HAEE HELLENIC ASSOCIATION *for* ENERGY ECONOMICS

Greek Energy Market Report 2025

Country Profile
Energy Transition
Electricity
RES & Storage
Natural Gas
Oil & Refining
Investments

Special Focus: **Energy Demand**

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| Greek Energy Market Report |

2025

HAEE

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| Greek Energy Market Report |

HAEE 2025

Hellenic Association for Energy Economics

Hellenic Association for Energy Economics (HAEE) brings together all those who study, debate and promote the knowledge of energy, environment and economy in our country. HAEE is the Greek affiliate of the International Association for Energy Economics (IAEE), which is a non-profit research and professional organization acting as an interdisciplinary forum for the exchange of ideas and experiences among energy experts.

HAEE was founded in 2015 in Greece and has a global orientation welcoming the participation of researchers and practitioners from around the world interested in energy, environmental and economic related subjects. It acts as an independent consulting body for national and international organizations to whom it provides a broad contribution on issues related to energy, economics, policymaking and theory.

Through meetings and joint initiatives HAEE also provides a means of professional communication and exchange within its members and the authorities defining the Greek energy policy. HAEE organizes meetings amongst experts and specialists interested in networking - organizes conferences and seminars on both national and international levels - promotes training initiatives in the energy and economic sector - provides researches, studies and other services for its members.

HAEE promotes the understanding of energy, environment and economy related topics within universities and encourages the participation in the Association's activities of young students who are invited to seminars and conferences and can make use of the IAEE library for their academic works. HAEE is financially supported by member dues, contributions for research activities carried out for companies and bodies involved in the energy field, and by the sale of conference proceedings as well as conference fees and other initiatives.

National Bank of Greece

National Bank of Greece stands out for its unique history and its dynamic future.

In its 183 years of operation, NBG has expanded, providing a wide range of financial services including mainly retail, corporate and investment banking, specialized asset solutions, transactional banking, leasing, factoring, brokerage, asset management, real estate management and insurance intermediation services.

Additionally, the Bank consistently invests in enhancing the service experience for its 2.9 million digitally active customers, by continuously enriching its range of products and services through digital channels, thus playing an extinctive role in Digital Banking within the Greek banking market.

NBG plays a pivotal role in the energy transformation as well as the energy security and autonomy of the country, by supporting major infrastructure projects as energy interconnections, production and storage. In the same direction, the Bank also contributes with key initiatives as follows:

- the introduction of pioneering solutions to the Greek market such as the Energy Baseload Swap
- the reinforcing of investments in "cleaner" fossil fuels in the energy mix, such as natural gas
- the long-term financial support of Renewable Energy Sources.

As the "Bank of Energy", NBG is a frontline player in Greece's drive for economic development and is committed to backing the country's potential as an energy hub for the European continent.

Foreword

Prof. Dr. Spiros Papaefthimiou
Chairman HAEE

It is my pleasure to welcome you to the Greek Energy Market Report 2025, a flagship publication of the Hellenic Association for Energy Economics (HAEE). Over the past decade, our Association has grown into a premier interdisciplinary forum bringing together academics, industry practitioners, policymakers, financial institutions, and young scholars committed to advancing the nexus of energy, environment, and economics.

This Report arrives at a moment of profound transformation. Greece is emerging from a chapter marked by economic challenges and geopolitical uncertainty, yet it stands today at the vanguard of Europe's energy transition. In 2024, over half of our country's electricity was produced from clean sources—solar, wind, hydro, biomass, and imports of green power—underscoring the success of targeted policy measures, market design reforms, and sustained private investment. Our credit rating was upgraded by Moody's in March 2025, reflecting not only stronger fiscal fundamentals but also international confidence in Greece's strategic pivot toward renewables and energy security.

Delivering a comprehensive, evidence-based overview of these developments is the purpose of this Report. Nine chapters span from a comparative country profile and macroeconomic outlook, through detailed sectoral analyses of electricity, natural gas, oil, and emerging alternative fuels, to investment trends. We have also dedicated a special focus to critical themes including hydrogen, carbon capture and storage, battery storage systems, and the digitalization of our grids. As Chairman of HAEE, I firmly believe that informed debate and robust research are the engines of sound policy, and this Report is intended to serve as an indispensable tool for decision-makers, investors, academics, and students alike.

Our analysis reveals that, for the first time, renewables accounted for over 50 % of electricity generation in 2024, driven by record additions of solar PV and wind capacity, alongside optimized hydro dispatch. Wholesale market prices exhibited a moderation compared with the volatility of 2022–2023, reflecting the maturing of our power exchange and deeper liquidity in intraday trading. On the demand side, electrification accelerated across transport and industry, with electric vehicle registrations growing by 35 % year-on-year and industrial cogeneration achieving new efficiency benchmarks. Yet the data also underscores persistent grid bottlenecks—particularly in the northern interconnection corridor—and a 12 % rate of renewable curtailment during peak injection periods, signaling an urgent need for storage solutions and enhanced grid flexibility.

It is my hope that this Report will inspire constructive dialogue, inform sound investment decisions, and guide effective policymaking. The decisions we make today will shape Greece's energy future for decades to come. Through collaboration, rigorous analysis, and a shared commitment to sustainability and economic prosperity, we can secure a low-carbon, resilient energy system that benefits all Greeks and contributes meaningfully to Europe's broader climate goals.

I invite you to explore the insights contained within and to join HAEE in advancing a prosperous, sustainable energy future for Greece.

Foreword

Prof. Dr. Kostas Andriosopoulos
BoD member, HAEE
Project Coordinator

It is my honor to present the Greek Energy Market Report 2025 on behalf of the Hellenic Association for Energy Economics (HAEE). This edition arrives at a pivotal moment, as the global energy landscape undergoes a paradigm shift driven by the dual imperatives of climate mitigation and energy security.

In Greece, this transition has gathered remarkable momentum: solar photovoltaic capacity has more than doubled over the past two years, onshore and offshore wind installations are advancing rapidly, and pioneering pilot projects in green hydrogen, battery storage, and carbon capture are laying the groundwork for the next phase of our clean-energy evolution. According to our analysis, renewables supplied over 51 percent of Greece's electricity in 2024—an achievement that places us among the European Union's leaders on a per-GDP basis and underscores the effectiveness of recent policy measures and market reforms.

Despite these successes, significant challenges remain. High RES penetration has led to a significant curtailment rate of renewable output during peak injection periods, demonstrating an urgent need for enhanced flexibility solutions and expanded interconnection capacity. On the other hand, our continued reliance on imported natural gas and oil exposes the country to volatile global markets and supply-security risks. These complex dynamics highlight the need for a comprehensive understanding of Greece's evolving energy landscape.

Within these pages, you will find an integrated, data-driven narrative that brings clarity to both Greece's achievements and its remaining hurdles. Sectoral analyses trace the evolution of electricity, natural gas, and oil markets, revealing how LNG imports have supplanted pipeline volumes as the marginal supply source and how industrial cogeneration has set new efficiency records. Our investment chapter documents a near-tripling of green bond issuances for energy projects, while demand-forecasting models project a doubling of peak electricity loads by 2030 under current policy trajectories.

Moreover, I have been privileged to work with an outstanding group of analysts and practitioners whose expertise has shaped every finding in this Report. Their rigorous dedication to excellence ensures that our conclusions are both empirically sound and policy-relevant. I extend my sincere gratitude to our contributors, partners, and sponsors—including the National Bank of Greece and the Hellenic Energy Exchange—whose support has been instrumental in bringing this project to fruition.

Looking ahead, Greece must accelerate permitting processes, deepen regional interconnections, and mobilize financing for next-generation assets to meet our National Energy and Climate Plan targets. Equally vital will be investing in human capital through targeted education and training programs that equip our workforce for a decarbonized economy. By aligning efforts across government, industry, finance, and academia, we can build upon the solid foundation laid over the past decade and steer Greece toward a sustainable, resilient, and prosperous energy future. I trust that the insights contained within this Report will inform sound decision-making, inspire constructive dialogue, and catalyze the collaborations needed to achieve our shared objectives.

Foreword

Mr. Pavlos Mylonas
CEO, National Bank of Greece

National Bank of Greece (NBG) has been supporting the Greek Energy Market Report since its inception 7 years ago, reflecting its aspiration to be at the forefront of energy initiatives in Greece and at the European level, and be viewed as the 'Bank of Energy in Greece'.

Current world development highlights the importance of energy security which has become tightly tied with energy autonomy.

To that end it is fortunate that the EU has actively pursued the green transition over the past several years. Indeed, currently EU produces 71% of its Electricity through clean sources (vs 42% for the US).

However, as EU (and Greece) are in line to achieve their RES targets, new challenges have a risen:

- Increasing RES production has led to negative prices (and non-acceptance of electricity production to the system), which cause investment uncertainty and threaten the viability of both such investments and of the network, with the recent experience in Portugal and Spain being indicative of the consequences of a potential system failure. In fact, EU grid congestion management costs - averaging €4–5 bn annually in recent years - are projected to rise sharply, reaching around €26 bn by 2030.

- The rise of the AI, whose integration into EU industries is a Competitiveness Compass goal, will possibly require re-estimation of the green transition path due to its massive energy needs, otherwise there is the risk and emission goal derailment, especially if AI fails to deliver substantial productivity gains (that can lead to a net emission reduction).

The EU has recognized these challenges and aims to address them, building on the RepowerEU and complementary initiatives (e.g. Clean Industrial Deal) – but time is of the essence. More specifically, grid and storage investments are necessary to accommodate RES overproduction during mid-day, whereas interconnection development and removal of energy market fragmentations can reduce energy prices across the EU. The return of nuclear power investments in the continent can also facilitate grid management, as a reliant balancing energy source. Digitalization of energy infrastructure is also important, as it can help manage the grid more efficiently and allow rapid demand response to energy price changes. Furthermore, gradual hydrogen production scale-up holds the promise of eventually greening energy-intensive industries that are heavily reliant on natural gas.

In this new era, Greece can play a defining role thanks to its RES potential (c.35% higher than EU) and its location as a natural gas entry point towards Europe.

Moreover, if the existence of natural gas reserves in Greece is confirmed, the country could become the backbone of the EU's green transition. If something similar is confirmed regarding the presence of critical raw materials necessary for the green transition (e.g. gallium production is set to begin in 2027 - a metal vital for technological and energy transition), then Greece can help EU achieve strategic energy autonomy against both China and the US, reaping significant economic benefits in the process.

All in all, unlocking this potential will require massive EU-wide investments in grid expansion, storage, interconnectors and hydrogen infrastructure—underscoring member states' determination to mobilize both funding and policy support.

In this evolving energy landscape, NBG remains steadfast in its commitment to leading Greece's energy transformation. Over the past three years, NBG has financed renewable energy (RES) projects exceeding €2 bn, while the Bank's total RES financing portfolio currently stands at approximately €3.1 bn. These projects span a broad spectrum of technologies (e.g., wind farms, photovoltaic, hydroelectric) with a total installed capacity of around 5.5 GW.

One of the most notable financings by the Bank in Greece is the Floating Storage Regasification Unit (FSRU), a project of strategic importance that began operations in 2024. Alongside the Combined Cycle Gas Turbine (CCGT) power plant in Alexandroupolis—expected to be operational by the end of 2025—these projects are set to play a vital role in Greece's transition toward a more secure and sustainable energy system.

NBG also financed the 300 MW wind farm in the Vermio region, a project featuring a long-term offtake agreement exclusively with Amazon. This marks one of the largest corporate Power Purchase Agreement (PPA) deals signed in Greece to date.

Furthermore, NBG recently agreed to finance the construction of Greece's first energy storage project utilizing battery energy storage system (BESS) technology. The 50 MW / 100 MWh facility will connect to the high-voltage grid via an on-site 33/150 kV medium-to-high voltage substation, with completion expected by the end of 2025. Despite its moderate size, this transaction represents a pivotal moment for the Greek energy market, as BESS technology is essential for enabling increased RES integration. By addressing the intermittency challenges of RES, battery storage enhances grid flexibility and stability, supporting applications such as peak shaving, supply-demand balancing, self-consumption optimization, and emergency backup.

Finally, it is worth mentioning NBG's innovative approach through the introduction of a pioneering risk-hedging product: the Energy Baseload Swap (EBS). This financial instrument allows both large and small enterprises to stabilize their energy costs—or revenues, in the case of producers—for up to 10 years through bilateral agreements with NBG. For energy-intensive consumers, EBS offers the opportunity to lock in energy prices over their desired timeframe. For RES producers, it enables fixed-price agreements without the need to secure PPAs with large buyers, thereby reducing investment risk and enhancing access to financing in the post–feed-in tariff era.

The above accomplishments reveal why NBG continues to be the preferred banking partner for energy projects, playing a vital role in building a more sustainable and resilient energy future for Greece and, by extension, Europe.

Coordinator

Prof. Dr. Kostas Andriosopoulos is Af. Professor in Finance and Energy Management and the Director of the HELLENiQ ENERGY Center for Sustainability and Energy @Alba Graduate Business School. Kostas is a member in various professional and academic associations, including President of the Energy Committee of the American Hellenic Chamber of Commerce; Founder, former Chairman and active Member of the BoD of the Hellenic Association for Energy Economics; board member of the Global Gas Center - World Energy Council as a Gas and LNG markets expert; member of the board of the International Association for Energy Economics (IAEE); founding board member of the Financial Engineering and Banking Society. As of August 2018, he is the Country Manager of Akuo Energy in Greece.

Lead Researcher

Dr. Filippos Ioannidis holds a PhD from the Department of Economics at Aristotle University of Thessaloniki, Greece. Filippos is a Certified Energy Trader from the Hellenic Energy Exchange. He holds an MSc in Banking and Finance from the School of Economics, Business Administration and Legal Studies (International Hellenic University, Thessaloniki, Greece). Moreover, Filippos holds an MSc in Economics from School of Economics and Management (Lund University, Sweden). He obtained his bachelor's degree in Economics from the Department of Economics (University of Macedonia, Thessaloniki, Greece). Currently, he is a Research Analyst of the Hellenic Association for Energy Economics.

Research Team

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Vasiliki Gemeni is a Geologist with an MSc in Applied Environmental Geology from the National and Kapodistrian University of Athens. Her main research fields are Carbon Capture Utilisation and Storage, low carbon technologies, sustainable mining, and renewable energy focusing on geothermal energy. She has participated in many European and national research projects and published her work in many scientific journals and conferences.

Research Team

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Eleni Ntemou is a PhD candidate at Aristotle University of Thessaloniki. She is a Research Associate at the Hellenic Association of Energy Economics (HAEE). Eleni obtained her MSc in Computational and Statistical Data Analytics and her bachelors (BSc) in Mathematics and from University of Patras (UoP), Greece.

The authors are grateful to Mr. **Eleftherios Soumpasis** (Relationship Manager / Large Corporate Banking Division - NBG) for his significant contribution towards the completion of this report.

Executive Summary

The Greek Energy Market Report 2025, is a valuable tool for energy professionals, legislators, researchers, academics, policymakers, students, and others interested in the developments, advances, and challenges regarding the Greek energy market. It is also an asset for market participants and international or domestic companies, willing to invest in the Greek energy sector.

The Report consists of nine distinct chapters that each one includes the most recent developments in the energy sector:

- **Chapter 1** examines the Country Profile of Greece by analyzing and providing its key demographic, macroeconomic, and key energy market statistics, compared with those of the EU, coupled with an analysis of the inflation effects.

- **Chapter 2** discusses the evolution of the energy market up to 2023, along with anticipations for the near and far future relating to the Energy Transition. Further boosts are expected with the expansion of offshore wind technologies in the upcoming years.

- **Chapter 3** analyzes the Electricity sector both in the EU and Greece, outlining various issues concerning prices, generation, demand, capacities, imports, exports, and RES share. The remarkable variations in the wholesale electricity market prices are highlighted as well as the biggest electricity producers in Greece. Also, the electricity generation of the Non-Interconnected Islands is included.

- **Chapter 4** focuses on the considerable contribution of RES to the Greek energy system, by providing the most up-to-date information on license procedure, market analysis, electricity special purchase prices, "green" PPA insights and updates regarding the RES penetration compared to EU.

- **Chapter 5** explores the Natural Gas market for both EU and Greece, regarding the continuing efforts to reduce their dependence on Russian gas and diversify the gas supply. LNG's key position in the supply side continues to stay strong both for EU and Greece.

- **Chapter 6** focuses on the Oil and Refining market, with an analysis on the European oil trade, especially the Russian exports. Also, the outlook of oil demand is showcased.

- **Chapter 7** addresses current energy investment trends in Greece and internationally. This chapter covers overall energy investments, and specifically clean energy technologies. There is also a comprehensive overview of the various EU support mechanisms and funds.

- **Chapter 8** puts a special focus on the energy demand in the world, EU and Greece, analysing the different sectors that will drive the demand in the future, such as AI and datacenters in general.

The energy sector of Greece in 2025 is undergoing significant transformations, spurred by strategic initiatives aimed at sustainability, diversification, and resilience. This transformation is intricately woven with global energy trends, particularly the transition away from fossil fuels towards cleaner, renewable energy sources, striving for stability after the previous years.

Executive Summary

While the Greek economy has gradually improved—with declining unemployment rates and stabilized inflation—the country still faces challenges such as regional disparities in labor participation and the need for enhanced educational outcomes. In parallel, Greece's fiscal performance has experienced positive momentum, with improvements noted in debt reduction, credit ratings, and budget overperformance, largely attributed to strengthened fiscal policies and initiatives to combat tax evasion.

In parallel to the economic recovery, Greece's energy transition is unfolding rapidly. The report shows how the country has steadily increased its share of clean energy—reaching 51% by 2024—through significant investments in renewable energy sources (RES). Solar photovoltaic (PV) installations, in particular, have doubled over recent years and now account for over half of Greece's renewable capacity, while onshore wind technologies remain a close second.

This expansion is supported by favorable government policies, a robust framework for market participation, and supportive financial instruments, including targeted incentives and special purchase prices that have helped to drive down capture costs. Despite this progress, Greece still relies heavily on imported energy, especially natural gas and oil, making it vulnerable to global price fluctuations and underscoring the urgency for developing domestic energy resources and storage technologies.

Electricity market dynamics have also undergone a marked transformation. The report details a significant drop in overall electricity demand post-COVID-19, with Greece witnessing a 15% decline in demand by 2024. At the same time, domestic generation has grown more efficient and aligned with decarbonization goals. Although Greece continues to depend on conventional fuels such as lignite and natural gas, there is a clear trend towards reducing these sources, as evidenced by the decreasing share of coal in the generation mix.

The market is further characterized by pronounced "duck curve" phenomena resulting from high solar penetration, which has led to periods of negative wholesale prices and underscored the critical need for improved energy storage solutions. The evolution of interconnection capacities—with plans to significantly expand both import and export capabilities by 2035—illustrates Greece's strategic move to bolster regional energy trade and enhance grid resilience.

In addition to domestic market adjustments, the report situates Greece within the broader European energy transition, where varied approaches to nuclear power, carbon capture, and renewable integration are observed. The advancements in renewable capacity and the surge in battery energy storage system (BESS) licensing play a pivotal role in bolstering Greece's decarbonization efforts. As the nation continues to refine its energy mix, future projections indicate that renewable energy and storage technologies will be central to achieving net-zero targets by mid-century.

The report thus provides a forward-looking perspective by emphasizing the potential for new technological deployments, improvements in grid management, and policy frameworks that align closely with European decarbonization strategies. Overall, the Greek Energy Market Report 2025 serves as a critical resource for investors, policymakers, and industry stakeholders by detailing a transformative period marked by resilient economic recovery, accelerating renewable energy investments, and a dynamic transition toward a low-carbon, sustainable energy future.

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"Everything that an investor needs to know about the Greek Energy Market in 2025"

1. Country Profile

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Highlights

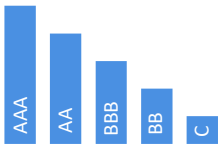
Greece experienced **strong economic growth in 2024**, driven by consumption, investment, and exports

Unemployment is falling, yet Greece still has the EU's **second-highest rate at 9.4%,** after Spain

Greece is on a path of **macroeconomic stability**, though external risks may hinder progress

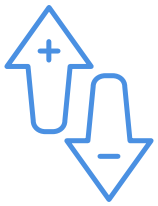
Inflation rate stood at 3% in 2024, slightly above the EU average, reflects additional pressures to consumers

Moody's recent upgrade to investment grade, signals **renewed investor trust** and improved market access



In 2023, Greece showed the **greatest decrease in FEC** among the EU27, compared to 2005

Declines in both PEC and FEC in 2023 improve the outlook for efficiency, decarbonization, and NECP targets



Greece's GHG emissions per capita **fell at 6.58 tCO_2e** thanks to reduced lignite use and growing penetration of renewable energy

More **frequent extreme weather events** pose threat to Greece's infrastructure and energy security

Overview

Greece continues to demonstrate solid economic performance in 2024, with GDP growth outpacing the eurozone average for the fourth consecutive year. This sustained momentum reflects improved macroeconomic fundamentals, bolstered by growing investor confidence and positive credit assessments. A significant milestone was reached this year with Moody's upgrade of Greece's credit rating for the first time in over a decade—marking a turning point that enhances Greece's credibility in international markets and facilitates easier access to capital.

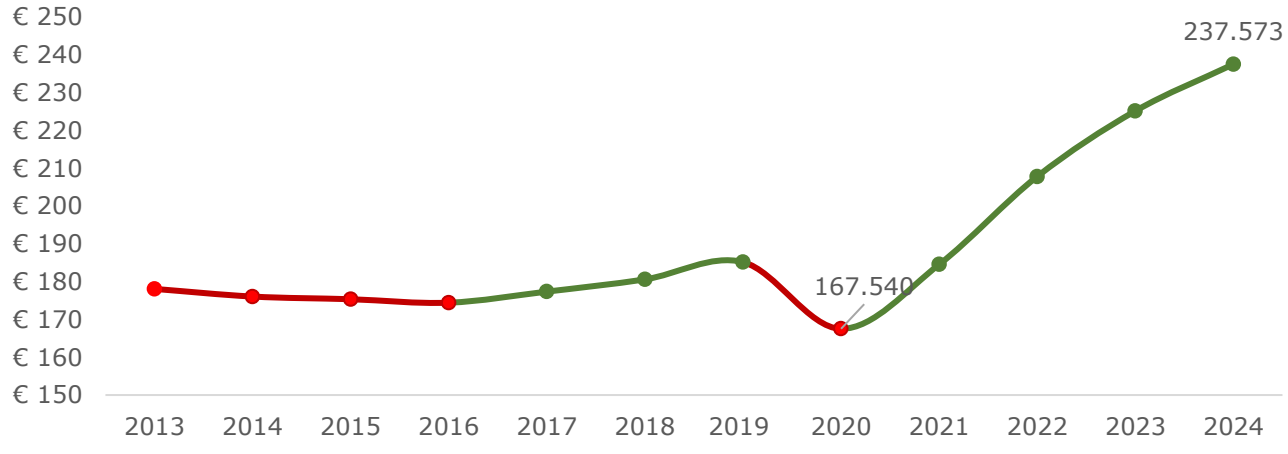
Labour market conditions have shown continued improvement, with unemployment figures steadily falling. However, structural challenges linger. Labour force participation remains comparatively low, and there are pronounced disparities in economic activity between regions, indicating uneven progress in inclusive growth. These issues underline the need for targeted policies to enhance workforce engagement and regional cohesion.

Inflation dynamics present a mixed picture. While energy-related inflation has moderated, underlying price pressures persist, particularly in core consumer goods and services. These ongoing pressures are contributing to broader concerns about the cost of living, highlighting the need for balanced fiscal and social policies to protect vulnerable groups.

