gov.ge/app/uploads/2022/07/law-on-ON-PROMOTING-THE-GENERATION-AND-CONSUMPTION-OF-ENERGY-FROM-RENEWABLE-SOURCES.pdf

Georgia. (2020). *Law of Georgia on Energy Efficiency.* Retrieved October 2024, from https://matsne.gov.ge/en/document/download/4873938/0/en/pdf

Georgia. (2021a). *Georgia's 2030 Climate Change Strategy (Mitigation).* Retrieved October 2024, from https://faolex.fao.org/docs/pdf/geo209870.pdf

Georgia. (2021b). *Georgia's Updated Nationally Determined Contribution (NDC).* Retrieved October 2024, from https://unfccc.int/sites/default/files/NDC/2022-06/NDC%20Georgia_ENG%20WEB-approved.pdf

Georgia. (2023). *Law of Georgia on Industrial Emissions.* Retrieved November 2024, from https://matsne.gov.ge/en/document/view/5845429?publication=1

Georgia Today. (2015). *LafargeHolcim and Georgian Company to Develop Concrete Market.* Retrieved January 2025, from http://gtarchive.georgiatoday.ge/news/1489/Lafarge Holcim-and-Georgian-Company-to-Develop-Concrete-Market

Georgian Oil and Gas Corporation. (2023). *Georgia starts producing green hydrogen.* Retrieved January 2025, from https://www.gogc.ge/en/press-article/georgia-starts-producing-green-hydrogen-/29

geostat. (2025). *Agriculture and Food Security / Food Security / Exports and Imports of Food.* Retrieved February 2025, from https://www.geostat.ge/en/modules/categories/297/food-security

GeoSteel. (2024). *geosteel - home.* Retrieved January 2025, from https://geosteel.com.ge/

GGF. (2025). *Green For Growth Fund - About the Fund.* Retrieved Febraury 2025, from https://www.ggf.lu/about-green-for-growth-fund

Glass International. (2023). *Sisecam completes €20 million glass investment in Georgia.* Retrieved January 2025, from https://www.glass-international.com/news/sisecam-completes-eur20-million-glass-investment-in-georgia

GM Pharma. (2024). *GM Pharma - manufacturing site.* Retrieved January 2025, from https://gmpharma.com/manufacturing-site

Green Climate Fund. (2025). *About GCF.* Retrieved January 2025, from https://www.greenclimate.fund/about

H2Global Stiftung. (2025). *Shaping the global energy transition.* Retrieved January 2025, from https://www.h2-global.org/

HeidelbergCement. (2025). *Plants / HeidelbergCement Georgia Ltd.* Retrieved January 2025, from https://www.heidelberg-cement.ge/en/plants-and-companies.html

HydrogenOne. (2025). *Investing in clean hydrogen for a climate-positive impact.* Retrieved January 2025, from https://hydrogenonecapitalgrowthplc.com/

ICMA. (2025). *Green Bond Principles (GBP).* Retrieved January 2025, from https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/

IEA. (2020). *Sustainable Bioenergy for Georgia: A Roadmap.* Retrieved February 2025, from https://iea.blob.core.windows.net/assets/5ec84fa6-e6fe-40ce-b1b0-661efa84f99c/Sustainable_Bioenergy_for_Georgia_A_Roadmap.pdf

IEA. (2024a). *Georgia.* Retrieved October 2024, from Energy system of Georgia: https://www.iea.org/countries/georgia

IEA. (2024b). *Global Hydrogen Review 2024.* Retrieved November 2024, from https://iea.blob.core.windows.net/assets/89c1e382-dc59-46ca-aa47-9f7d41531ab5/GlobalHydrogenReview2024.pdf

IFA. (2024). *IFASTAT.* Retrieved November 2024, from Consumption: https://www.ifastat.org/databases/plant-nutrition

IFC. (2024). *IFC commits new financing to Isbank Georgia to boost access to finance for SMEs.* Retrieved February 2025, from https://www.ifc.org/en/pressroom/2024/ifc-commits-new-financing-to-isbank-georgia-to-boost-access-to-finance-for-smes