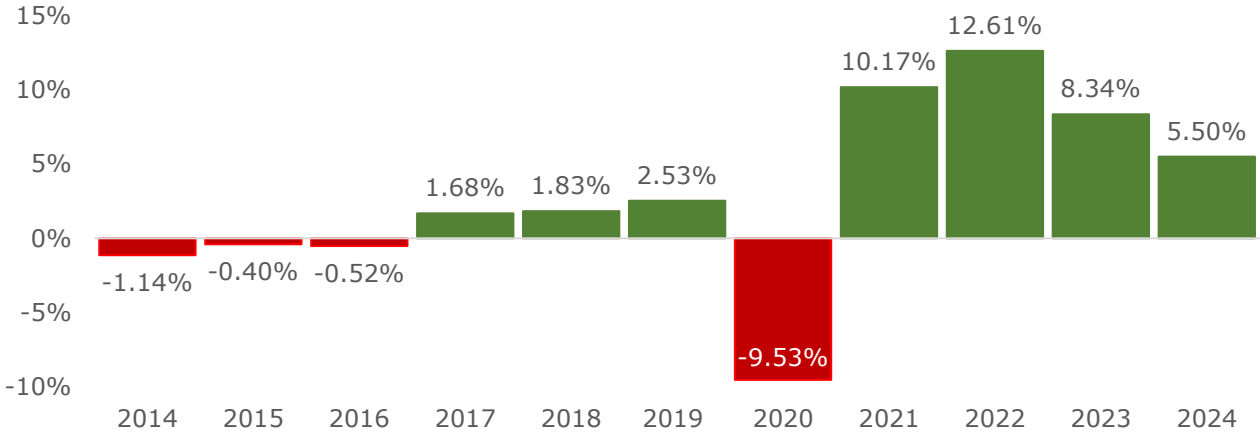
On the

The Greek economy grew at a satisfactory pace in 2024, significantly higher than that of the eurozone for the fourth consecutive year

GDP in Current Prices in Greece (billion €), [2013-2024]



Year on Year Change in GDP in Greece (%), [2014-2024]



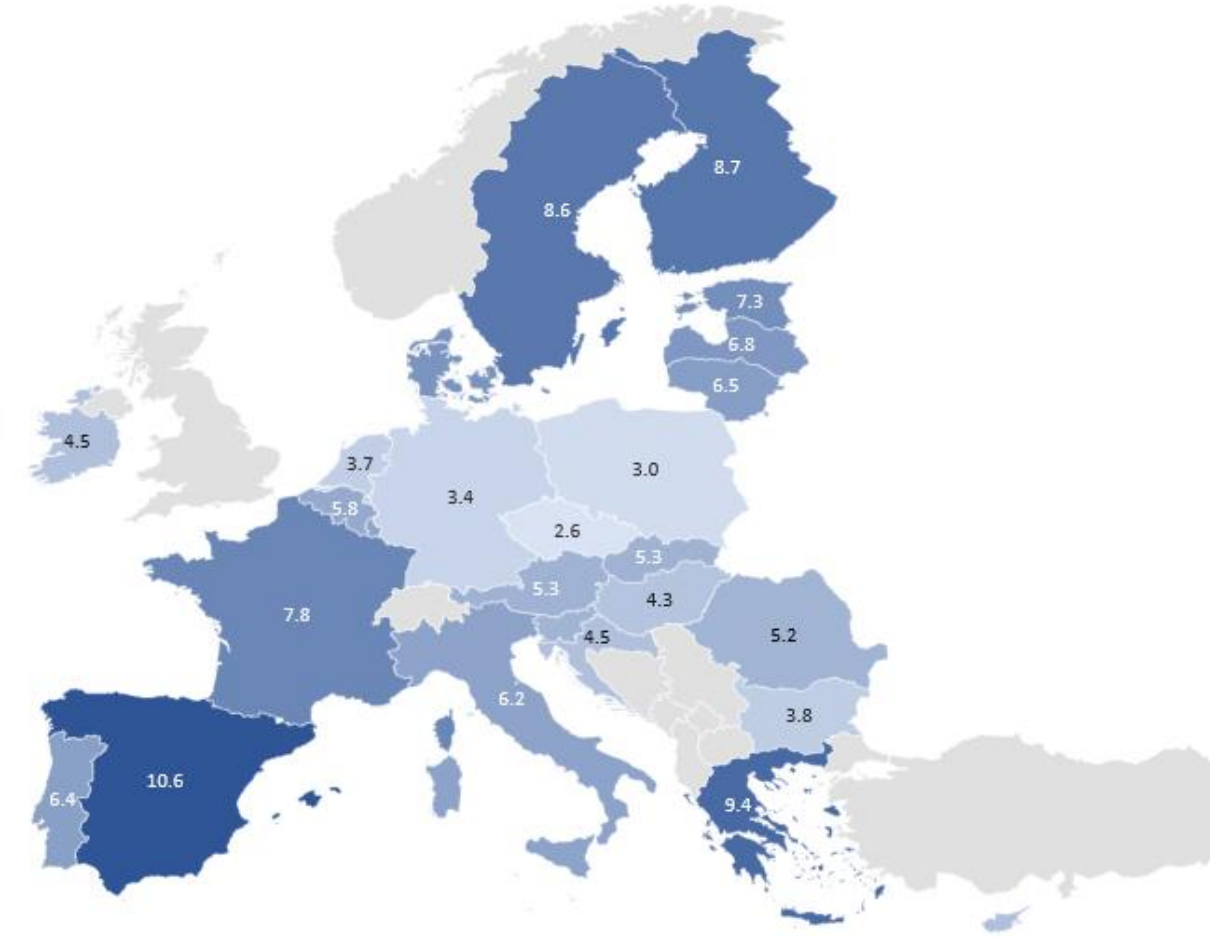
Source: ELSTAT, HAEE analysis

Highlights

- GDP reached €237.6 bn in 2024, indicating ongoing growth and a positive environment for energy investments, particularly in renewables and infrastructure.
- Economic growth was mainly driven by private consumption, investments, and exports of services, contributing positively to the expansion of the economy.
- The annual real GDP growth rate reached 2.3% in 2024 (the same as in 2023), approximately 2.5 times higher than the corresponding growth rate of the eurozone.
- This growth period underpins increased energy consumption and greater investor confidence, key for planning supply, grid upgrades, and green transition policies.
- The US administration's high tariffs could indirectly impact Greece by slowing global trade, reducing demand for Greek exports, and discouraging investment.

Unemployment in Greece keeps decreasing, yet challenges such as low labour force participation and regional disparities persist

Unemployment Rate in EU-27 (%), [2024]



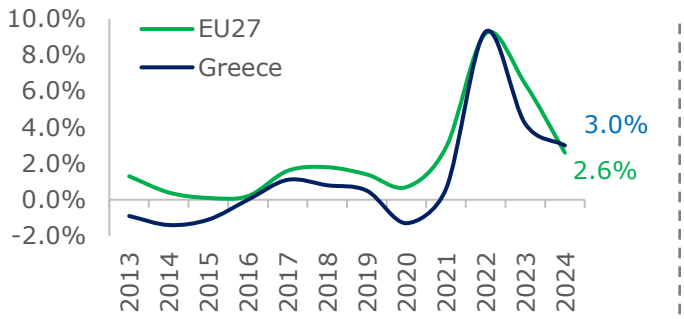
Highlights

Source: Eurostat, HAEE analysis

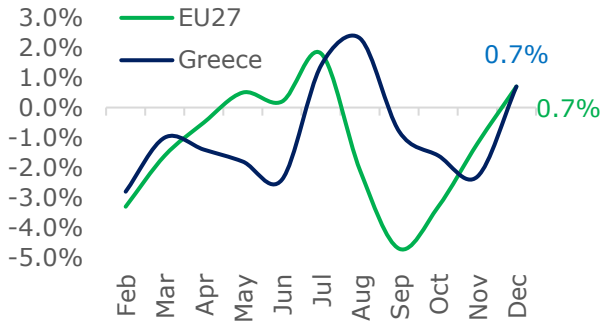
- The unemployment rate in Greece continued its downward trend reaching 9.4% in December 2024, marking single-digit levels for the first time since 2009.
- Although unemployment has declined, Greece remains among the EU27 countries with the highest rates, ranking second after Spain at 10.6%.
- Women's participation in the workforce stands at 52.7% and youth participation reaches only 43.4%, lower than the 44.9% a year earlier.
- In Q3 of 2024, the region of Eastern Macedonia and Thrace recorded the highest unemployment rate (12.7%) and South Aegean (3.1%) the lowest.
- Skill mismatches, low education outcomes in basic skills and lack of proper incentives still discourage people from looking for work and restrain innovation.

Despite the decrease in energy inflation, core inflation pressures persist, suggesting broader cost-of-living challenges

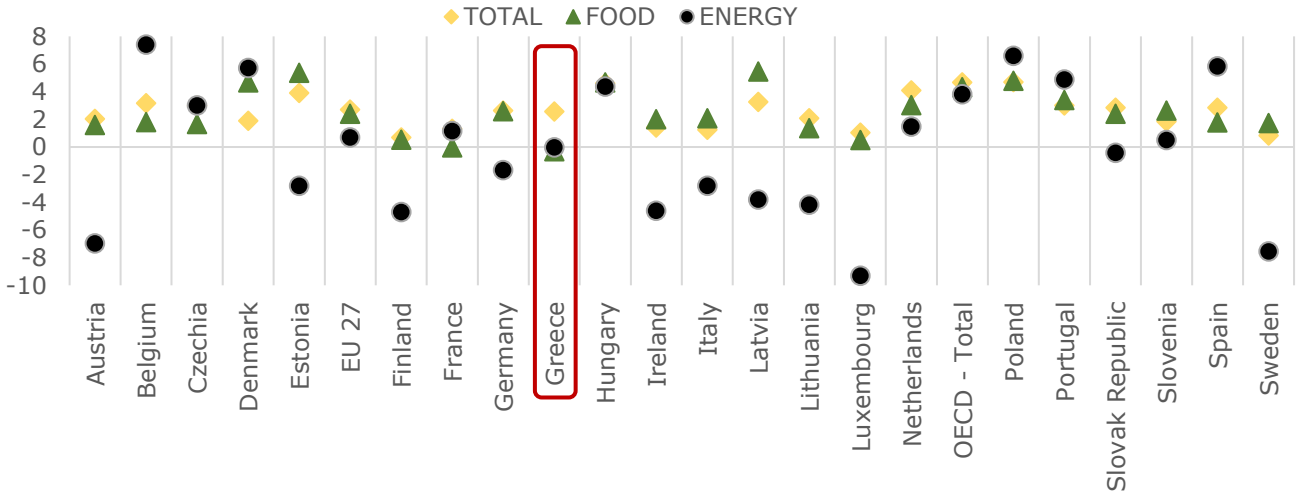
HICP - Inflation Rate (%) in EU27 and Greece (annual average rate of change), [2013-2024]



HICP - Energy (annual %), [Feb 2024-Dec 2024]



Inflation (CPI) Total / Food / Energy, Annual Growth Rate (%), [Dec 2024]



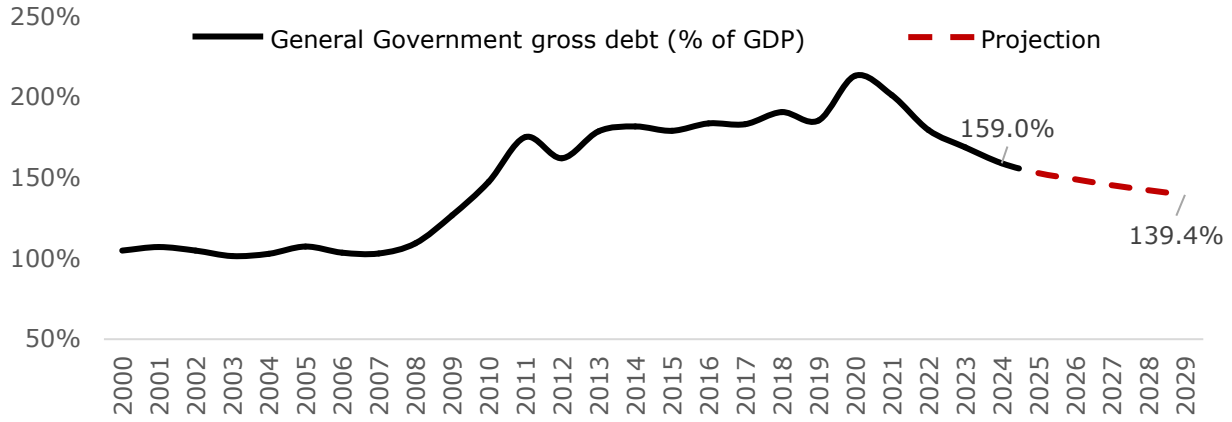
Source: Eurostat, OECD, HAEE analysis

Highlights

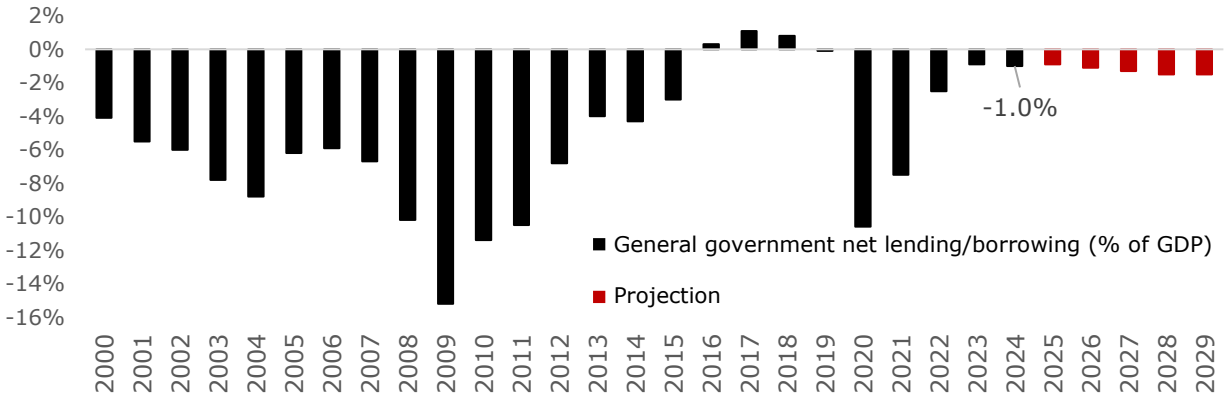
- Greece's inflation rate stood at 3.0% in 2024 slightly higher that the EU27 average at 2.6%.
- The ongoing decrease is mainly attributed to a significant drop in food prices, which led the food index to shift downwards.
- However, significant price increases were recorded in rents (8.5%), electricity (7.6%), natural gas (8.7%) and passenger transport by air (47.7%).
- In December 2024, both EU27 and Greece recorded a 0.7% annual change in the HICP - Energy index, indicating a shift from negative values in previous months.
- While the country's inflation is easing, risks remain from energy volatility, persistent core pressures and global economic uncertainty, calling for continued policy caution.

Greece demonstrates a clear trajectory toward macroeconomic stability, however, vulnerability to external risks could slow progress

Greek General Government Gross Debt (% of GDP), [2000-2028]



Greek General Government Net Lending/Borrowing (% of GDP), [2000 - 2029]



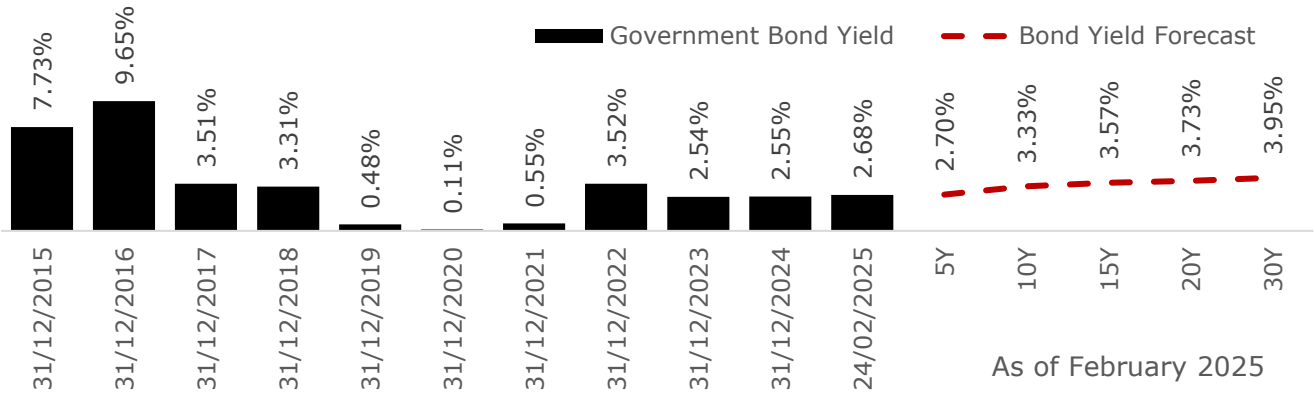
Source: IMF, HAEE analysis

Highlights

- Greece's general government gross debt decline since 2020, highlights its gradual improvement in debt sustainability and its ability to manage fiscal pressures.
- Although still in deficit, the ongoing fiscal consolidation reflects progress in reducing borrowing needs.
- Non-performing loans in banking hit their lowest since 2001, while the "fifth pole" emerged with smaller banks' capital increases and the Pankritia-Attica Banks merger.
- While the forecasted improvement in Greece's fiscal and debt metrics is promising, global economic challenges, (e.g. trade tensions) could pose risks.
- Monitoring and adjusting fiscal policies will be key to maintaining the trajectory of debt reduction and fiscal stabilization.

For the first time in over a decade, Moody's upgrade to investment grade boosts investor confidence and market access for Greece

Greece Government 5 Year Note Bond Yield and Projection (%), [2015-2025]



Greece Credit Ratings, [2009 - 2024]

	2009	...	2019	2020	2021	2022	2023	2024	2025
Moody's	A2		B1	Ba3	Ba3	Ba3	Ba1	Baa2	Baa3
Standard & Poor's	A- / BBB+		BB-	BB-	BB	BB+	BBB-	BBB-	-
Fitch Ratings	BBB+		BB-	BB	BB	BB	BBB-	BB+	-

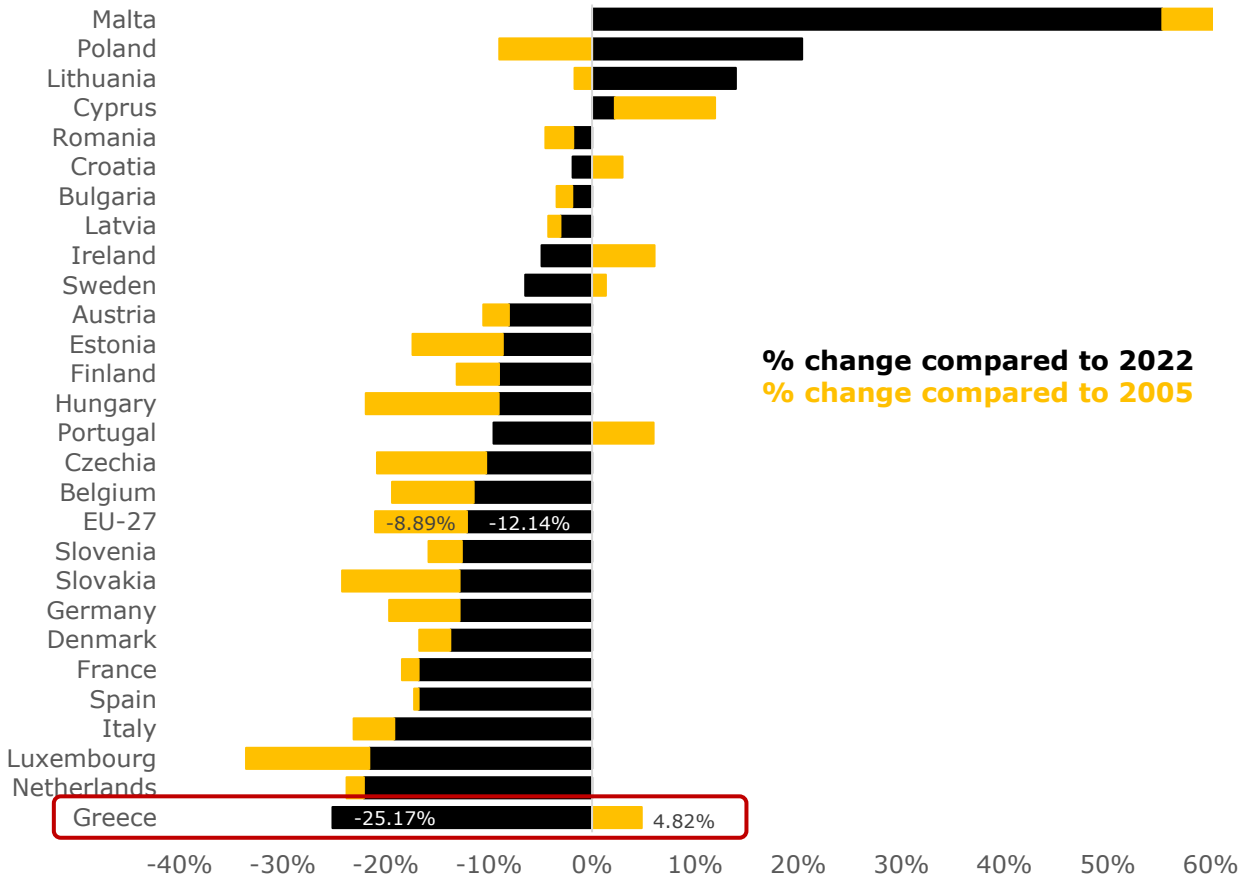
Source: World Government Bonds, HAEE analysis

Highlights

- Yields stabilization in 2023–2025 indicates a return to stability and renewed market trust in Greece's medium-term economic prospects.
- The bond yield forecast suggests continued fiscal discipline and credible policy implementation, reinforcing Greece's economic recovery path.
- Moody's upgrade in March 2025 highlighted the rapid reduction of debt, the increase in revenues, the budget's overperformance, and the decline in non-performing loans.
- This upgrade is expected to increase the investment appeal, reduce borrowing costs for the government and benefit both public and private sector financial conditions.
- This reflects a clear improvement in the country's fiscal structure and marks its shift from post-crisis vulnerability to long-term macroeconomic resilience.

EU-wide final energy consumption levels dropped by 3% in 2023 compared to 2022, contributing to lower environmental pressures

Final Energy Consumption in EU27 Member States
(% change compared to 2005 and 2023), [2023]



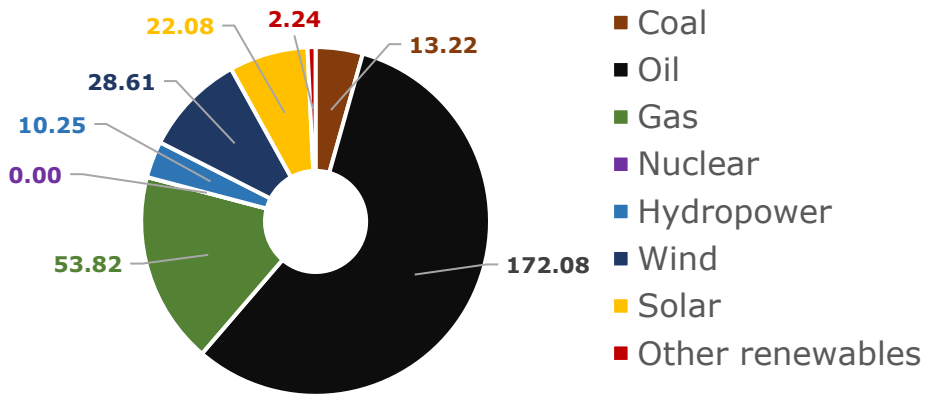
Source: EEA, HAEE analysis

Highlights

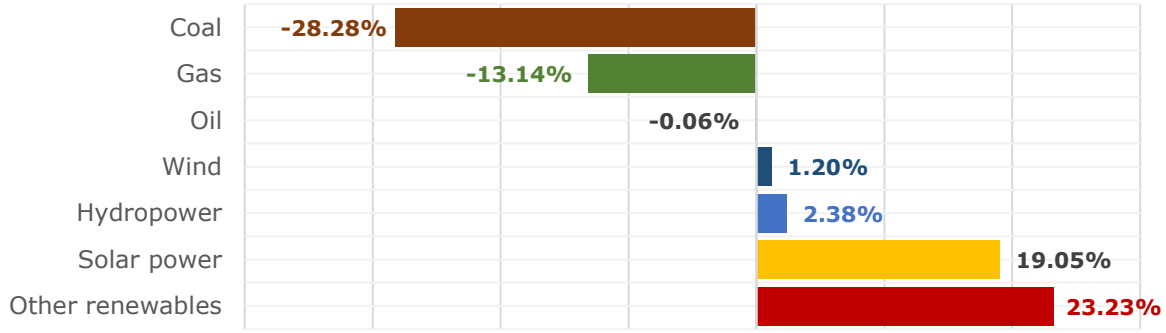
- 23 Member States decreased their FEC in 2023. Greece showed the greatest decrease once more, followed by the Netherlands and Luxembourg.
- Only 4 Member States saw their FEC increase, with the highest being Malta at 46.08%.
- The highest rise in FEC in 2023 compared to 2022 was recorded in Cyprus, with an increase of 9.71%.
- On the other hand, Hungary recorded the smallest decline in Final Energy Consumption (FEC) in 2023 compared to 2022, with a decrease of 12.89%.
- Figures show 3 consecutive years of promising FEC reductions at a rate that would need to be sustained through the end of this decade for the 2030 targets to be met.

Declining fossil fuels and growing renewable energy sources shape the trend for Greece's primary energy consumption

Primary Energy Consumption by Source in Greece (TWh), [2023]



Annual Change in Primary Energy Consumption in Greece (%), [2023]



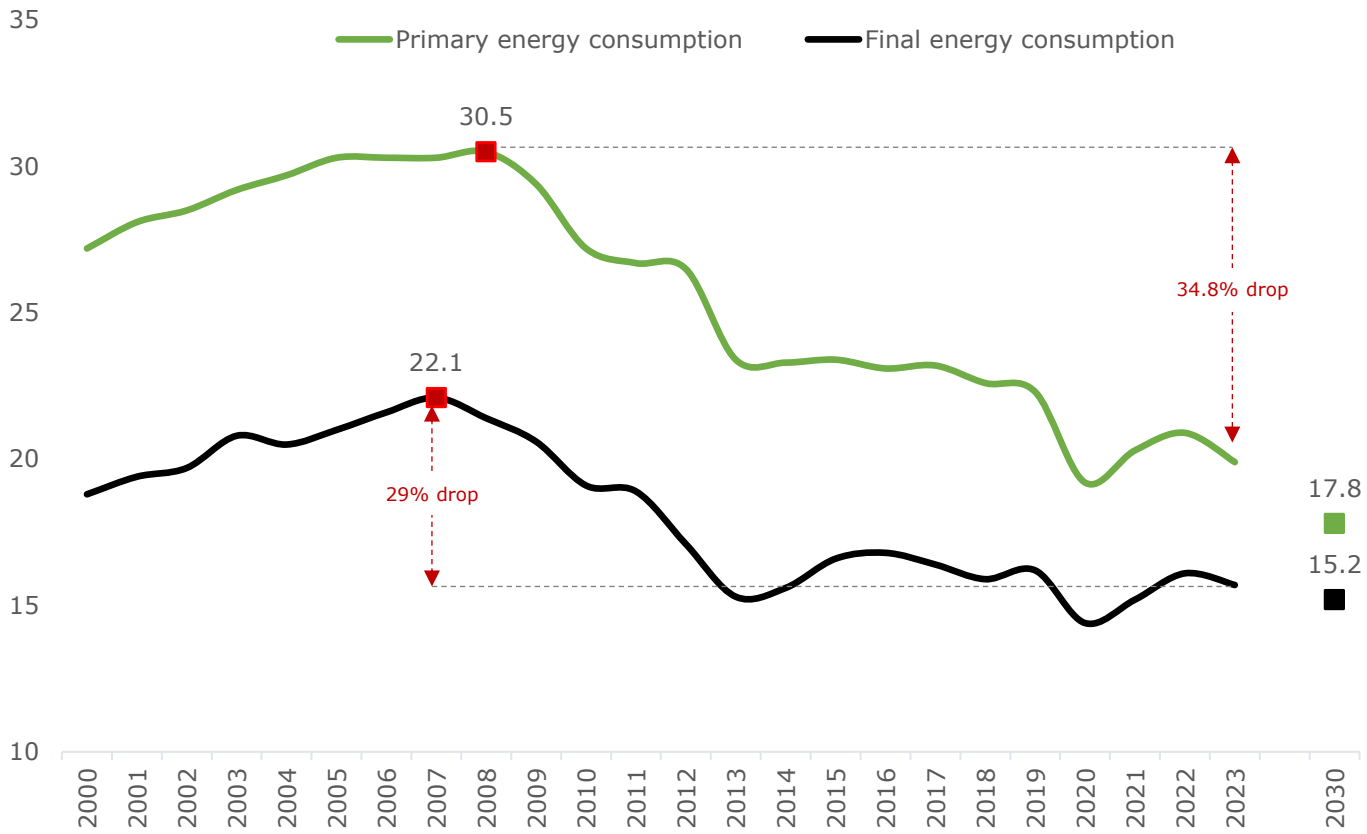
Source: Our World In Data, HAEE analysis

Highlights

- Oil remains the dominant source of primary energy in Greece (172.08TWh), underscoring the country's ongoing dependence on oil-based fuels.
- Natural gas scores second (53.82 TWh), reflecting its role as a transitional fuel in Greece's energy mix.
- Renewable energy sources collectively contributed 63.18 TWh, led by wind (28.61 TWh) and solar (22.08 TWh), confirming steady growth in clean energy integration.
- There is a significant drop in coal and gas consumption (28.28% and 13.14% from 2022), probably due to environmental policies and cleaner alternatives adoption.
- Similarly, RES recorded impressive increases showcasing Greece's transition to a more sustainable energy system.

A decline in both PEC and FEC strengthens the country's outlook for improved efficiency, decarbonization and NECP aligned goals

Primary vs Final Energy Consumption in Greece (mtoe), [2000-2023]



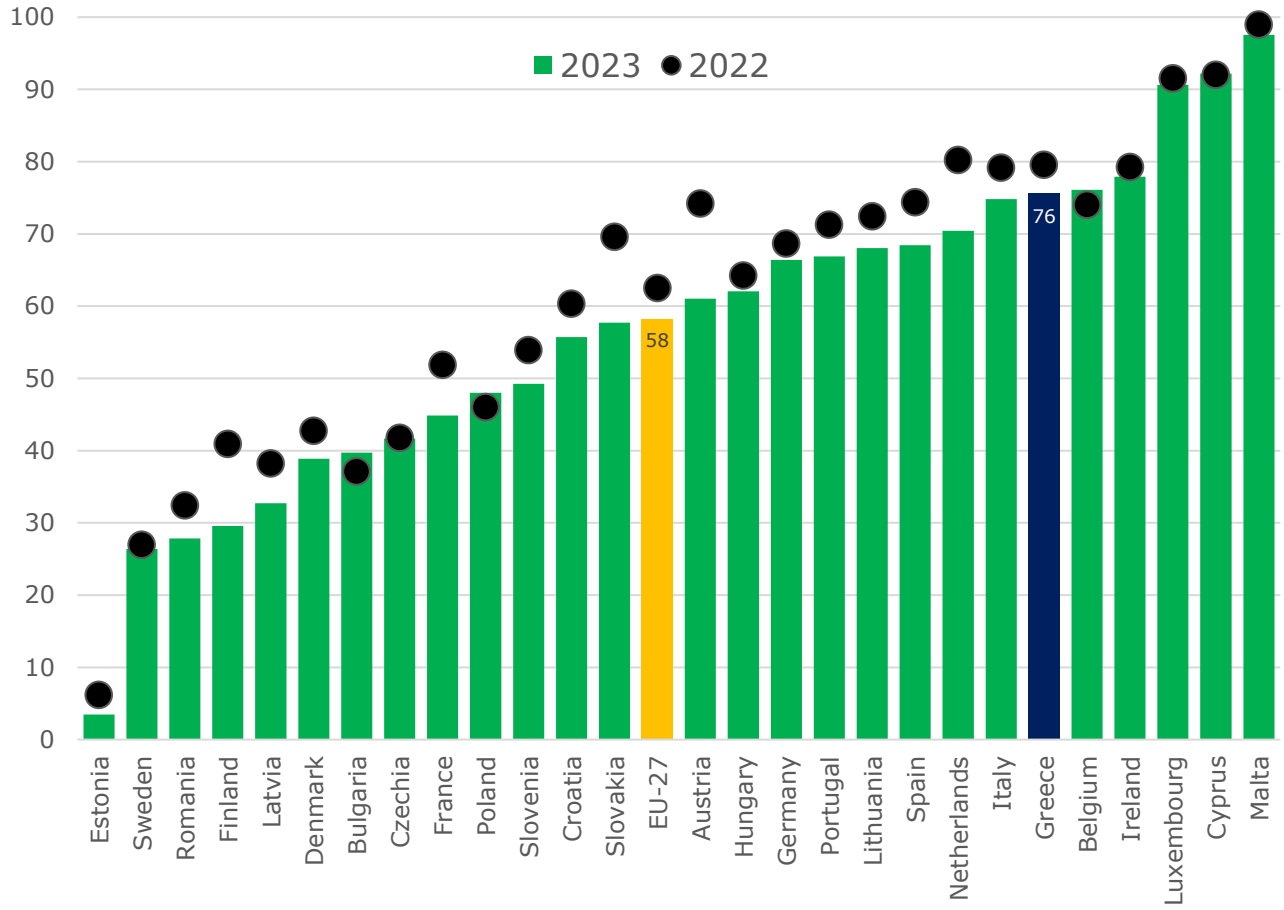
Source: Eurostat, HAEE analysis

Highlights

- While both FEC and PEC presented an increase in the period 2020-2022, a decline is observed in 2023.
- According to the revised NECP 2025, FEC should not exceed 15.2 Mtoe in 2030, an 8% drop compared to the target of the former NECP for the same year (16,5 Mtoe).
- PEC is expected to reach 17.8 Mtoe in 2030, showing a decrease of 13% compared to the corresponding target set in the previous NECP.
- 2030 projected values suggest continued decline in both PEC and FEC, reinforcing a trend toward greater efficiency and decarbonization.
- The slightly narrowed gap between primary and final consumption suggests improvements in energy conversion and system efficiencies.

More than half of the EU's energy comes from imports, exposing the countries to external hazards and risking energy security

Energy Imports Dependency Rate in Europe (%), [2023]



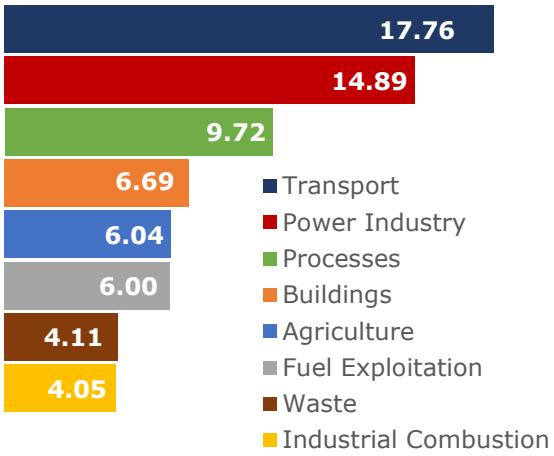
Source: Eurostat, HAEE analysis

Highlights

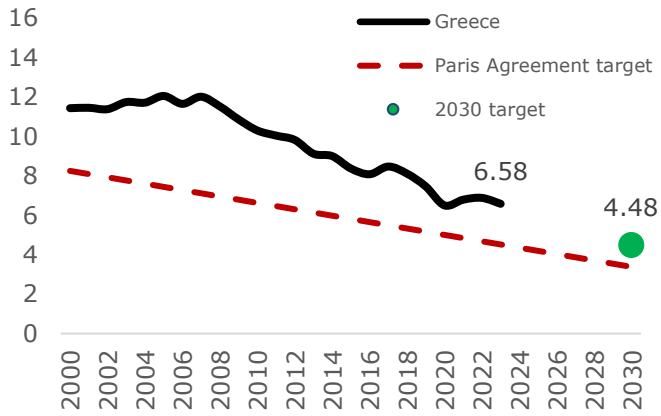
- The EU-27, reduced its reliance on energy imports, from 63% in 2022 to 58% in 2023. However, while some member states make significant progress, others delay.
- Malta (98%) and Cyprus (92%) are highly dependent on energy imports, making them vulnerable to supply chain disruptions and price volatility.
- Estonia (3%) and Sweden (26%) show significantly lower import dependency, likely due to strong domestic energy production, RES, and nuclear energy investments.
- Greece has slightly reduced its energy imports dependency from 80% (2022) to 76%, indicating efforts toward energy diversification.
- Despite improvements, Greece remains heavily dependent on imported energy, particularly natural gas and oil, making it vulnerable to global price fluctuations.

GHG emissions in Greece have declined due to a drop in lignite use for electricity generation and the expansion of renewables

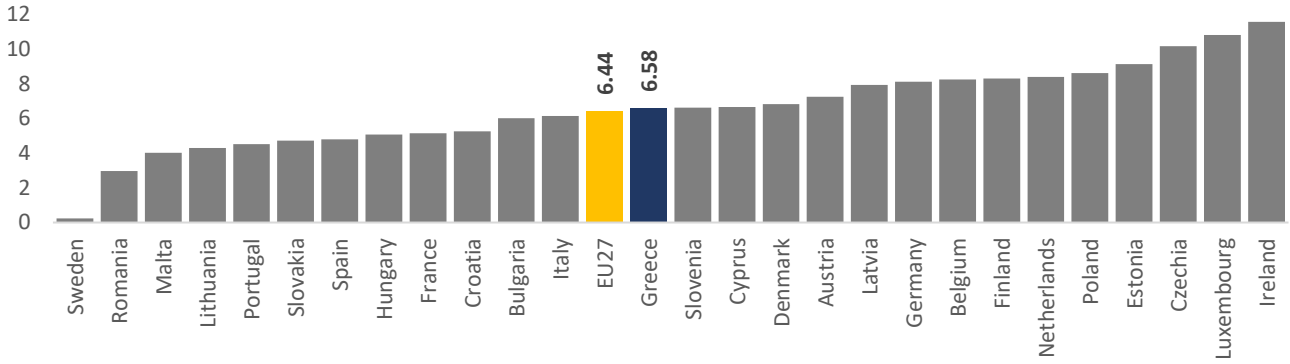
GHG Emissions by Sector in Greece (in Mt CO2eq/yr), [2023]



GHG Emissions per Capita in Greece compared to Paris pledge and 2030 target (tCO2/cap), [1990-2030]



GHG Emissions per Capita by Country (tCO_2/cap/yr), [2023]



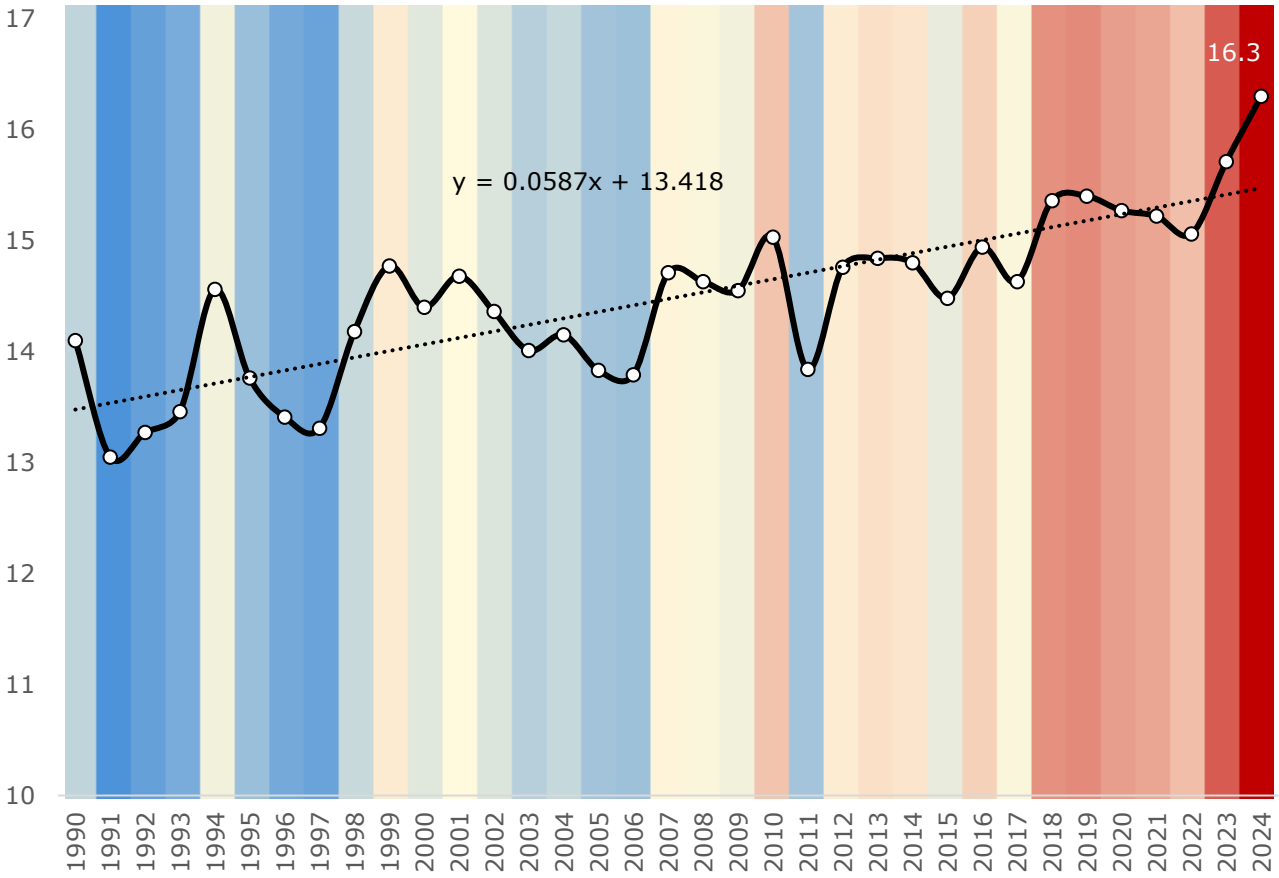
Source: EDGAR, CCPI, HAEE analysis

Highlights

- Greece's per capita GHG emissions (6.58 tCO_2e) slightly exceed the EU-27 average (6.44 tCO_2e), indicating the need for further decarbonization.
- Greece is on track to meet its emission reduction targets under the Paris Agreement, with a clear downward trend in GHG emissions.
- Meeting the 2030 target will require accelerated efforts across all sectors, with a focus on transport decarbonization, industrial innovation, and further RES expansion.
- The sectors contributing the most to GHG emissions in 2023 were transport (17.76%), power industry (14.89%) and processes sectors (9.72%).
- On the contrary, industrial combustion (4.05%), waste (4.11%) and fuel exploitation (6.00%) had a lower share of total emissions.

Greece has been facing an escalating environmental crisis, with wildfires, flash floods and extreme weather events

Annual Average Temperature in Greece (°C), [1990-2024]



Source: Meteoblue, Eurostat, HAEE analysis

Highlights

- The Climate Risk Index (CRI) by Germanwatch ranks Greece as the 4th most affected country globally by extreme weather events' impacts in 2022.
- According to IEA, higher annual mean temperatures and more frequent extreme heat events could threaten Greece's electricity supply security.
- The number of extreme weather events in Europe has increased by 48% to 16,956 in 2023/24, up from 11,442 in 2021/22.
- Extreme weather events are causing large economic damages, underscoring the need for EU-wide solutions to climate adaptation.
- Incorporating climate hazard planning into infrastructure projects is crucial to enhance future resilience.

2. Energy Transition

Contents

Highlights

Europe's battery storage capacity needs to **quadruple by 2030**

Most EU countries have **decreased their carbon intensity** for the year 2024

Global solar PV capacity leaped from **200 GW** to **550 GW** between 2022 and 2024

Alternative fuels will play a significant role in Greece's future of transport

China emerges as a dominant player in the **critical raw materials** market, capturing **38%** of the global share

The EU is embracing clean energy, with **nuclear** accounting for **24%** of electricity generation

Greece boosted its **clean energy share to 51% in 2024**, marking significant progress

EV adoption in Greece is surging, with annual sales reaching **17,000 EVs**

CCS is on the rise in Greece with an expected capacity of **5Mt**

Overview

In recent years, Europe has made significant strides toward decarbonizing its energy mix. Renewables now constitute a major part of the electricity generation portfolio, with renewables and nuclear together dominating the mix. For instance, the EU recorded nearly 48.7% renewables and 23.6% nuclear power by 2024, with fossil fuels such as coal dwindling to a modest share. This transformation is a result of robust policy measures, substantial investments in clean technologies, and a growing consensus on climate action across the continent.

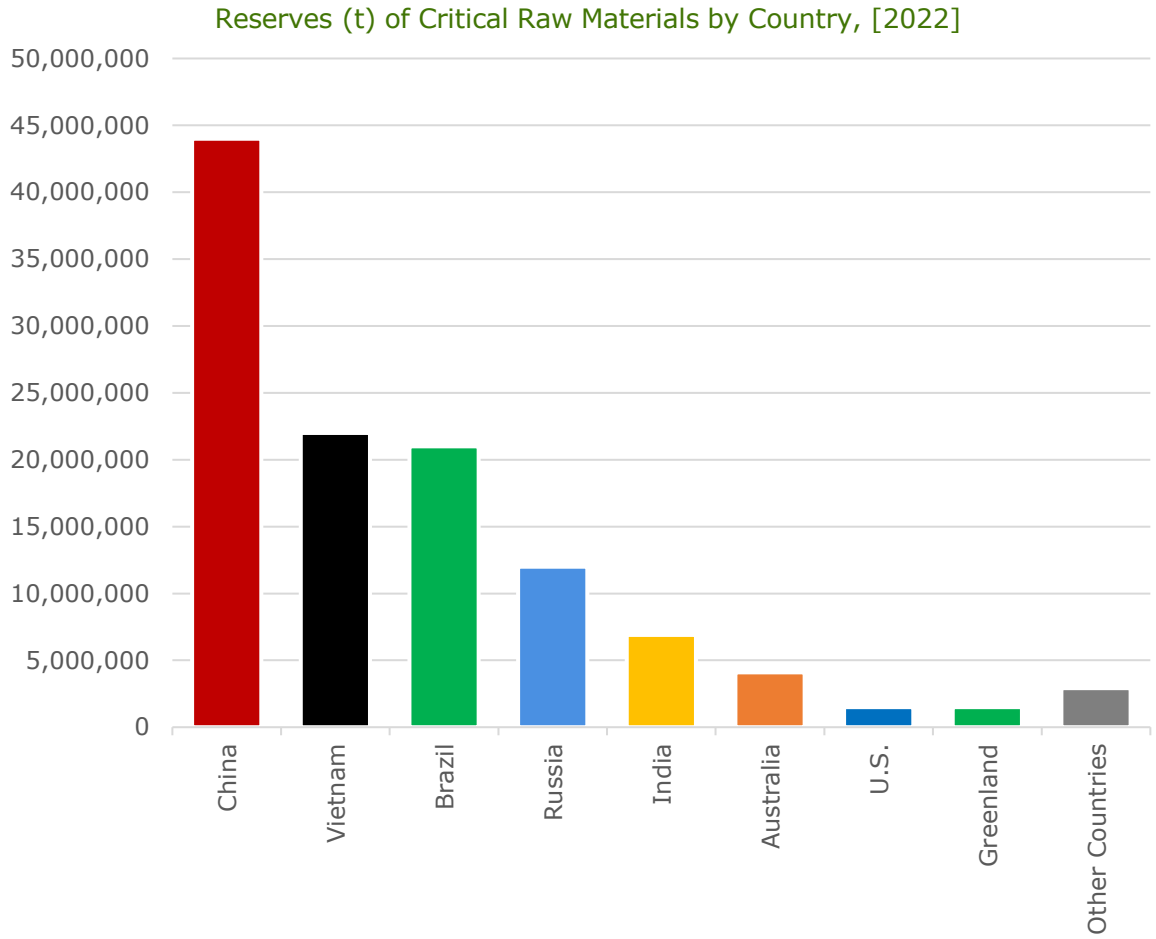
Greece, traditionally more dependent on fossil fuels, has seen a remarkable shift in its energy landscape. Its clean energy share has steadily climbed from 2010, reaching 51% by 2024. This upward trend is largely driven by accelerated solar and wind capacity additions, which are gradually supplanting coal reliance and stabilizing natural gas usage. The steady momentum of renewables in Greece reflects a successful policy framework that aligns well with the broader European decarbonization agenda.