IRENA. (2021). *Innovation Outlook: Renewable Methanol.* Retrieved November 2024, from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jan/IRENA_Innovation_Renewable_Methanol_2021.pdf

JamNews. (2024). *Georgian manganese mines and ferroalloy plant halt operations.* Retrieved February 2025, from https://jam-news.net/georgias-manganese-mines-and-ferroalloy-plant-halt-operations/

KfW. (2024). *New KfW-AFD-EU cooperation for green transition in Georgia.* Retrieved February 2025, from https://www.kfw.de/About-KfW/Newsroom/Themen-kompakt/Europa/#:~:text=It%20is%20designed%20as%20a,and%20more%20with%20EU%20legislation.

KfW. (2025). *Welcome to the PtX Platform of KfW Banking Group.* Retrieved January 2025, from https://www.kfw-entwicklungsbank.de/Our-topics/PtX/PtX-platform/

Methanol Institute. (2024). *Methanol Price and Supply/Demand.* Retrieved November 2024, from Methanol Institute: https://www.methanol.org/methanol-price-supply-demand/

MIGA. (2025). *World Bank Group / Guarantees MIGA.* Retrieved January 2025, from https://www.miga.org/history

Ministry of Economy and Sustainable Development of Georgia. (2023). *Integrated National Energy and Climate Plan of Georgia.* Retrieved February 2025, from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiB-npL6zIyNAxUi0AIHHTMMKKoQFnoECBUQA-Q&url=https%3A%2F%2Fwww.energy-community.org%2Fdam%2Fjcr%3A4dfd3e00-78c0-47a8-a2d9-01ec62459010%2FNational__Energy_and_Climate_Plan_of_Georgia_(DRAFT)%2520(2).pdf&usg=AOvVaw2F-cJ_tnuyXyUwtW-2yH9Tk&opi=89978449

Ministry of Economy and Sustainable Development of Georgia. (2024). *Hydrogen in Georgia.* Retrieved February 2025, from https://secca.eu/wp-content/uploads/2024/05/5-Georgia-ENG.pdf

National Statistics of Georgia. (2023). *Energy Balance of Georgia 2022.* Retrieved October 2024, from https://www.geostat.ge/media/59320/Publication-Energy-Balance-of-Georgia_2022.pdf

ODA. (2025). *Products.* Retrieved February 2025, from https://www.greenville.ge/products

OEC. (2024). *Georgia.* Retrieved October 2024, from The best place to explore trade data: https://oec.world/en/profile/country/geo

OEC. (2025). *Float glass in Georgia.* Retrieved February 2025, from https://oec.world/en/profile/bilateral-product/float-glass/reporter/geo

OpenStreetMap. (2024). *Georgia.* Retrieved October 2024, from Open Street Map: https://download.geofabrik.de/

PtX Development Fund. (2025). *Guidelines and Criteria.* Retrieved January 2025, from https://www.ptx-fund.com/guidelines-criteria

PtX Hub. (2025). *H2Uppp extends Call for Proposals for PtX Projects.* Retrieved January 2025, from https://ptx-hub.org/h2uppp-extends-call-for-proposals-for-ptx-projects/

RMG. (2022). *Rich Metal Group RMG.* Retrieved February 2025, from Company Profile: https://greenalt.org/app/uploads/2022/04/RMG_Eng_2022.pdf

Rustavi Azot. (2024). *About Us - The design capacity of the prop-duction.* Retrieved January 2025, from https://rustaviazot.ge/about/who_are_we

RustaviSteel. (2024). Retrieved January 2025, from https://www.rustavisteel.ge/en/about-us/

Semiconductor Digest. (2018). *EUV lithography adds to increasing hydrogen demand at leading-edge fabs.* Retrieved January 2025, from https://sst.semiconductor-digest.com/2018/03/euv-lithography-adds-to-increasing-hydrogen-demand-at-leading-edge-fabs/?utm_source=chatgpt.com#

Smith, C. (2019). *Current and future role of Haber–Bosch ammonia in a carbon-free energy landscape.* Retrieved February 2025, from Royal Society of Chemistry: https://pubs.rsc.org/en/content/articlehtml/2020/ee/c9ee02873k