Recent news emphasize the evolving role of nuclear power, particularly in Europe, where France remains the leading nuclear generator. The continent's reliance on nuclear, paired with expanding wind and solar capacities, has set a benchmark for other regions. In Greece, while the role of nuclear power is less pronounced, strategic initiatives in carbon capture and storage (CCS) are gaining ground. The Prinos CO2 Storage Project, for example, is poised to permanently store significant amounts of CO_2 by 2050. With a phased increase in storage capacity—from 1 $MtCO_2$ per year by 2027 to 3 $MtCO_2$ per year by 2029—this project underscores Greece's commitment to innovative decarbonization technologies.

Furthermore, there is a global surge in clean technology deployments. Solar PV installations have seen dramatic growth, while wind and electric vehicle (EV) adoption continue to expand. These developments are complemented by increasing investments in alternative fuels such as hydrogen and advanced biofuels, which promise to transform both energy production and transport sectors. Notably, Greece's rapid EV market growth highlights the urgency for further infrastructure development and supportive policy mechanisms.

The integration of innovative technologies, coupled with proactive policy frameworks and significant investments, is reshaping the energy landscape. Amid a backdrop of rising carbon prices and evolving market dynamics, the energy transition is not only redefining energy security but also steering the region towards a sustainable, low-carbon future.

Global raw materials distribution remains uneven, with China dominating and shaping resource supply dynamics



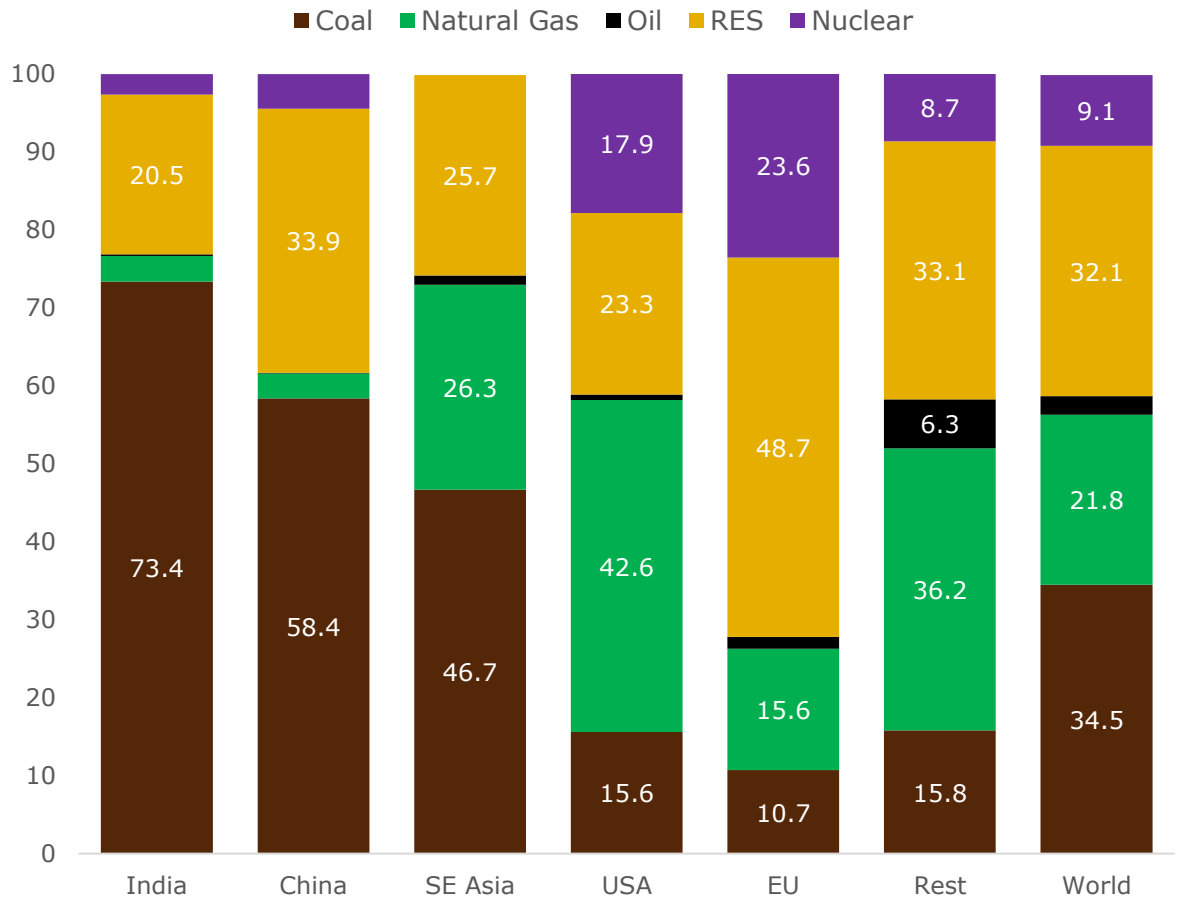
Source: Visual Capitalist, HAEE's analysis

Highlights

- China claims the largest portion at 38%, indicating global dominance in this critical resource market.
- Vietnam stands second with a 19% share, reflecting rising production capacity overall in Southeast Asia.
- Brazil ranks third at 18%, underscoring abundant natural reserves and expanding domestic resource extraction efforts.
- Russia holds 10% market share, maintaining its strategic footprint despite geopolitical tensions impacting supply chains.
- Collectively, India, Australia, and minor players form 14% total, emphasizing diverse sources complementing major producers.

Coal dominates developing regions, while renewables and gas spur decarbonization in advanced economies by 2024

Electricity Generation Mix (%) for Selected Regions, [2024]



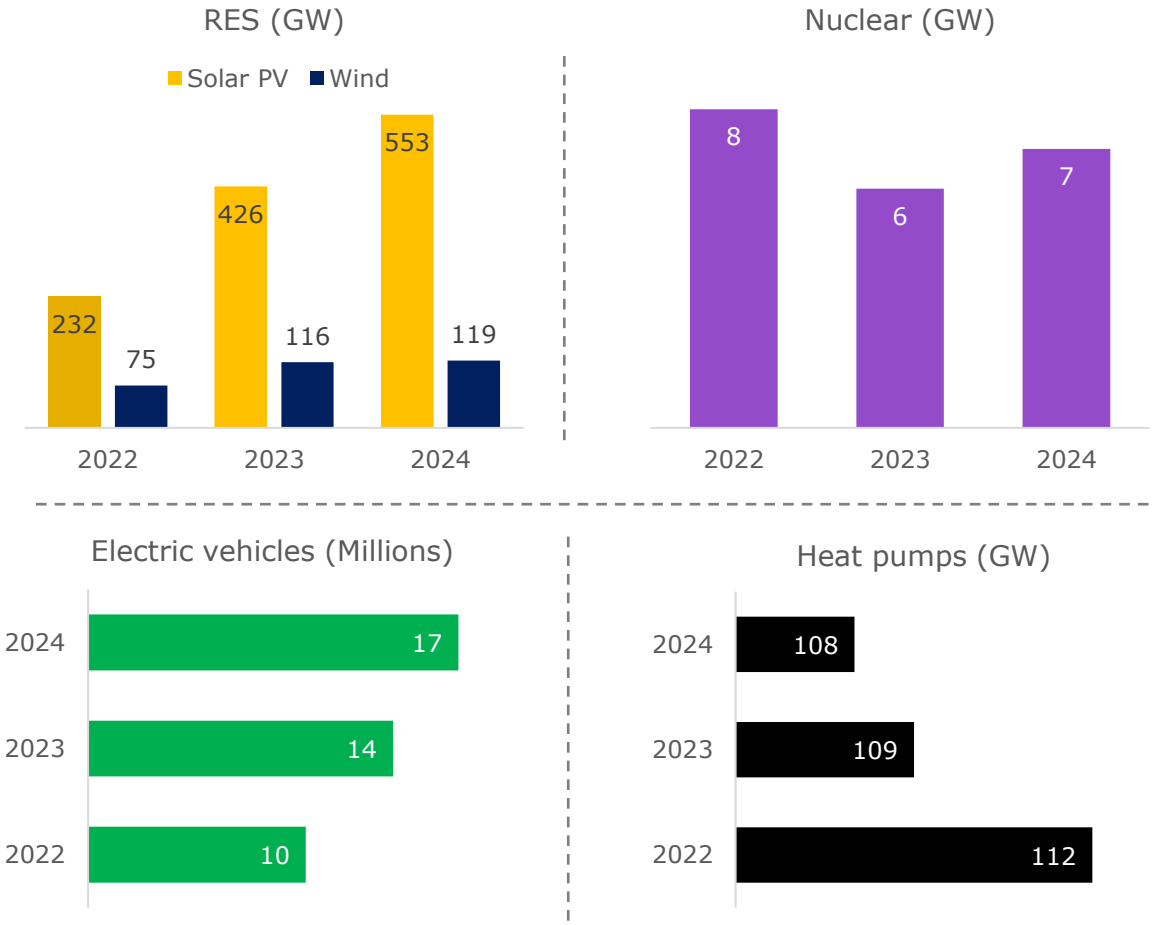
Source: IEA, HAEE analysis

Highlights

- India's electricity strongly depends on coal (73.4%), while renewables gain traction at 20.5% in 2024.
- China's generation mix balances coal (58.4%) and growing renewables (33.9%), reflecting decarbonization efforts by 2024.
- Southeast Asia relies on coal (46.7%) and gas (26.3%), though renewables (25.7%) are gaining ground.
- The United States employs gas (42.6%) and renewables (23.3%), with moderate coal (15.6%) usage remaining.
- Finally, the EU's electricity mix boasts the highest share of renewables (48.7%) and nuclear (23.6%), overshadowing coal's modest 10.7% share.

Global deployment of nuclear, renewables, EVs, and heat pumps underlines the clean-energy transition

Clean Technologies Deployment Globally, [2022-2024]



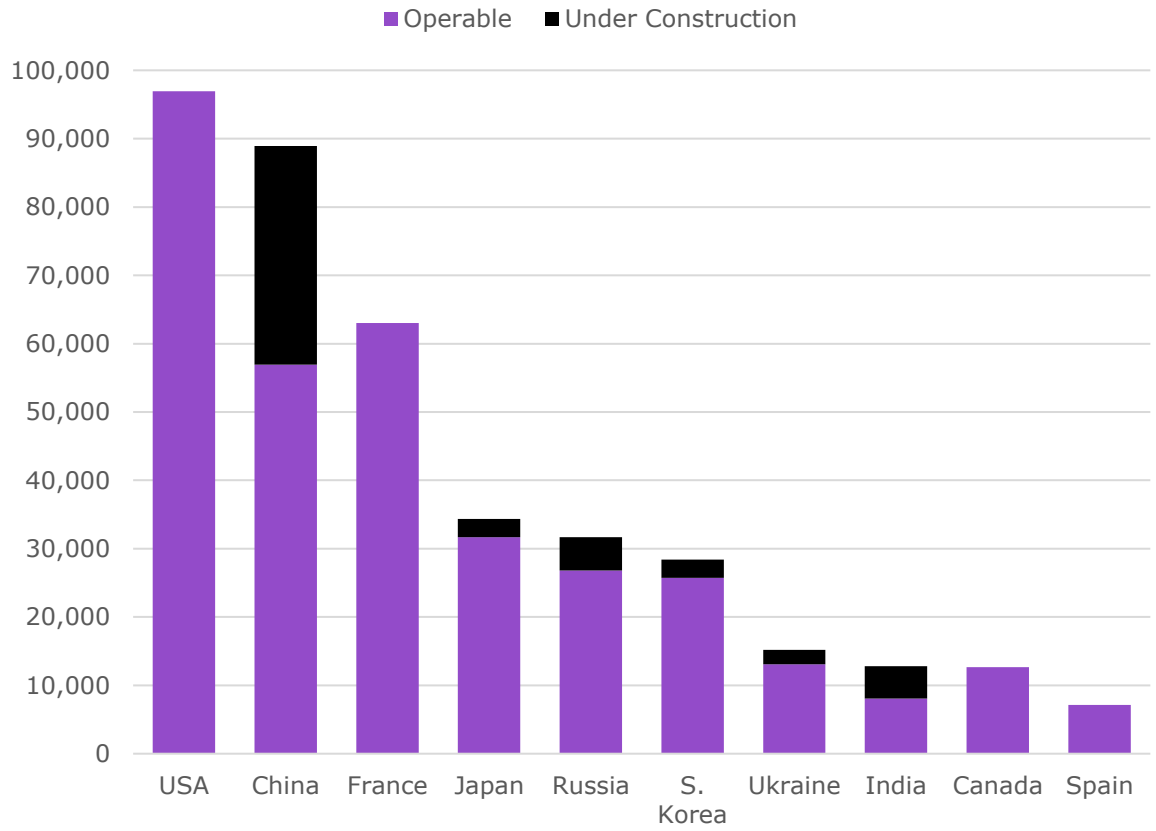
Source: IEA, HAEE analysis

Highlights

- Nuclear generation capacity remains around 8.5 GW, edging somewhat upward between 2022 and 2024 worldwide.
- Solar PV additions surge over the last two years, growing from 200 GW to 550 GW by 2024.
- Wind capacity grows steadily in 2024 but remains smaller than surging solar capacity expansions.
- Electric vehicle stock rises from 10 million to 16 million, emphasizing accelerating global electrification trends.
- Only heat pump added capacity declines from 113 GW to 107 GW, indicating technology or policy focus changes.

Nuclear power remains a critical source for many countries, with a changing guard of the key players in the coming years

Operable and Under Construction Nuclear Powerplants (MWe) in Various Countries, [2024]



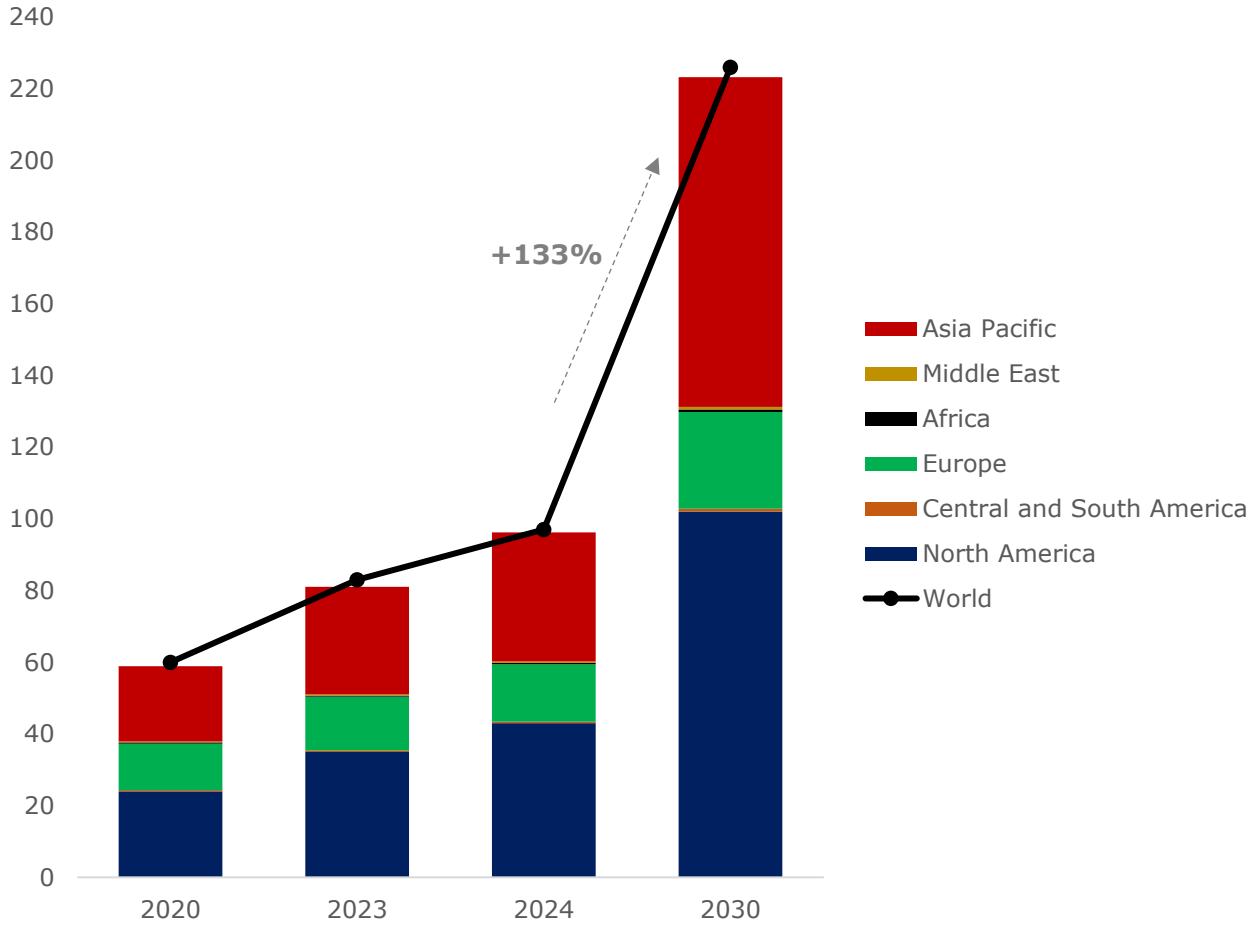
Source: World Nuclear Association, HAEE analysis

Highlights

- France holds as Europe's clear top nuclear generator, comfortably exceeding 320 TWh of power in 2024.
- Slovakia and Czech Republic maintain moderate-sized fleets, each operating fewer than ten commercial nuclear reactors.
- The US holds the top spot of nuclear power, but with no power plants under-construction, its place is not secured.
- Overall, Europe's nuclear output remains highly concentrated, with France overshadowing other nations in installed capacity.
- China, with an impressive 32 GW of under-construction nuclear power plants will climb to the second place, only behind the US.

Global data center capacity surges across regions, driven by digital transformation and ever-growing computing requirements

Data Centers Installed Capacity (GW) by Region, [2020-2030]



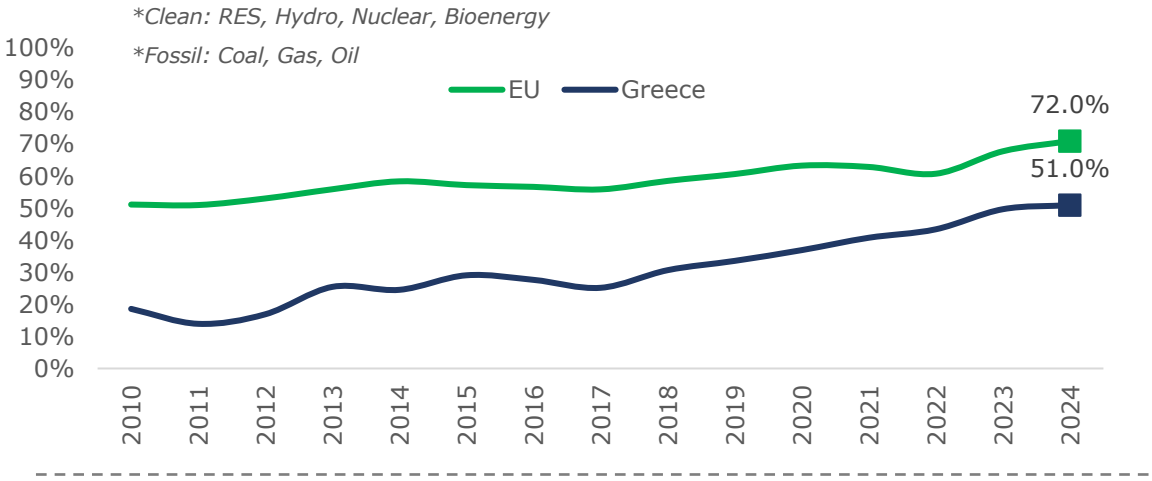
Source: IEA, HAEE's analysis

Highlights

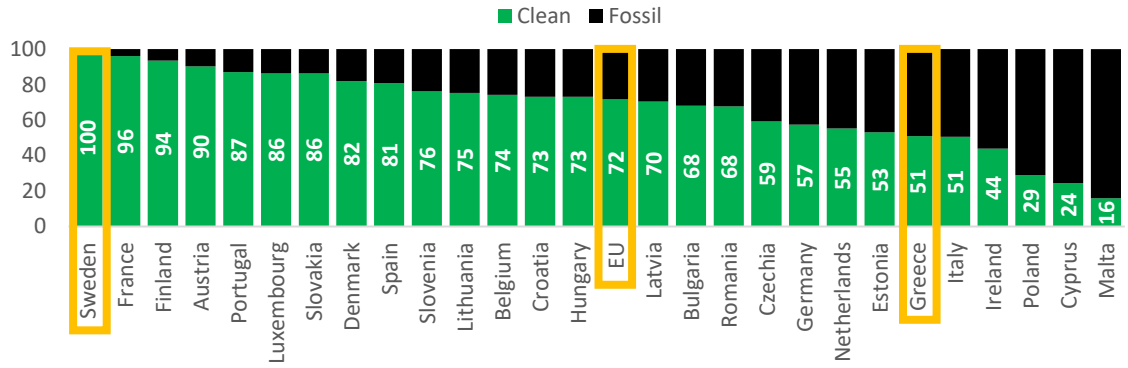
- Global data center capacity rises from under 100 GW in 2020 to almost 250 GW by 2030.
- Asia-Pacific dominates total data center capacity growth, reflecting expanding infrastructure and burgeoning cloud service requirements.
- North America remains significant, though overshadowed by Asia's surge, consistently driving investment in new facilities.
- Europe's share grows moderately, reflecting increased data regulations, digitalization, and sustainable energy initiatives across countries.
- By 2030, global capacity jumps 133%, emphasizing data-driven economies and heightened demand for computational power.

Clean technologies in electricity generation continue to grow across Europe, confirming its commitment to the energy transition

Clean Energy* Share of Total Electricity Generation (%) in EU and Greece, [2010-2024]



Clean Energy* vs Fossil Fuel** Share of Total Electricity Generation (%) in EU countries, [2024]



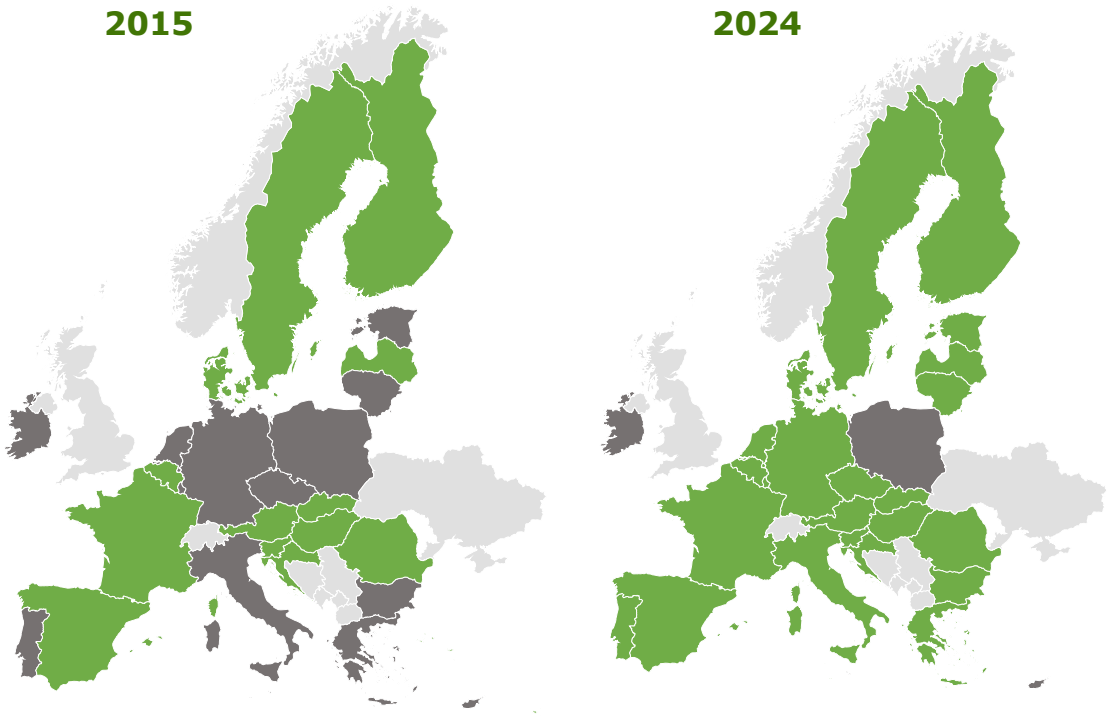
Source: Ember-Climate, HAEE analysis

Highlights

- Greece's clean energy share has steadily increased since 2010, closing the gap with the EU average, reaching 51% in 2024.
- European Union maintains a higher clean energy share, but Greece shows strong upward momentum post-2018.
- Fossil fuel dependency in Greece is declining, replaced gradually by renewables and cleaner energy sources.
- The EU's clean energy transition is stable, while Greece's growth accelerates in recent years.
- Greece's clean energy progress aligns with broader European decarbonization trends, highlighting policy effectiveness.

Rising clean energy shares highlight Europe's growing ambition during the past 10 years of energy transition

EU Countries with Clean Share in Electricity Generation above 50% (Green), [2015 & 2024]



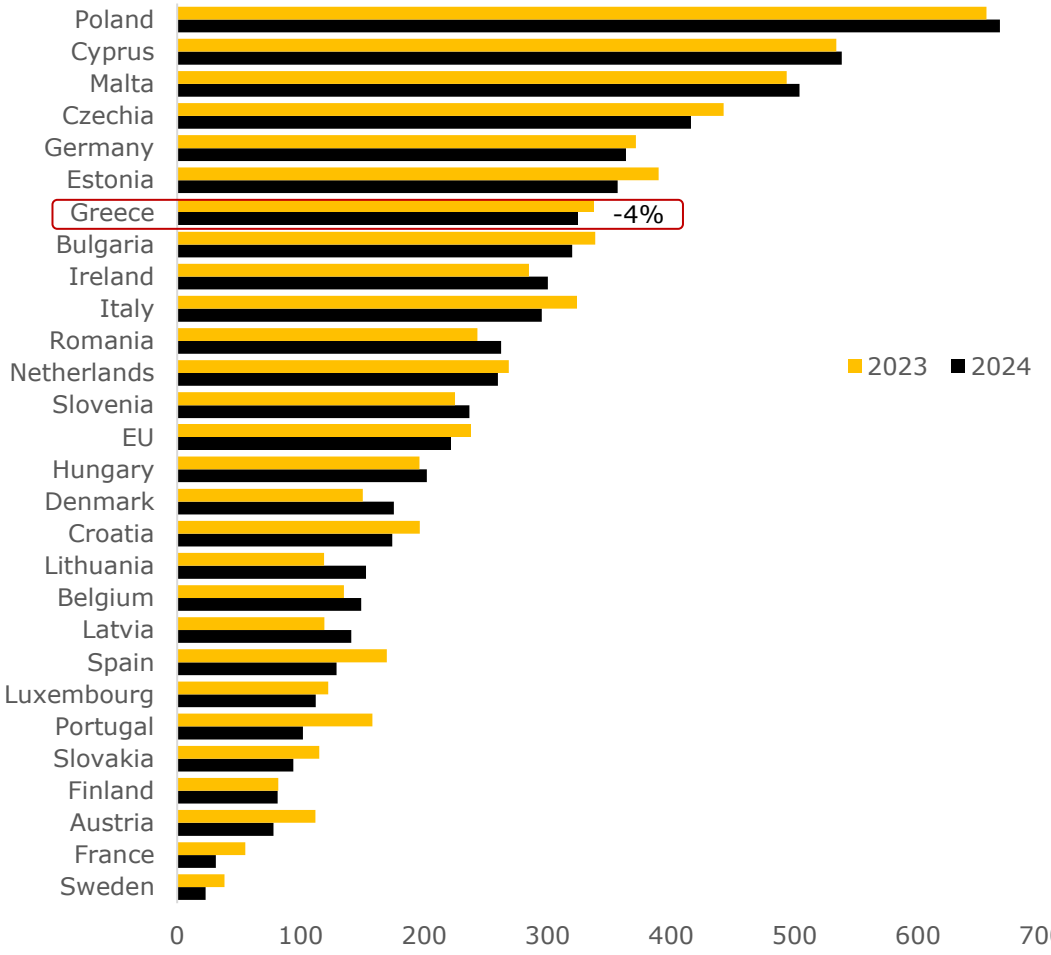
Source: Ember-Climate, HAEE analysis

Highlights

- Europe's overall clean energy share expands significantly from 2015 to 2024, reflecting widespread renewables uptake.
- Countries like Sweden and Denmark remain leaders, surpassing typical EU rates in renewable electricity generation.
- Eastern Europe sees improvements, though coal dependency persists, slowing progress towards higher clean energy thresholds.
- Germany transitions steadily, increasing renewable capacity yet still relying partly on fossil generation in 2024.
- Overall decarbonization accelerates across Europe, with more than half the nations crossing 50% clean electricity targets by 2024.

The effort towards a decarbonised energy system continues with most of the EU countries reducing their carbon intensity

Carbon intensity (gCO2/kWh) in Europe, [2023-2024]



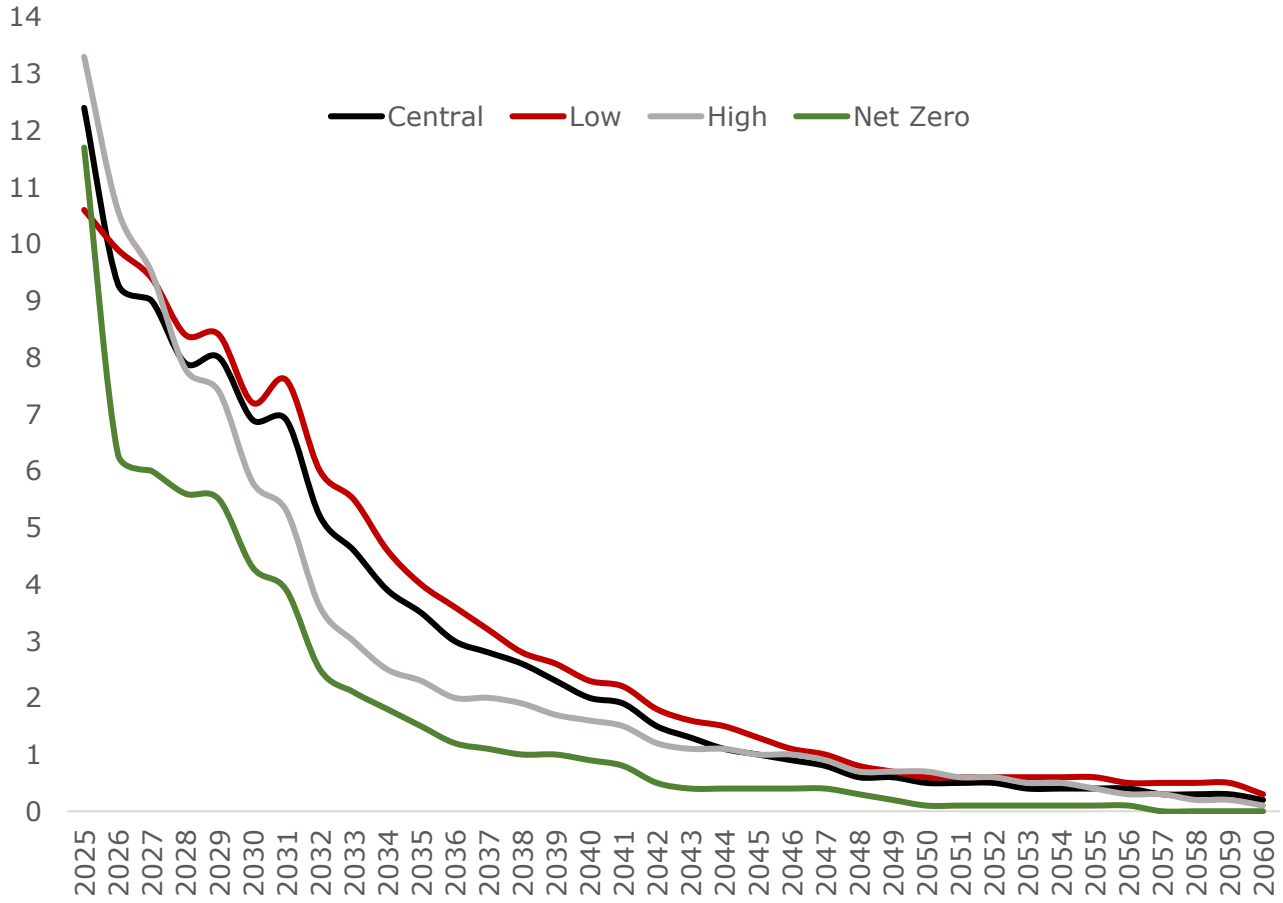
Source: Ember-Climate, HAEE analysis

Highlights

- Sweden and France record Europe's lowest carbon intensity, significantly beating the EU average carbon footprint.
- Poland displays Europe's highest carbon intensity, exceeding 650 gCO_2/kWh, reflecting heavier reliance on coal generation.
- Greece's carbon intensity sits above the EU average, suggesting a continued reliance on fossil fuels but still lower than the highest-emitting Member States.
- Hungary, Czechia, and Germany remain above the EU average, despite advancements in clean energy technologies.
- Sizable differences persist across member states, underscoring Europe's uneven progress toward decarbonizing electricity generation pathways.

Forecast scenarios project Greece's power sector emissions plummeting to near-zero by 2050 under various decarbonization pathways

Total Power Sector Emissions (MtCO2) Forecast for Greece, [2025-2060]



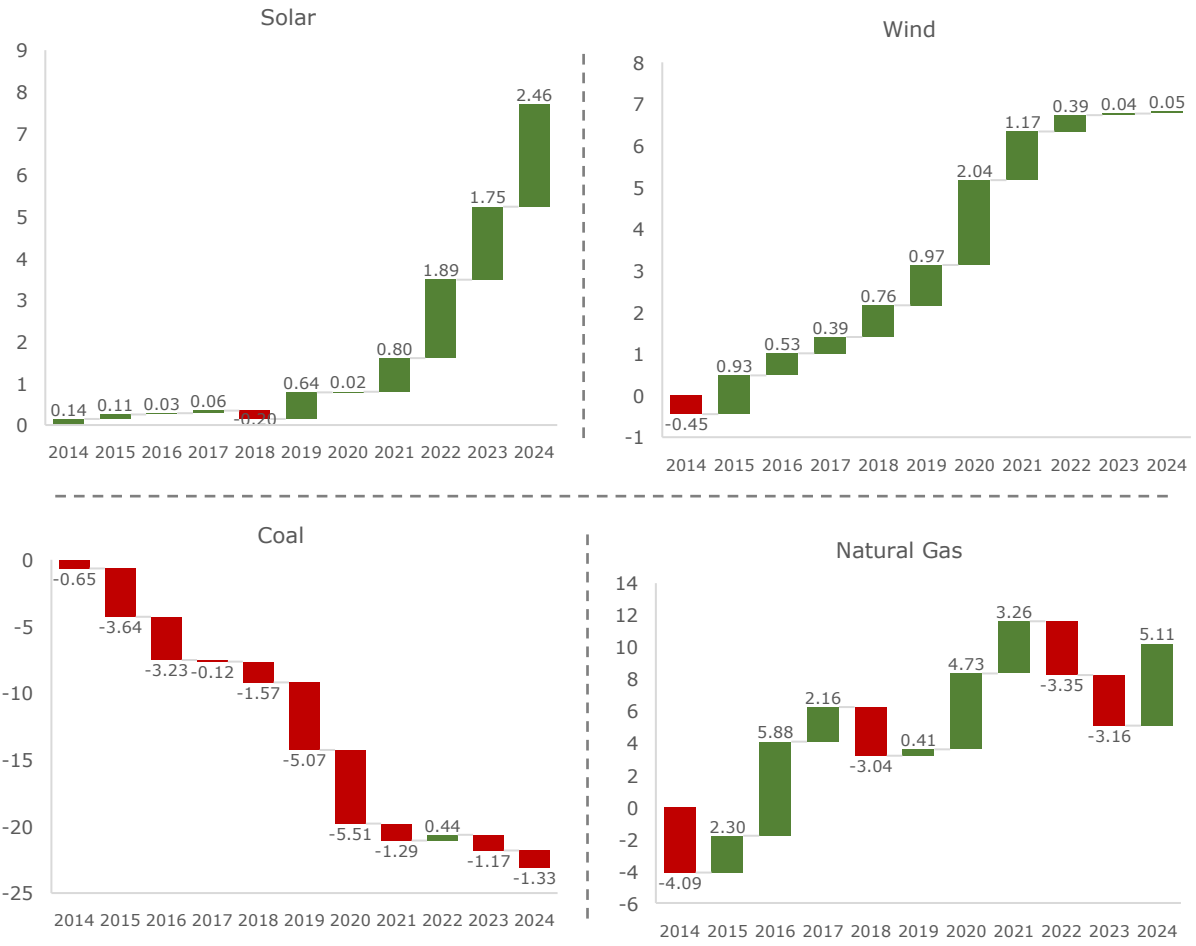
Source: Ember-Climate, HAEE analysis

Highlights

- Achieving net zero by 2040 requires immediate deployment of renewables, storage, and grid modernization strategies.
- Central scenario highlights the critical role of consistent policy and investment to halve emissions by 2035.
- Early emission cuts yield long-term benefits, avoiding lock-in of carbon-intensive infrastructure and stranded asset risks.
- Failure to accelerate transition, as seen in low scenario, risks missing EU climate neutrality deadlines.
- Scenario divergence underscores how policy ambition directly shapes Greece's energy security and decarbonization success.

Greece’s energy transition is marked by surging solar & wind, falling coal, and volatile gas, signaling a challenging course towards net-zero

YoY Change in Fuels of Electricity Mix in Greece (TWh), [2014-2024]



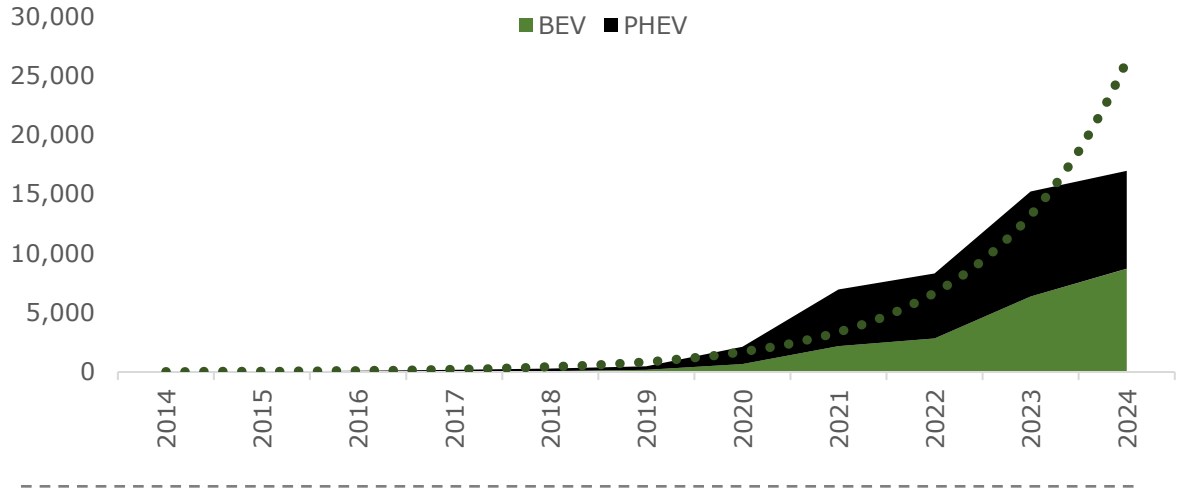
Source: Ember-Climate, HAEE analysis

Highlights

- Solar power experiences steady yearly gains, ultimately culminating in a 2.46 TWh jump by 2024.
- Wind additions remain moderate yet incrementally positive, culminating in 0.05 TWh additional capacity by 2024.
- Coal usage consistently declines year-over-year, exemplified by large negative trends between 2016 and 2020 especially.
- Natural gas expansions fluctuate, peaking in 2016 then dipping, before rebounding 5.11 TWh by 2024.
- Overall, renewables sustain strong momentum, gradually offsetting Greece’s coal dependence and variable gas utilization patterns.

Skyrocketing EV sales in Greece coincide with China's battery dominance, reflecting shifts in clean mobility

BEV+PHEV Sales (vehicles) in Greece, [2014-2024]



EV Battery Manufacturing Capacity (GWh) by Region, [2023]

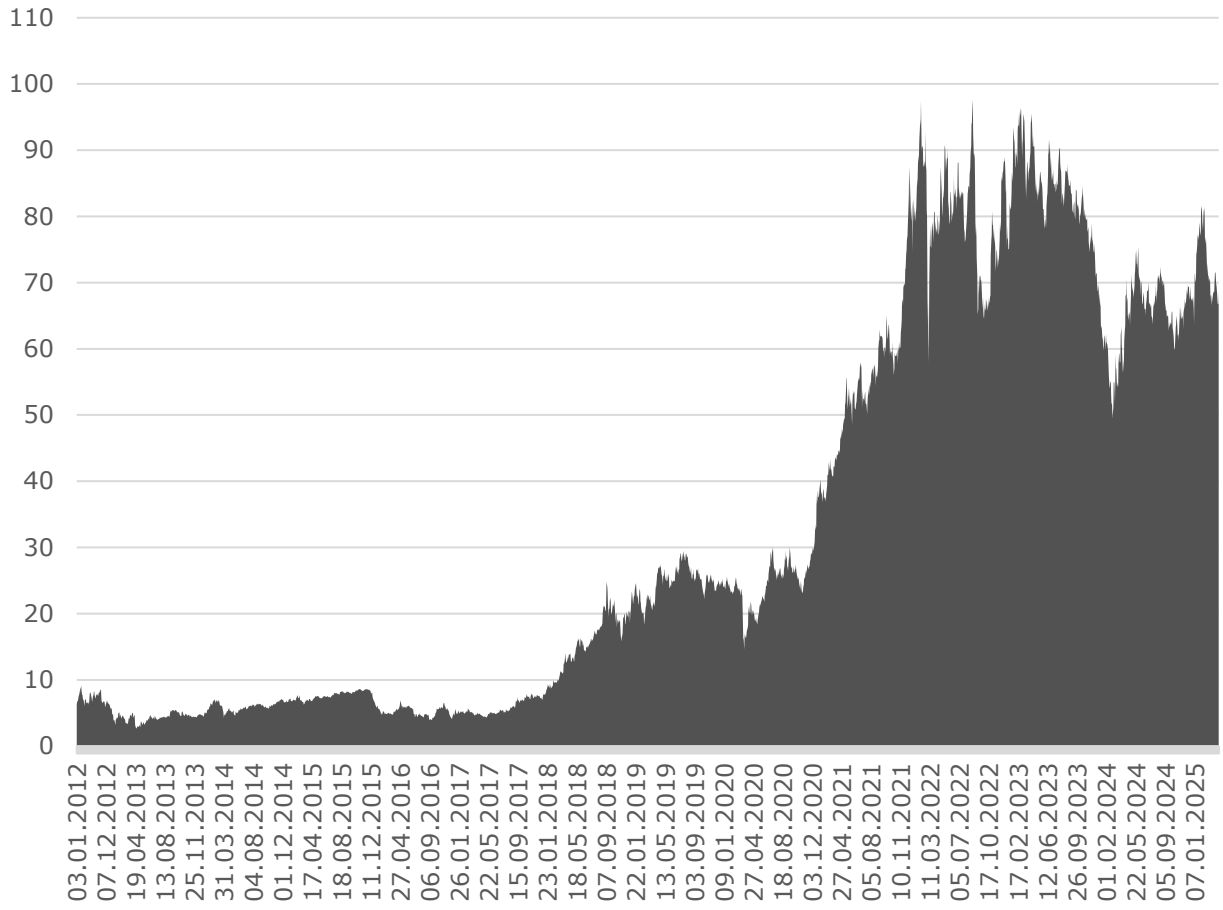
Source: evstats.gr, IEA, HAEE's analysis

Highlights

- Greek BEV sales experience exponential growth, surpassing PHEVs, culminating in approximately 30,000 units by 2024.
- Battery electric vehicles outpace plug-in hybrids, strongly highlighting consumer preference for fully electric drivetrain solutions.
- China dominates current EV battery manufacturing capacity, dwarfing Europe, the United States, and other regions.
- Europe's share grows steadily but remains behind Asia, necessitating further investments in domestic battery production.
- Higher Greek EV adoption underscores urgency for infrastructure, highlighting charging network expansion and supportive policies.

Rising carbon allowance prices approach CCS costs, prompting abatement strategies and accelerating Europe's decarbonization efforts

EU ETS Price Index (€/t CO2), [Jan 2012 - Mar 2025]



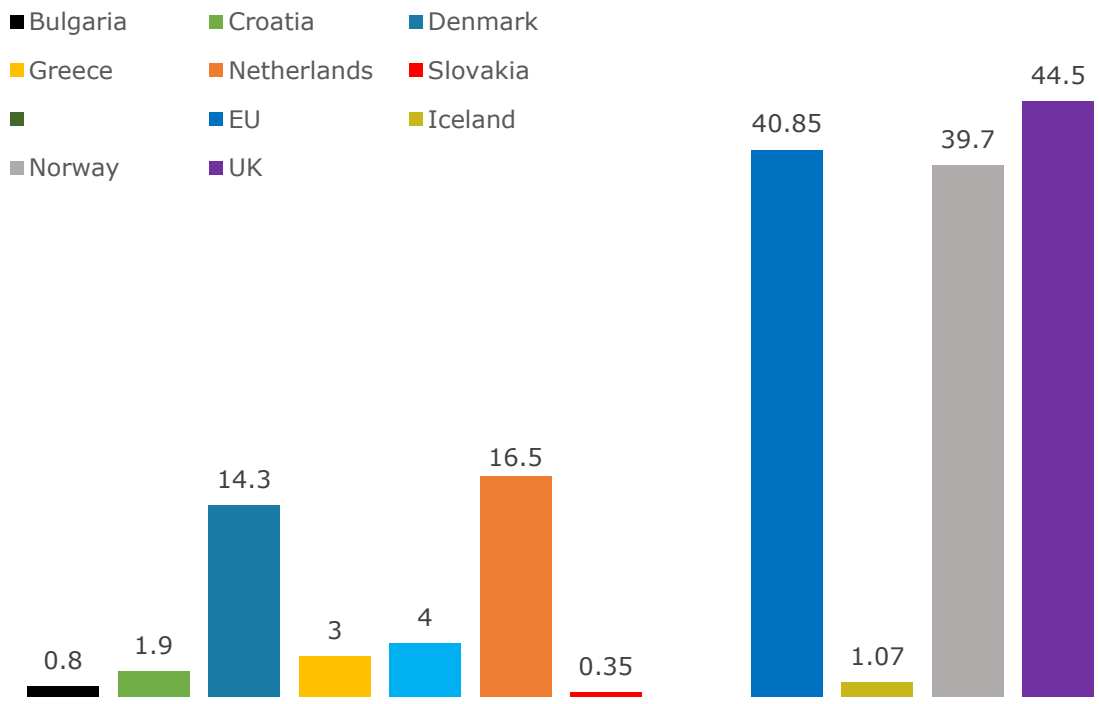
Source: energy instrat, HAEE analysis

Highlights

- EU ETS soared from below 10 €/t to near 100 €/t, surpassing many typical carbon capture costs.
- Since 2018, policy signals boosted allowance prices, improving economic viability for CCS in heavy industries.
- Price volatility persists, occasionally dropping below CCS break-even levels, yet significantly trending upward over time.
- Higher ETS costs encourage emissions abatement, raising carbon capture interest despite still-evolving commercial-scale deployment challenges.
- Projected prices near 80 €/t in 2025 could incentivize CCS investments across power and industrial sectors.