Statista. (2024). *Chemical industry worldwide - statistics and facts.* Retrieved January 2025, from https://www.statista.com/topics/6213/chemical-industry-worldwide/

Tbilisi Energy. (2024). *Tariffs for natural gas consumption for household customers / non-household customers.* Retrieved October 2024, from https://te.ge/en/22/static/my-business-tariff.html

TBS Capital. (2024). *Electricity Market 2023 Overview.* Retrieved November 2024, from https://tbccapital.ge/static/file/202401222607-tbc-capital-electricity-market-2023-overview-full-report-eng.pdf

Trans Logistic. (2024). *Oil Refinery in Georgia.* Retrieved November 2024, from https://www.translogisticllc.com/oil/refinery

UFK-Garantien.de. (2025). *Untied Load Guarantees at a glance.* Retrieved January 2025, from https://www.ufk-garantien.de/en/products/guarantees/for-untied-loan-guarantees/untied-loan-guarantees.html

Vaziscremli. (2025). *The oil production.* Retrieved February 2025, from https://vaziscremli.com/

Wasserstoff Kompass. (2022). *Wasserstoff im Stahlsektor - Factsheet.* Retrieved January 2025, from https://www.wasserstoff-kompass.de/fileadmin/user_upload/img/news-und-media/dokumente/Fact_sheet_Stahl.pdf

WITS. (2024a). *Georgia Mineral or chemical fertilizers with nitrogen, exports in 2023.* Retrieved November 2024, from https://wits.worldbank.org/trade/comtrade/en/country/GEO/year/2023/tradeflow/Exports/partner/WLD/product/310520

WITS. (2024b). *Georgia Methanol (methyl alcohol) imports in 2023.* Retrieved November 2024, from https://wits.worldbank.org/trade/comtrade/en/country/GEO/year/2023/tradeflow/Imports/partner/ALL/product/290511

WITS. (2025a). *Gerogia Sodium hydroxide in aqueous solution (soda lye) imports by country in 2022.* Retrieved February 2025, from https://wits.worldbank.org/trade/comtrade/en/country/GEO/year/2022/tradeflow/Imports/partner/ALL/product/281512

WITS. (2025b). *Georgia Hydrogen peroxide presented as a medicament - imports by country in 2023.* Retrieved January 2025, from https://wits.worldbank.org/trade/comtrade/en/country/GEO/year/2023/tradeflow/Imports/partner/ALL/nomen/h5/product/300490

World Bank. (2024). *Georgia.* Retrieved November 2024, from https://data.worldbank.org/country/georgia

World Bank Group. (2023). *World Bank proposes 10 GW clean hydrogen initiative to boost adoption of low-carbon energy.* Retrieved January 2025, from https://www.worldbank.org/en/news/press-release/2023/11/17/world-bank-proposes-10-gw-clean-hydrogen-initiative-to-boost-adoption-of-low-carbon-energy

World Steel Association. (2024). *Total production of crude steel.* Retrieved November 2024, from https://worldsteel.org/data/annual-production-steel-data/?ind=P1_crude_steel_total_pub/CHN/IND

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Project Development Programme (PDP)
Köthener Str. 2–3
10963 Berlin, Germany
T +49 30 – 40 81 90 – 219/285
F +49 30 – 40 81 90 – 109

E pep@giz.de
I www.giz.de/en

Programme/project description
Project Development Programme (PDP)

Authors
Fichtner GmbH & Co. KG
Stuttgart, Germany

Responsible/Editor
Anja Wucke, Sonia Rueda and Levan Tsulaia

Design/Layout
DITHO Design GmbH, Cologne

On behalf of
German Energy Solutions Initiative of the
German Federal Ministry for Economic Affairs and
Energy (BMWE), Berlin
Department VB4 German Energy Solutions Initiative, Market Entry
Programme Berlin

Berlin, 2025

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Sitz der Gesellschaft / Registered offices
Bonn und Eschborn / Bonn and Eschborn

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Deutschland / Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Deutschland / Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de/en