The CO2 storage injection capacity in Europe will be around 126 Mtpa by 2030 assuming that all announced projects start-up on time

CO2 Storage Injection Capacity (Mt CO2 /a) by 2030 for selected European Countries



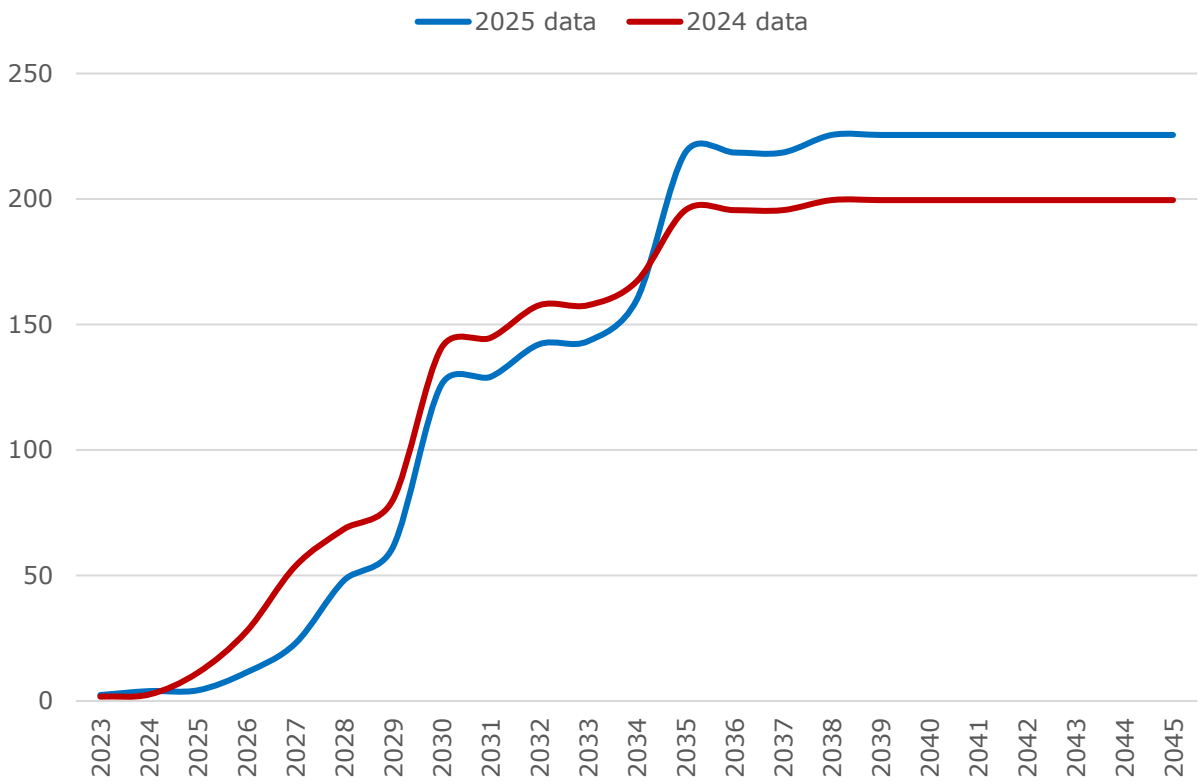
Source: IOGP Europe, HAEE's analysis (last update: Mar 2025)

Highlights

- Only 7 countries in EU (27) have announced CO2 Storage projects that could contribute to the target of NZIA Regulation for 50 MtCO2/year by 2030.
- Netherlands and Denmark are leading the CO2 storage applications in EU (27), followed by Italy and Greece, while at the end are Croatia, Bulgaria and Slovakia.
- The availability of depleted offshore Oil & Gas fields in those 7 EU countries played a critical role for this development.
- The total CO2 Storage injection capacity in EU (27) will be 41 Mtpa by 2030 which is the same order of magnitude with the storage capacity of Norway or UK.
- In Iceland, Direct Air Capture technologies have been applied successfully. Onshore basaltic rocks have been used for CO2 storage.

The projected CO2 storage injection capacity by 2030 in Europe (EU, Norway, UK, Iceland), has been decreased by around 15 Mtpa

CO2 Storage Injection Capacity (Mt CO2 /a) by 2030 in Europe based on 2024 and 2025 Projections



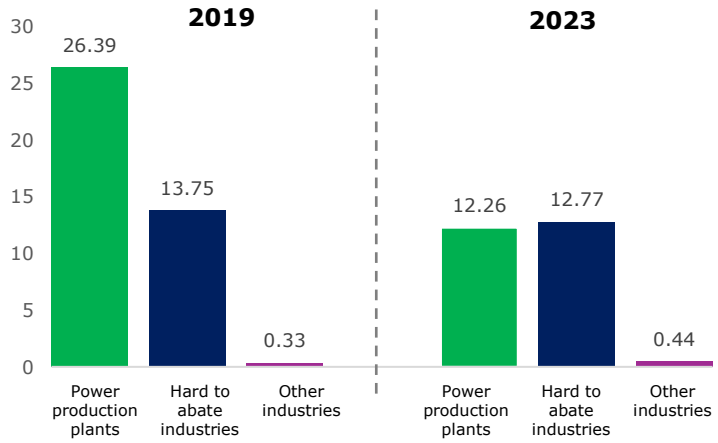
Source: IOGP Europe, HAEE's analysis (last update: Mar 2025)

Highlights

- According to 2024 data, the projected CO2 storage injection capacity in Europe (based on the announced projects) is around 141 Mt CO2 p.a. by 2030.
- According to 2025 data, the projected CO2 storage injection capacity in Europe (based on the announced projects) is around 126 Mt CO2 p.a. by 2030.
- In just 1 year, due to project cancellations and postponements, the projected CO2 storage injection capacity by 2030 in Europe has been decreased by 15 Mt CO2 p.a.
- It is highly probable that as years go by, the projected CO2 storage injection capacity in Europe will decrease furthermore by 2030.
- The sharp increase of the CO2 storage injection capacity in Europe between 2029 – 2030, is also indicative that the projected targets may not be met by 2030.

The annual CO2 emissions from power plants in Greece have been decreased by around 50% between 2019 and 2023

Industrial CO2 Emissions in Greece (Mt CO2 /year)



Annual CO2 emissions from power production plants in Greece (Million Tonnes)

	2019	2023
Coal fired power plants	16.85	4.38
Oil fired power plants	3.43	2.84
Gas fired power plants	6.11	5.04
Total	**26.39 Mt**	**12.26 Mt**

Annual CO2 emissions from hard to abate industries in Greece (Million Tonnes)

	2019	2023
Refineries	5.45	6.02
Cement industries	5.35	4.69
Steel / Aluminum industries	2.12	1.43
Lime Production industries	0.57	0.46
Fertilizer industries	0.26	0.17
Total	**13.75 Mt**	**12.77 Mt**

Source: Union Registry / Climate Action, HAEE Analysis

Highlights

- In 2019, the annual industrial CO2 emissions in Greece were 40.5 Mt (26.39 Mt came from power production plants and 13.75 Mt came from hard to abate industries).
- In 2023, the annual industrial CO2 emissions in Greece were 25,5 Mt (12,26 Mt came from power production plants and 12.77 Mt came from hard to abate industries).
- The significant reduction of the annual CO2 emissions in Greece between 2019 – 2023 is attributed to the close of several coal fired power plants.
- Between 2019 – 2023 there hasn't been any significant reduction in the annual CO2 emissions of hard to abate industries.
- Given that the CO2 storage capacity in Greece will be 3 Mtpa by 2030 (Prinos CO2 Storage project), it becomes apparent that new CO2 storage sites are needed.

The CO2 storage injection capacity in Greece will reach 3 Mtpa by 2030 and it is already reserved, based on the announced projects

Announced CCS Projects in Greece

Elements of the CCS value chain covered	Project Name	Participants	Planned start of operations	Initial Capacity (Mtpa)	Capacity after expansion (Mtpa)	Type of project
Capture	IFESTOS	TITAN	2029	1.9	-	CO2 Capture at cement plant (Kamari, Viotia)
Capture	OLYMPLUS	HERACLES Group	2029	0.9	-	CO2 Capture at cement plant (Milaki, Evoia)
Capture	IRIS	MOTOR OIL	2028	0,5	-	CO2 Capture at refinery (Korinthos)
Transport	APOLLO CO2	DESFA	2029 Expansion date: no data	5	10	Pipeline Network & Export Terminal (Revithousa)
Storage	PRINOS CO2 STORAGE	ENEARTH (subsidiary of ENERGEAN)	2027 Expansion date: 2029	1	3	CO2 Storage at offshore depleted oil field (Prinos)

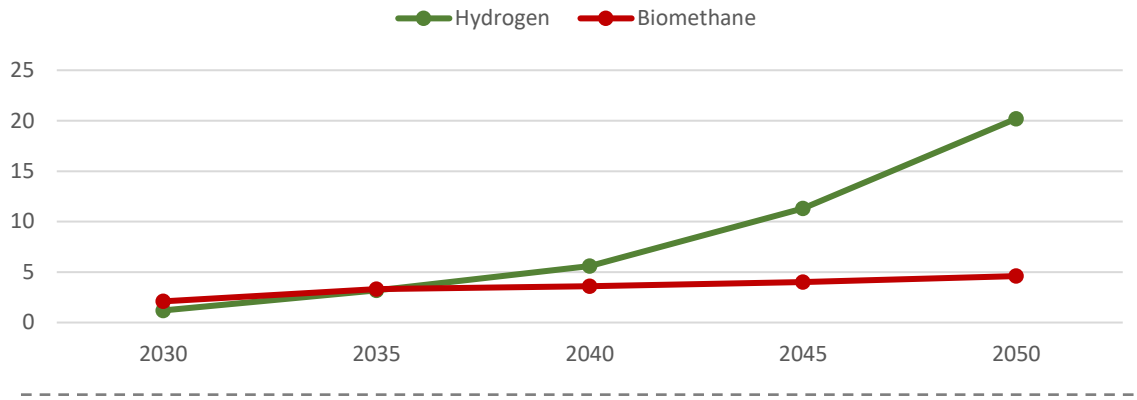
Source: HAEE Analysis

Highlights

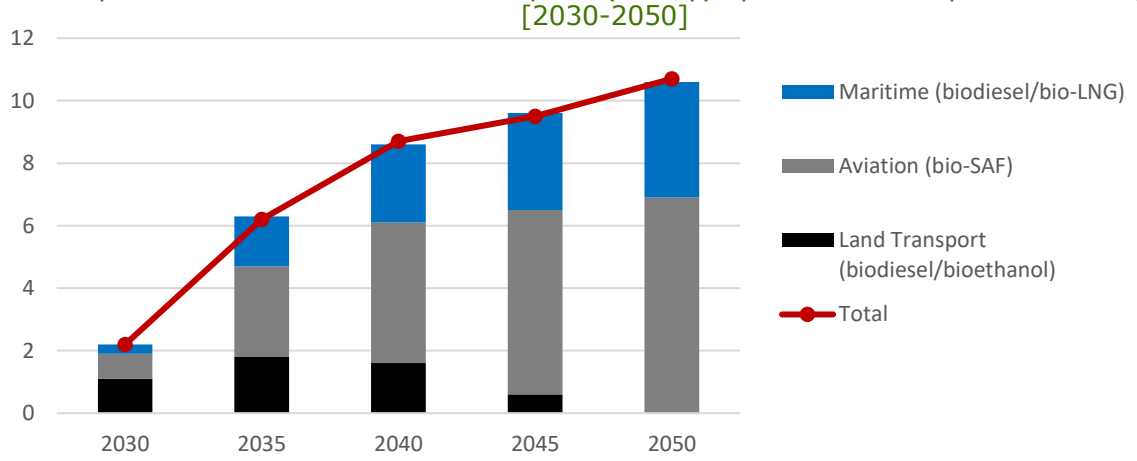
- Prinos CO2 Storage project is the only announced CO2 storage project in Greece, and it is expected to store permanently up to 66 MtCO2 by 2050.
- Prinos CO2 Storage project will be able to store 1 MtCO2 p.a. by 2027 (Phase 1) and 3 MtCO2 p.a. by 2029 (Phase 2).
- The capacity of Prinos CO2 Storage project (3 MtCO2 p.a.) has been already reserved by 3 capture projects under development in Greece (IFESTOS, OLYMPUS, IRIS).
- Apollo CO2 project will provide the Greek industries the option to export their CO2 emissions in neighboring countries.
- Prinos CO2 Storage project and Apollo CO2 project have obtained the status of EU Projects of Common Interest (PCI).

Greece’s alternative fuel roadmap forecasts hydrogen, ammonia, and biofuel adoption, transforming energy and transport sectors

Expected Alternative Fuels Production (TWh/y) in Greece, [2030-2050]



Expected Alternative Fuels Consumption (TWh/y) by Mode of Transport in Greece, [2030-2050]



Source: NECP, HAEE analysis

Highlights

- Hydrogen production rises sharply from negligible levels in 2030 to surpass 20 TWh by mid-century.
- Advanced biofuels expand steadily as advanced production technology improves, diversifying Greece's portfolio of low-carbon alternatives.
- Biomethane output expands moderately, supplementing natural gas alternatives and supporting renewable integration across multiple sectors.
- Transport consumption of alternative fuels surges, particularly in aviation, boosting sustainable approaches in this sector.
- Aviation and land transport also adopt biofuels, further driving Greece’s total clean-fuel usage toward 2050.

3. Electricity

Contents

Highlights

Greece became an **electricity net-exporter** in 2024

For 2024, **RES** and **Hydropower** amounted to **41%** of the total electricity produced in **Greece**

For **2024** in the **EU27**, **49%** of the generated electricity originated form **Clean Energy Sources**

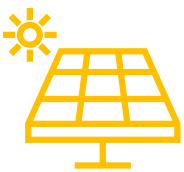
On average electricity prices of the industrial sector **dropped by 9%** in **2024**, compared to **2023**

In November 2024, DAM reached on average **137€/MWh,** reaching highest levels of the year

Electricity demand in **Greece** rose by **3%** in **2024**, compared to 2023, but has dropped by 15% compared to 2018

In renewable energy, **DAPEEP** still holds the **52.68%** of the load

In April 2024, the **RES curtailed energy** in Greece surpassed the **290 GWh**



In November of 2024, Greece had the greatest **Exports** volume, reaching **850GWh**

Overview

Throughout 2024 in Greece, the renewable sources capacities increased to 24.28 GW. Wind and solar energy contributed 33% to the electricity mix over the year, including hydropower, they contributed in total to 41.25%. Due to that, lignite faced an astonishing 40% decrease in demand, while natural gas as a complementary fuel for the energy transition faced an 26.28% increase. Still, in the electricity mix for the interconnected system to the mainland in Greece, fossil fuels accounted for 58.74%. At the same time given these statistics electricity demand for the interconnected system in Greece increased by 1.2%, and by 3% for the whole electricity system.

Among the EU27 member states for 2023, Greece ranked 13th in the electricity demand. Though as mentioned, in 2024 an increase in electricity demand was prominent compared to 2023, when comparing to 2018 a significant 15% reduction in electricity demand was observed. Among the EU 27 member states Greece was on the 3rd place for electricity generation from natural gas, with Ireland and Italy holding 1st and second place respectively. Seemingly such a high dependency on fossil fuels for Greece may indicate a resistance towards net-zero, though we should remember that the dependency is on natural gas, and it serves as a transitioning fuel, being one of the cleanest fossil fuels in the mix.

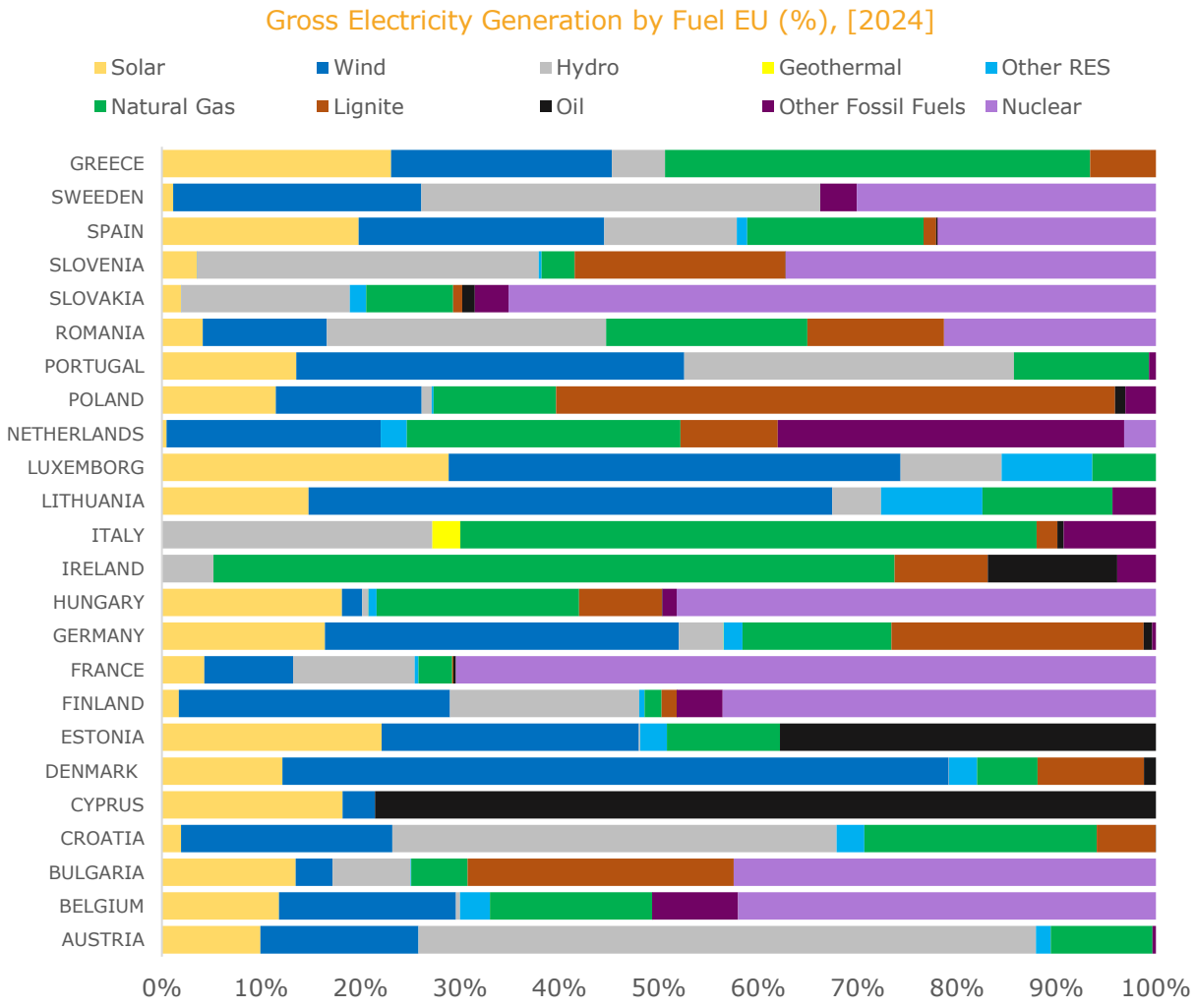
The top 5 EU27 Member States with the highest share in RES electricity generation were Luxemburg (94.88%), Austria (89.76%), Portugal (86.86%), Denmark (84.09%, and Lithuania (83.06%). The member states that are most heavily dependent on natural gas for electricity production are Ireland (68.5%), Italy (53.46%), and Greece (42.78%). On a harder polluter, lignite Poland (56.1%), Bulgaria (26.65%), and Germany (23.46%) are the most dependent, even so, the percentage of lignite and coal in the mix is relatively low.

The electricity demand in Greece, in 2024, was 39.57 TWh, while the electricity generation amounted in 41.29 TWh (in the interconnected system) making Greece a net exporter. Main countries Greece exported electricity to where Italy, Bulgaria, and North Macedonia, exporting 3100 TWh, 2922 TWh, and 1340 TWh respectively. The country that contributed the most to the electricity imports in Greece for 2024 was Bulgaria, importing 43% of the total imports.

As per the Greek NECP, GREGY – Green Energy Interconnector by 2035 will be the greatest interconnection , with total transfer capacity of 3,000 MW. On February 7th,2025, the SPV interconnection with Saudi Arabia was announced by IPTO, with the total transfer capacity still an open matter. These interconnections are expected to accelerate the energy transition, and limit RES energy curtailments domestically.

As Greece has become oversaturated with RES technologies, curtailments in non-dispatchable RES have become a significant problem in the country. At the same time, as not all RES installations were equipped with SDACA it is impossible to calculate the exact amount of RES energy curtailments. The calculation of curtailed energy sum up to approximately 1TW.

RES technologies hold the greatest share in the electricity mix for most EU27 member states in 2024



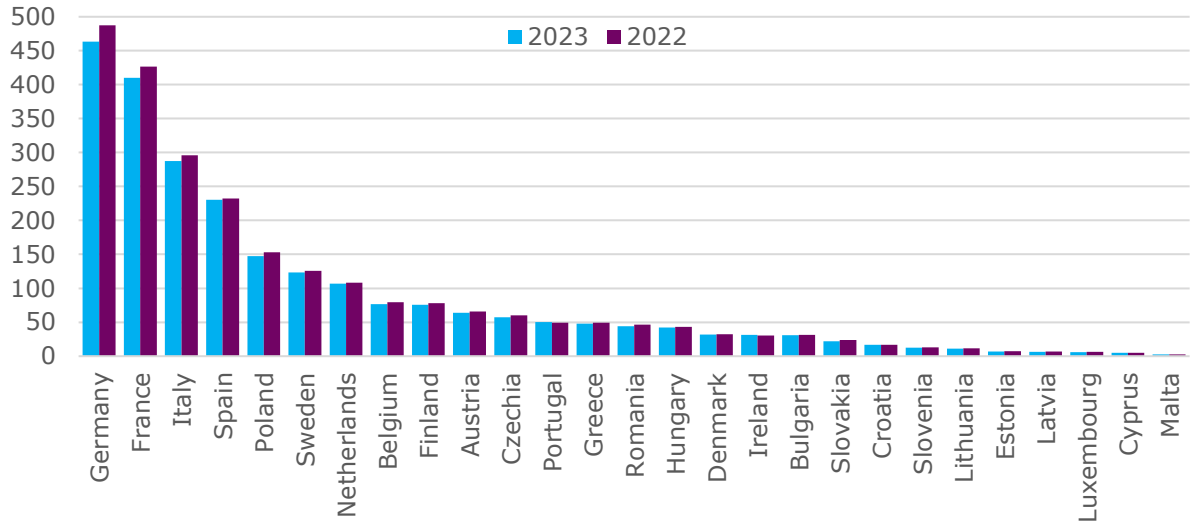
Source: ENTSOE, HAEE's analysis

Highlights

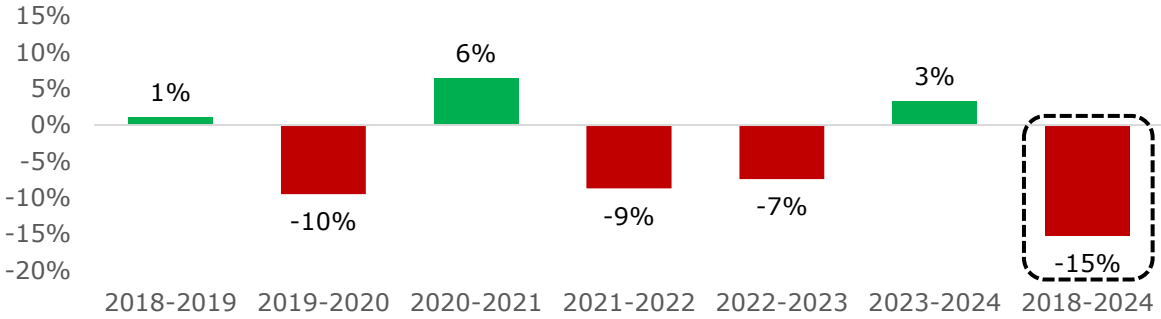
- Some of the EU27 member states , as France, Slovakia, and Hungary rely heavily on nuclear energy for electricity production, partially due to low prices/LCOE.
- Scandinavian EU27 member states have in common the higher renewable energy penetration in the electricity mix.
- Greece will continue to rely on lignite and natural gas for the upcoming years, though the electricity mix is getting greener each year.
- The overall electricity consumption trend has been decreasing in the past 2 years, since 2021-the post Covid19 era.
- Combustible fuels remain a key component in the electricity mix for most EU27 member states, regardless of the saturation of RES technologies.

Since 2018, the Electricity demand in Greece during 2024 has dropped by 15%, though since 2023 the demand has risen by 3%

Electricity Demand in the EU (TWh), [2022-2023]



Year on Year Change in Electricity Demand in Greece (%), [2018-2024]



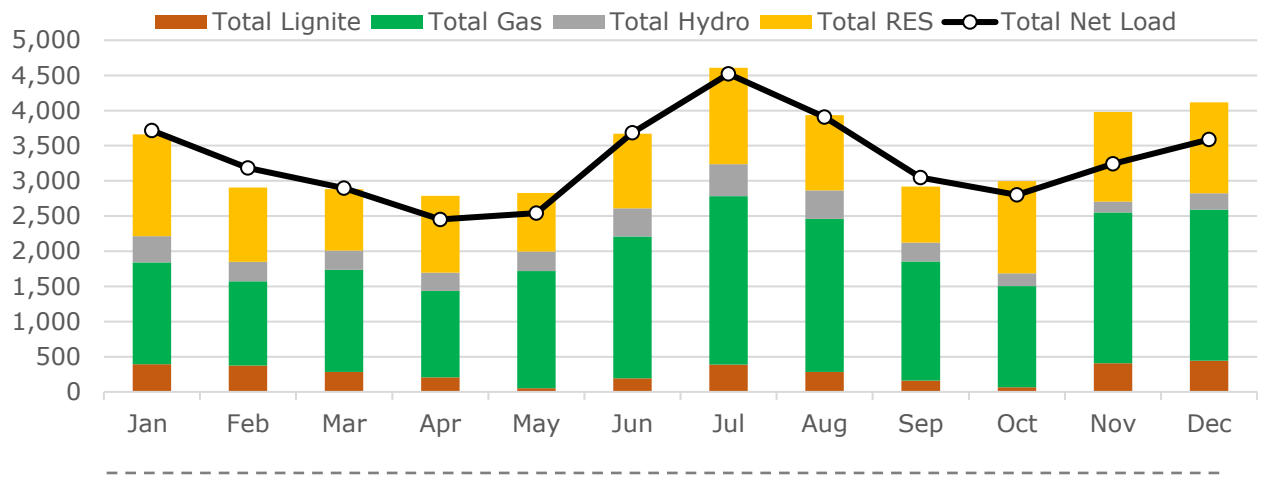
Source: EMBER, IPTO, HAEE's analysis

Highlights

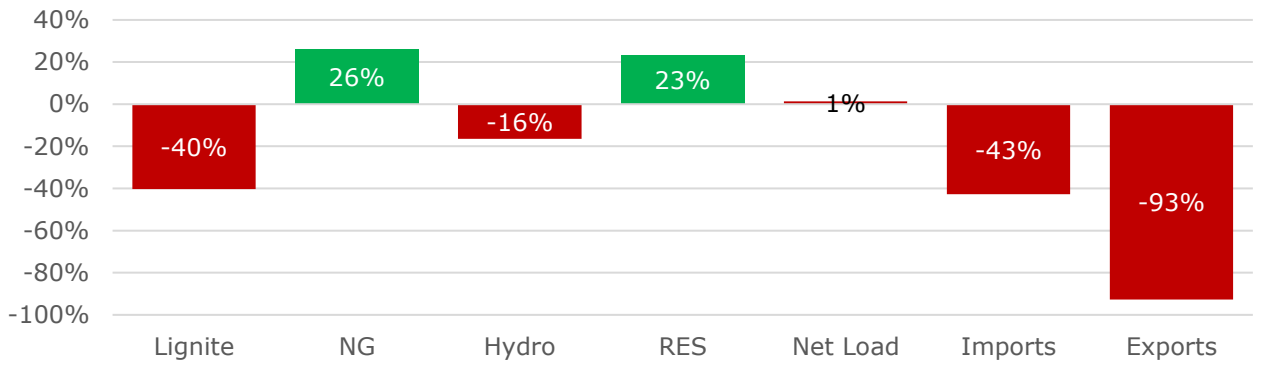
- In 2023 Greece had an electricity demand lower than the average electricity demand across all EU27 member states.
- The year-on-year growth in demand was most significant in Hungary, where the demand spiked by 3% in 2023 compared to 2022.
- Netherland on the other hand had the most decrease in electricity demand in 2023 compared to 2022, a decrease of 7%.
- Germany that is the EU27 member state with the greatest electricity consumption among all member states, faced a decrease of 3% in demand.
- Greece had a decrease in electricity demand of 7% in 2023, and a growth of 3% in 2024, still the overall trend since 2018 is a decrease in demand.

Natural Gas and Renewable Energy Sources continue to dominate the electricity mix in Greece during 2024

Energy Sources Covering Electricity Demand in Greece (GWh), [2024]



YoY change in the Electricity Mix (%), [2023-2024]



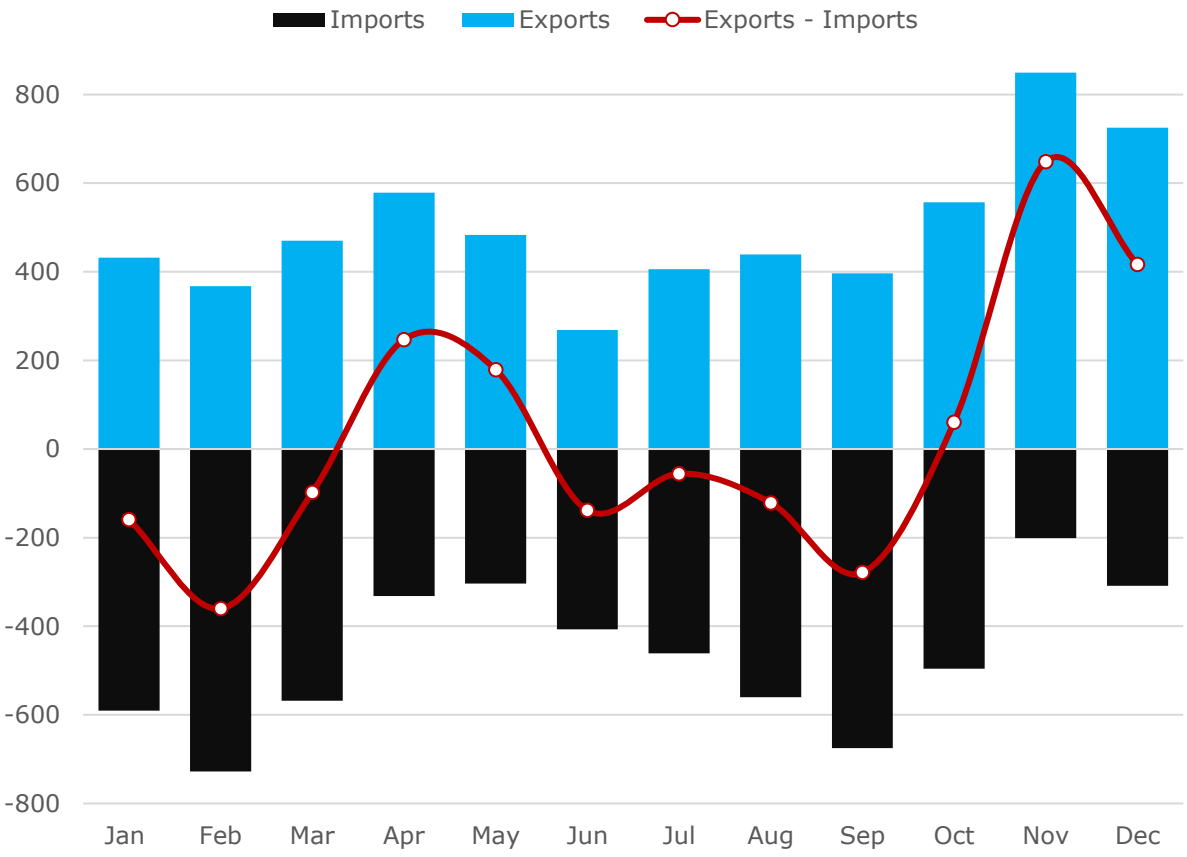
Highlights

Source: IPTO, HAEE's analysis

- A significant reduction in lignite production for the electricity mix in Greece is prominent, setting the way for decarbonization.
- Although the last Greek NECP signified that lignite will stop being used for electricity generation by 2025, it is not the case due to lack of storage technologies.
- Natural Gas still holds a great chunk in the electricity mix, acting as complementary to renewable energy for the transition to net-zero.
- The electricity load in Greece has been following a downward trend for the last years, making a change in 2024 with 1% increase.
- Hydropower continues to drop for a second consecutive year, compared to other renewable technology.

In 2024 Greece became a net-exporter, exporting 341.9 GWh on annual basis with the highest exports recording during November

Imports and Exports by Month in Greece (GWh), [2024]



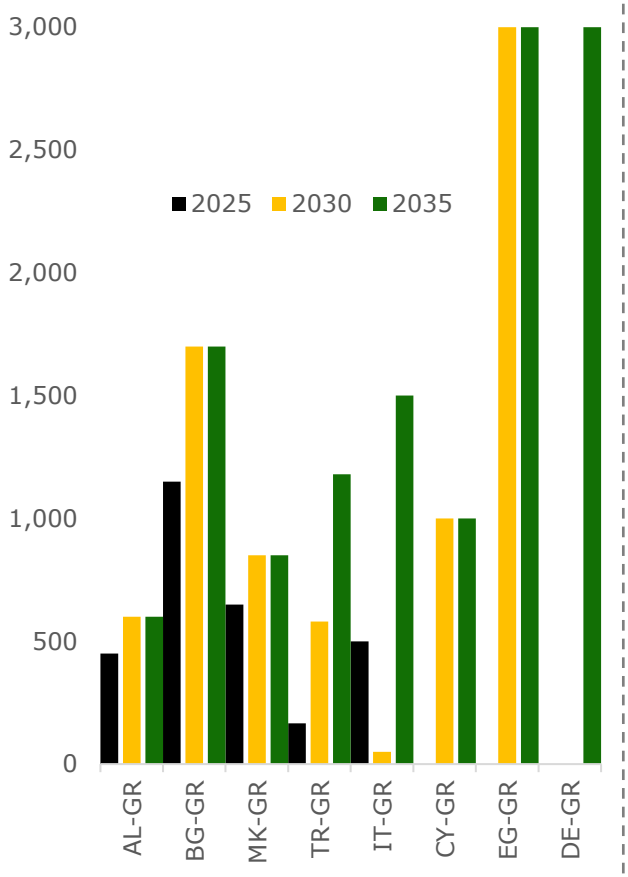
Source: EnExGroup, IPTO, HAEE's analysis

Highlights

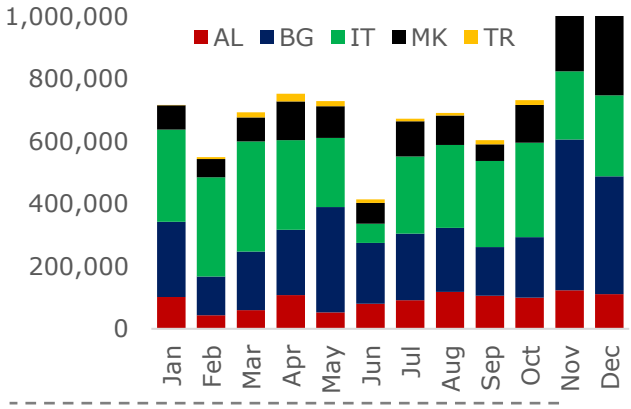
- Both electricity imports and exports in Greece in 2024 were considerably lower than in 2023.
- During the summer months less electricity exports can be observed, due to high domestic consumption rates.
- In November 2024, Greece had the most significant number of exports, with net exports reaching almost 650GWh.
- The months from October to December contributed for Greece to become a net exporter for 2024.
- In the beginning of 2024, and during the summer months Greece could be characterized as a net importer.

Greece became a net exporter in 2024, with the balance in the end of the year reaching almost 45,000 GWh

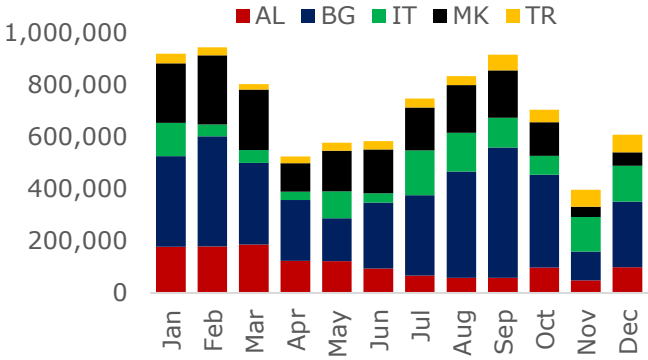
Installed and Planed Interconnection Capacities (MW), [2025-2035]



Electricity Exports Between Greece and Neighboring Countries (GWh), [2024]



Electricity Imports Between Greece and Neighboring Countries (GWh), [2024]



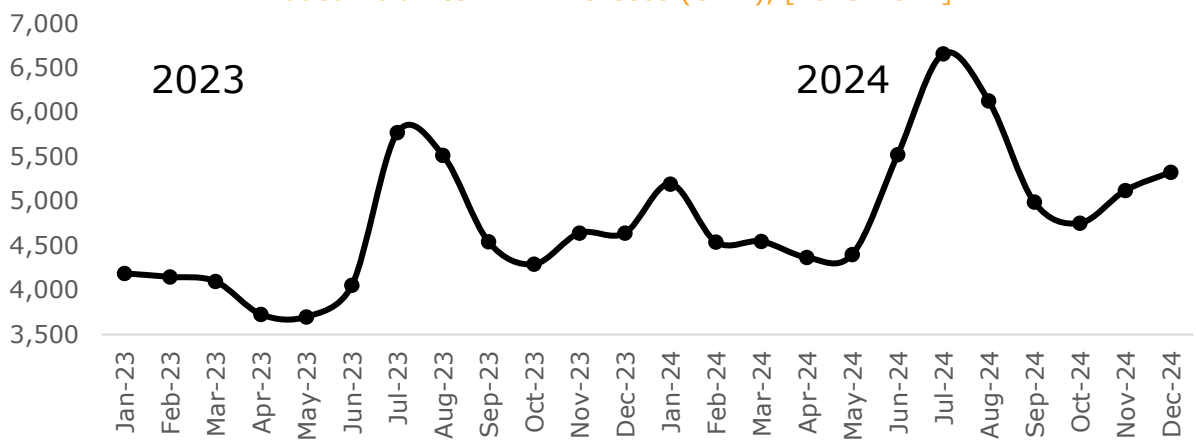
Source: IPTO, HAEE's analysis

Highlights

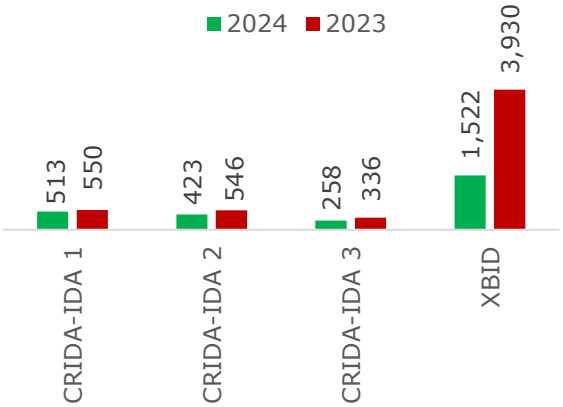
- Main importer for 2024 for Greece was Bulgaria, a neighbouring EU27 member state, contributing 43% of the total imports.
- Italy became the main partner in exporting, acquiring 36% of the total exports, while Turkey, had only 2% of the total exports.
- IPTO is planning to increase the export capacity of Greece by 2035 by 356%, and the import capacity by 339%.
- Currently Greece has export capacity of 2818MW and import capacity of 2916 across all interconnected countries.
- In 2035 the export and import capacities in Greece will reach 12860 MW and 12830 MW, respectively.

Traded volumes in Day Ahead Market display a constantly increasing trend in the domestic market with July reaching peak levels

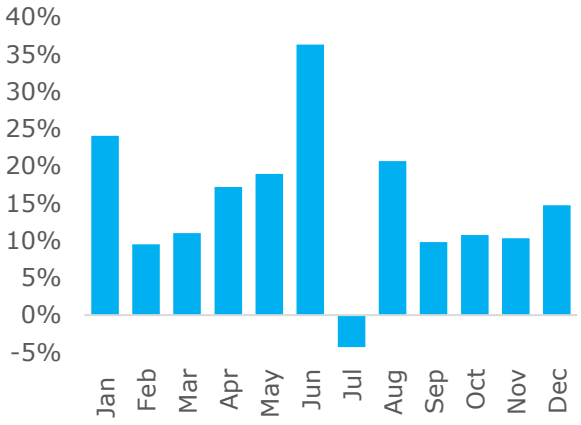
Traded Volumes in DAM Greece (GWh), [2023-2024]



Traded Volumes in Intraday Markets (GWh), [2023 - 2024]



Monthly Change in DAM Traded Volumes (%), [2023 - 2024]



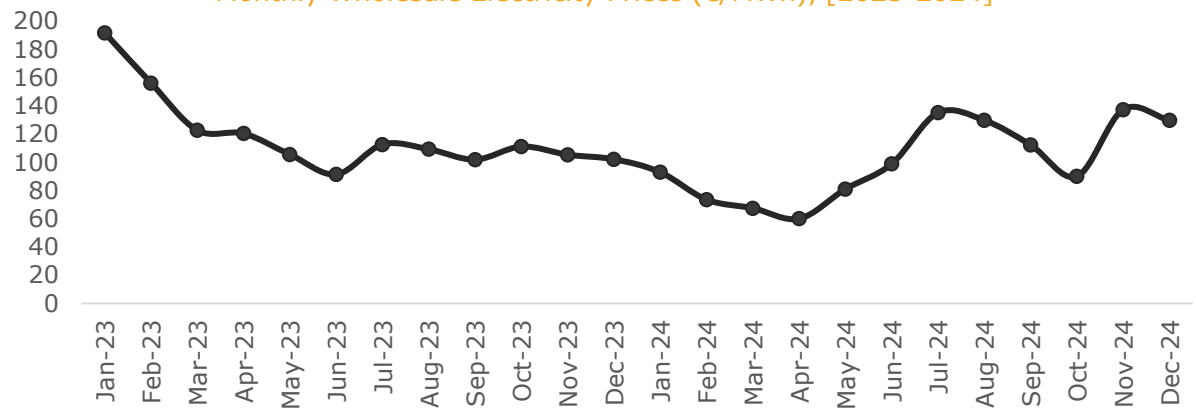
Source: EnExGroup, HAEE's analysis

Highlights

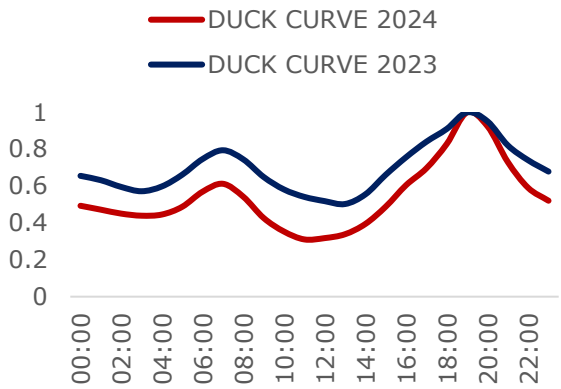
- The "XBID Live" platform gains popularity with the constant integration of RES technologies in the Greek energy mix.
- The traded volumes in DAM increased across all months except from July, and June having the greatest increase.
- Following the same pattern as in DAM, traded volumes increased across all intraday markets as well.
- Volumed traded in "XBID live" platform increased by 158% in 2024, compared to 2023.
- Even though the Spot Market holds most of the traded electricity volumes, to ensure a smooth energy transition more OTC trades should be established.

Following the soaring electricity prices in 2022, we observe a significant decrease during 2023, yet prices followed an upward trend in 2024

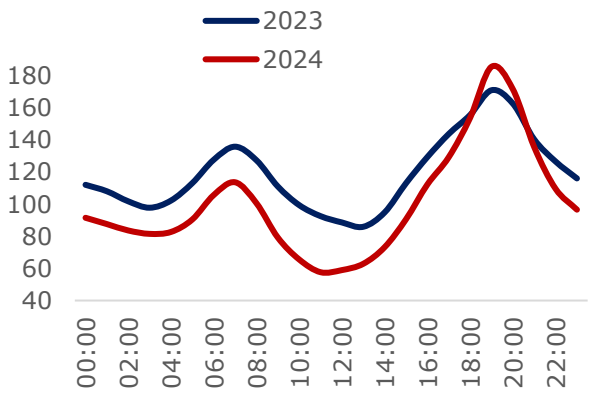
Monthly Wholesale Electricity Prices (€/MWh), [2023-2024]



Normalized Hourly DAM Prices in Greece, [2023-2024]



Hourly Average DAM Prices in Greece (€/MWh), [2023-2024]



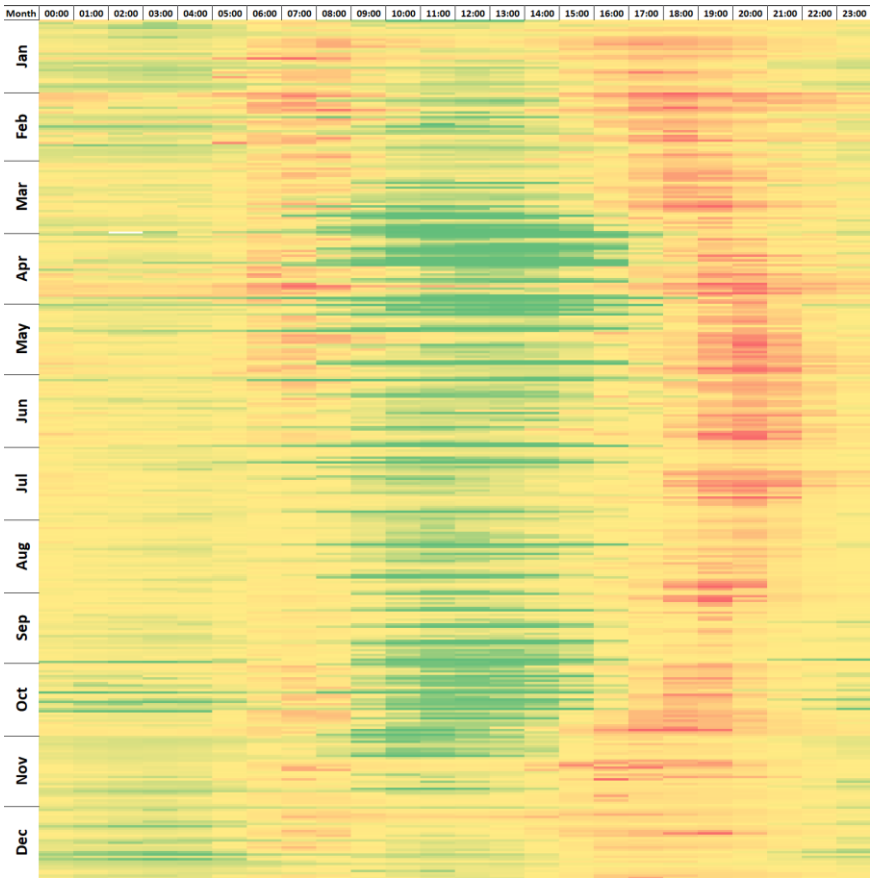
Source: EnExGroup, HAEE's analysis

Highlights

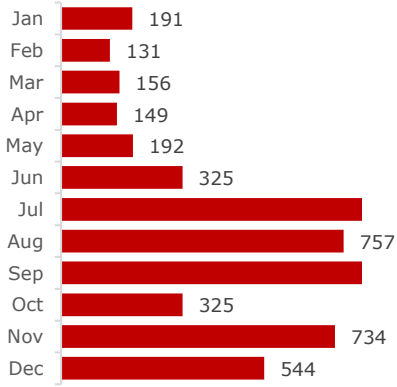
- The "duck curve" becomes more prominent with each passing year, due to oversaturation of solar PVs in the system.
- Electricity prices on hourly average in Greece were lower in 2024 compared to 2023, except in the peak demand hours (19:00-20:00).
- The lowest average monthly price of DAM was in April, compared to November where average monthly price of DAM peaked.
- The volatility in DAM prices in Greece becomes is rather high with DAM ranging between -1.02 and 942 €/MWh.
- In 2024 the Greek DAM had 18 zero price hours and 11 negative price hours, indicating the oversaturation of RES and lack of Storage technologies.

Wholesale Electricity Prices in Greece make more prominent the "duck curve" due to high Solar PV installations on the mainland

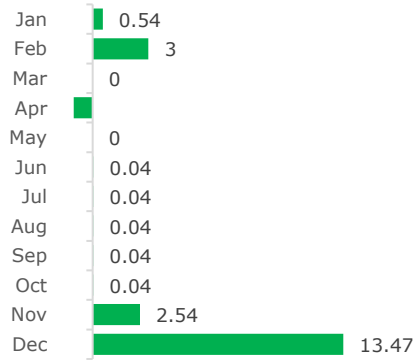
Hourly Heatmap for Greek wholesale DAM prices, [2024]



Maximum Monthly DAM Prices (€/MWh), [2024]



Minimum Monthly DAM Prices (€/MWh), [2024]



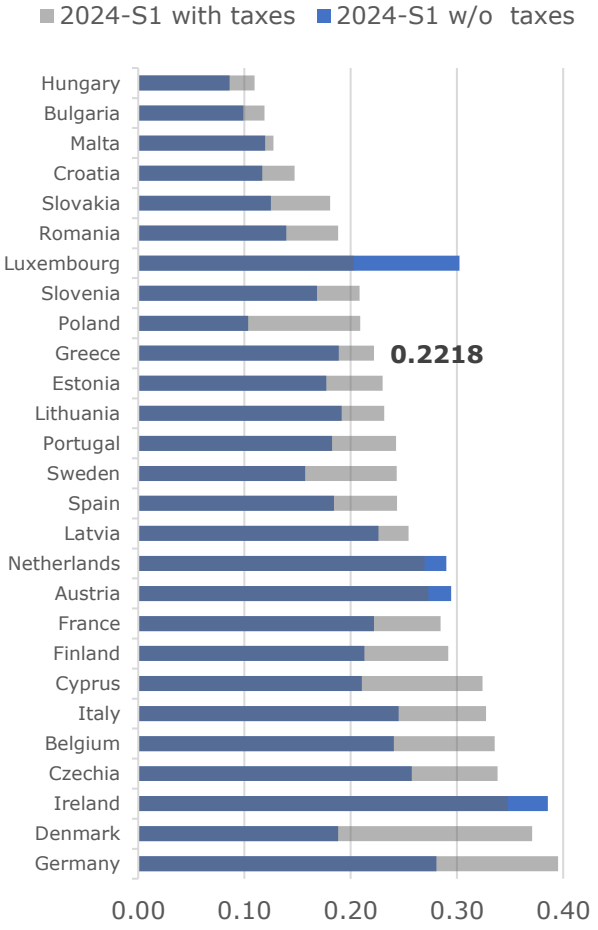
Source: EnExGroup, HAEE's analysis

Highlights

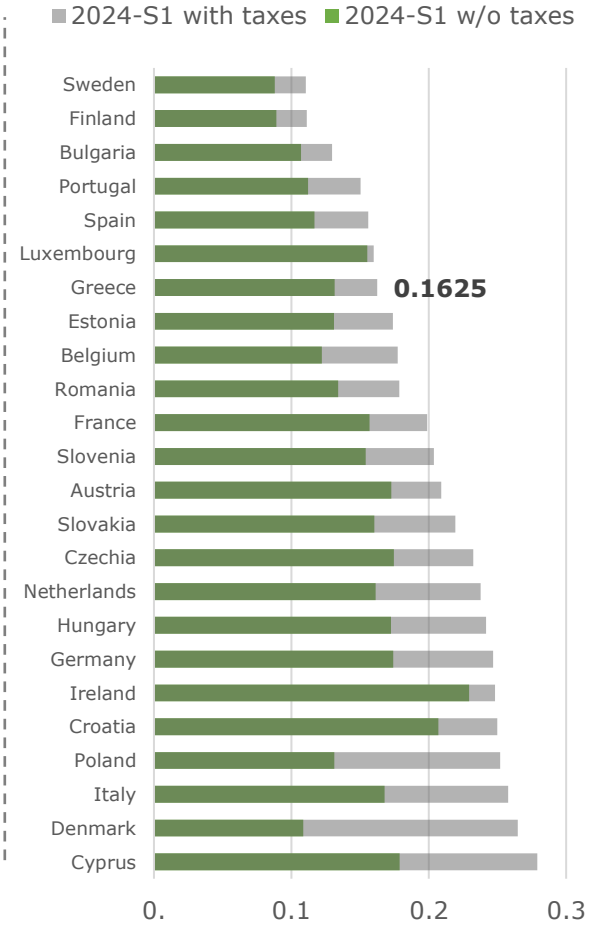
- In 2024 electricity prices in the wholesale market ranges from negative -1.02 €/MWh to an extreme of 942 €/MWh.
- April was the month with the lowest wholesale electricity prices, and the month when the most negative price was detected.
- In September the Greek wholesale electricity market observed the highest price, but in general July was the month with the highest prices.
- Rather high prices can be observed during 6:00-9:00pm due to high domestic electricity consumption.
- In 2024, 211 distinct hours in the wholesale market had prices lower than 1 €/MWh, 201 lower than 0.5 €/MWh, and 11 distinct hours with strictly negative values.

For most EU27 member states electricity prices decreased both for household and non-household consumers during 2024

Electricity Prices for Household Consumers (€/kWh), [EU27-2024 S1]



Electricity Prices for all bands Industrial Consumers (€/kWh), [EU27-2024 S1]



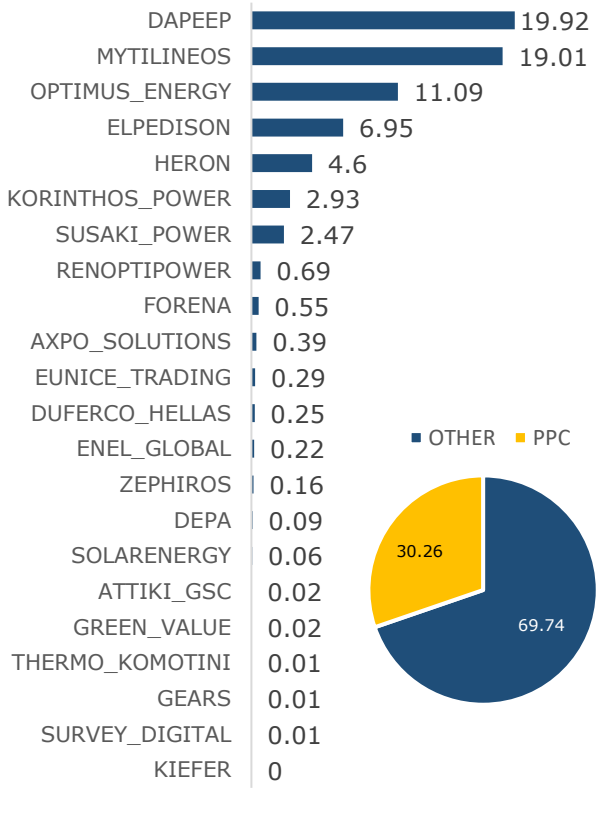
Source: Eurostat, HAEE's analysis

Highlights

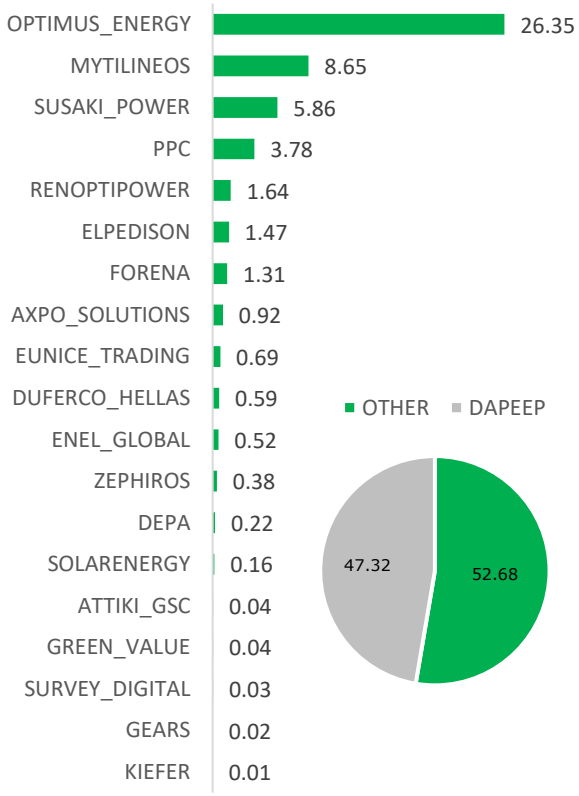
- The household consumers in Greece pay 31.7%, after taxes, more than the industry consumers in the 500-1,999MWh band.
- 9 out of 27 member states raised their household electricity prices form 2023 S2 to 2024 S1, with Sweden raising by 12%.
- Only in 4 out of 27 member states, electricity prices after taxation for non-household consumers from 2023 S2 to 2024 S1 were raised.
- Hungary has the lowest prices both before and after taxation for household consumers, where Germany has the highest prices after taxes.
- For non-household consumers, Finland has the lowest electricity prices, with a 20% decrease in prices from 2023 S2 to 2024 S1.

PPC once again holds the greatest market share in terms of generation in Greece, maintaining over 30% of the total share

Market Shares for Generation per Participant (%), [December 2024]



Market Shares for RES Generation per Participant (%), [December 2024]



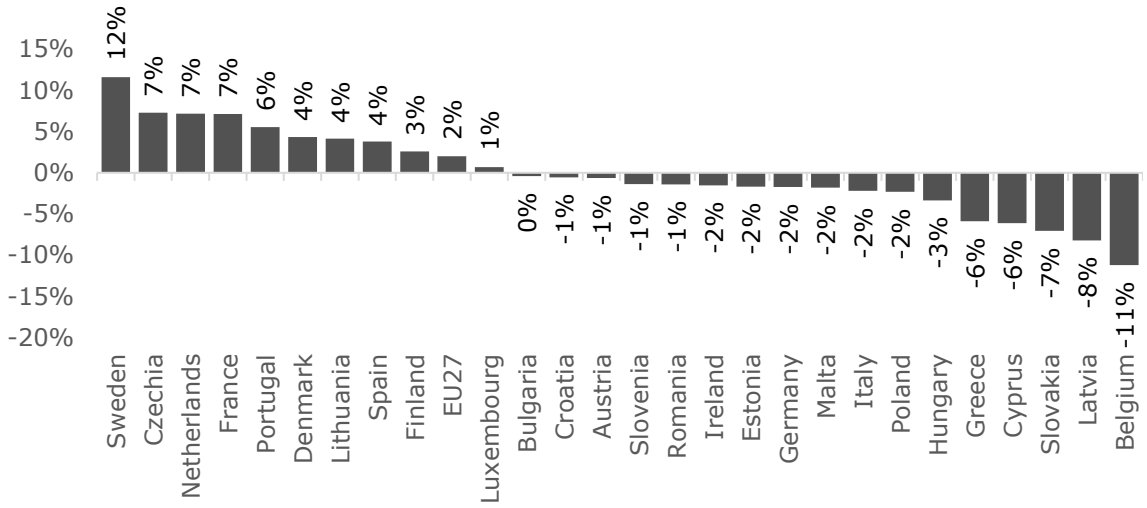
Source: EnExGroup, HAEE's analysis

Highlights

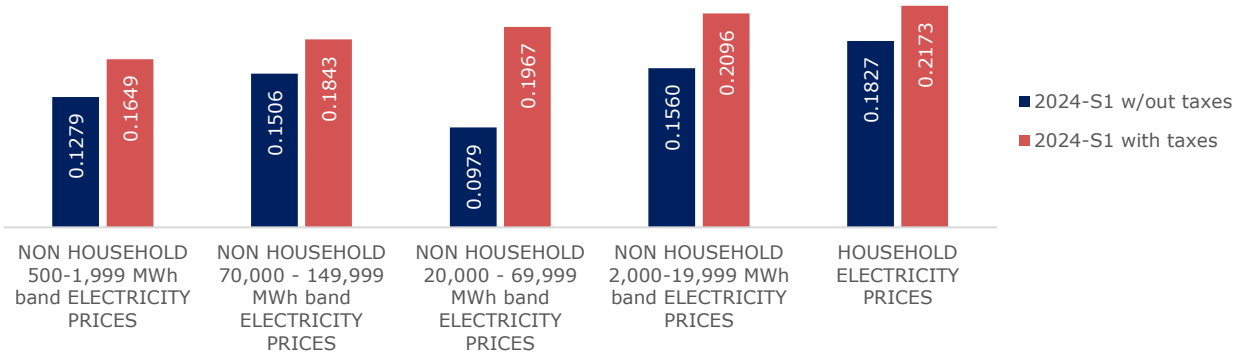
- Market share for domestic load in December 2024, apart form PPC was dominated by DAPEEP, holding 19.92% of the total share.
- In renewable energy, DAPEEP still holds the leading 52.68% of the load, with OPTIMUS_ENERGY holding second place with 26.35% of the total renewable load.
- Apart from DAPEEP and PPC in domestic load MYTILINEOS and OPTIMUS_ENERGY hold over 30% of the total load.
- In renewables energy, only 3 providers hold over 80% of the total RES load, DAPEEP, OPTIMUS_ENERGY and MYTILINEOS.
- PPC's market share in renewable generation continues to drop, holding only 3.78% of the total renewable generation in December 2024.

Greece ranked on the 20th place in terms of electricity prices considering the industrial consumption among EU27

YoY change in Electricity Prices for Household Consumers (%), [2023 S2-2024 S1]



Electricity Prices for Households and Industry band Consumers (€/kWh), [EU27-2024 S1]

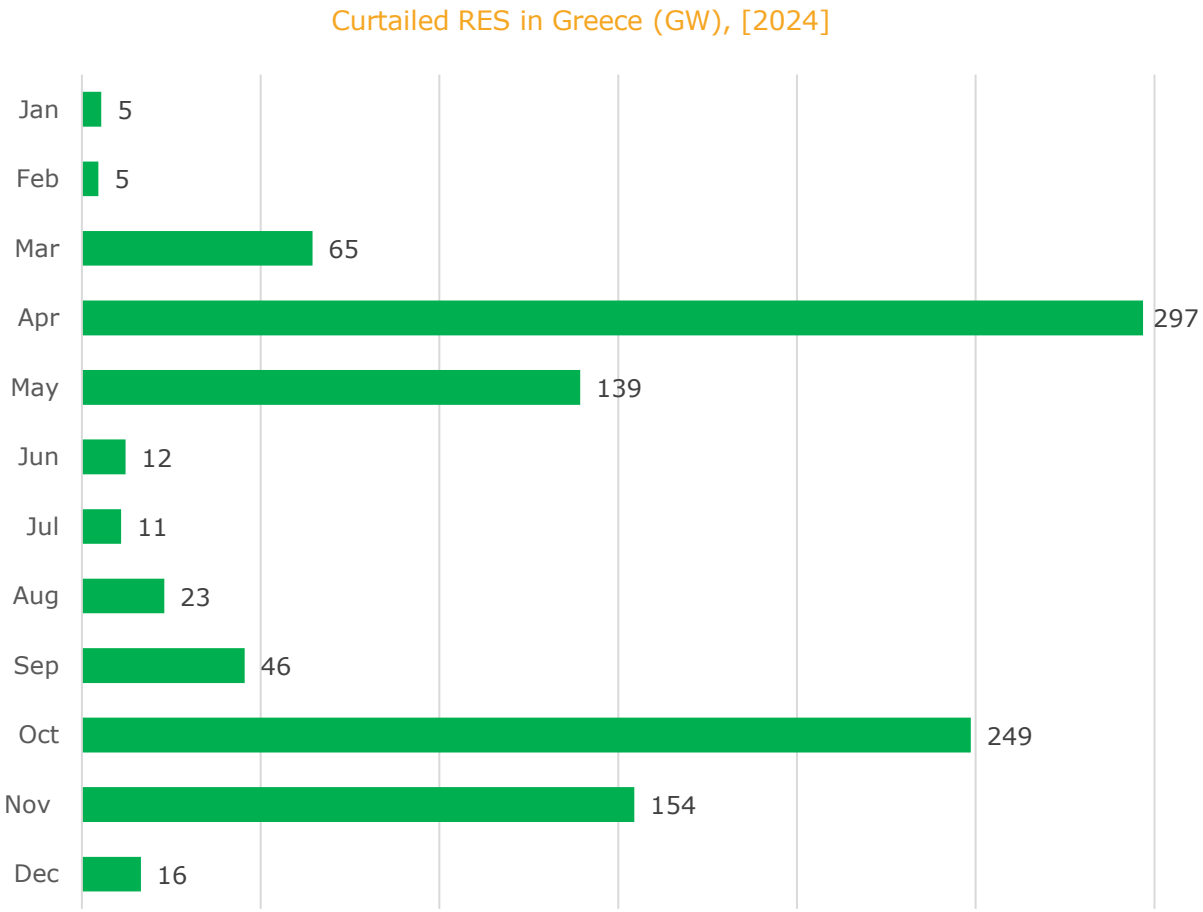


Source: Eurostat, HAEE's analysis

Highlights

- The household consumers in Greece pay only 4% more after taxation than the 2,000-19,999 MWh industry band.
- Greece is one of the most expensive electricity providers for the 20,000-69,000 MWh industry band across the EU27 member states.
- In Greece the 20,000-69,000 MWh industry band faces the most taxation on electricity prices, where taxes reach 22.3%.
- At the same time, across all EU27 member states Belgium has the most most taxation on electricity prices for the same industry band, reaching 149%.
- Slovenia and Czechia are the member states that are facing the lowest taxes amounting in only 7% of the electricity price.

Curtailments from renewable energy generation remains a big problem for the Greek electricity system in 2024



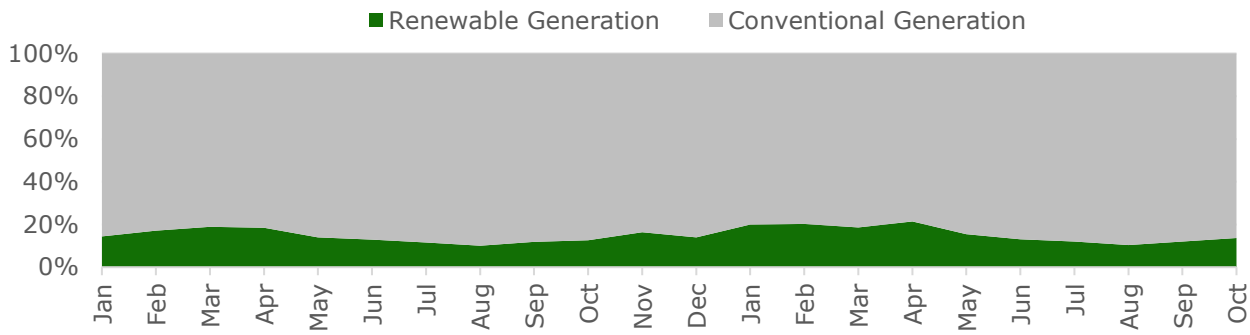
Source: IPTO, HAEE's analysis

Highlights

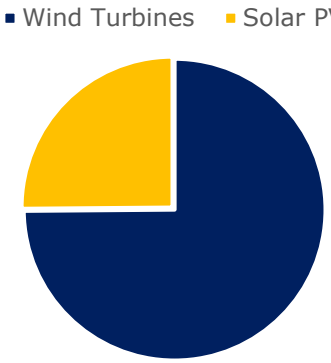
- The exact curtailed volumes cannot be determined, as non-dispatch RES technologies did not have SCADA systems.
- SCADA systems in all non-dispatchable RES (solar PV mainly), became mandatory in Greece only in 2025.
- The curtailments from non-dispatch renewable generation in Greece by an estimate in 2024 surpass the mark of 1000GW.
- Main curtailed RES generation volumes can be observed during the low demand seasons in Greece, spring and fall.
- The curtailed RES generation volumes can be seen during the solar PV peak production hours, when electricity demand is at its lowest.

Electricity generation in the Greek NIIs reliant on conventional generation, indicating the need for distributed renewable sources and storage

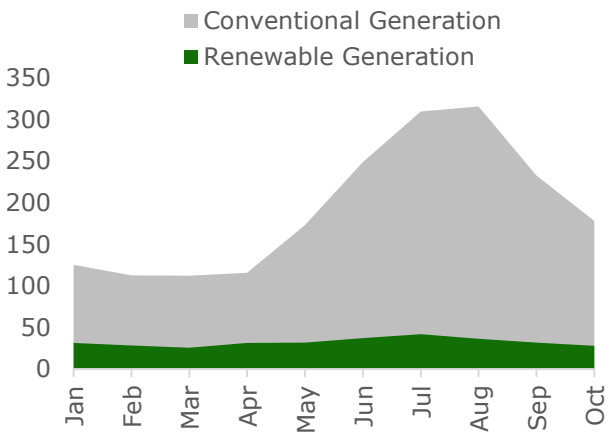
Electricity Generation in the Non-Interconnected to the Mainland Greek Islands (%), [Jan 2023-Oct 2024]



RES Generation Breakdown in the Non-Interconnected to the Mainland Greek Islands (%), [Jan 2024 – Oct 2024]



Electricity mix in the Greek NIIs (MWh), [Jan 2024-Oct 2024]

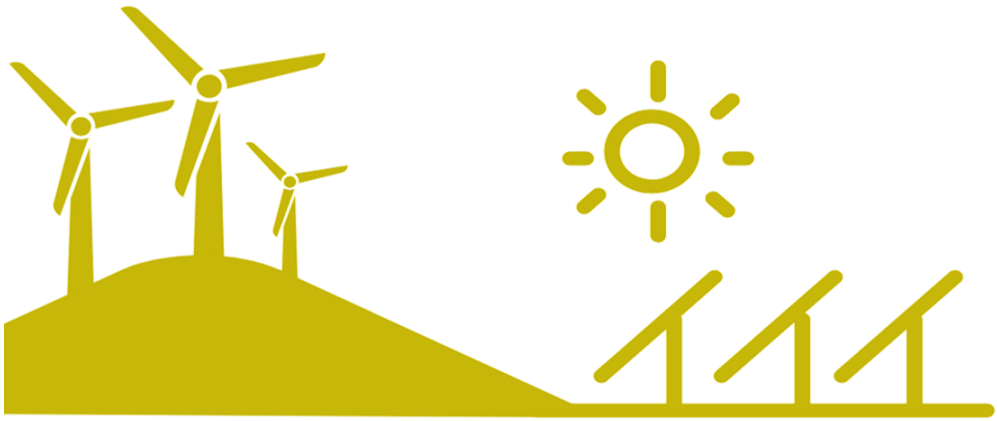


Source: HEDNO, HAEE's analysis

Highlights

- Electricity generation and consumption in the Greek NIIs is peaking during summer season, mainly due to cooling purposes and high tourist rates.
- The conventional generation in the electricity mix of the Greek NIIs has increased by almost 1% in 2024 compared to the same months in 2023.
- Main contributor to the renewable electricity mix in Greek NIIs, remains onshore wind energy.
- Onshore and Offshore Wind potential in northern Aegean is the main driver for high wind penetration in the renewable electricity mix.
- The revised Greek NECP plan is installing 1.9 GW and 11.8 GW of offshore Wind capacity by 2030 and 2050, respectively.

4. Renewable Energy Sources and Storage



Contents

Highlights

Greece ranked at the **11th** place in terms of **RES penetration** to the **energy mix** among the EU member states

24,28 GW

RES Capacity in Greece in **2024** reached **24.2 GW**, an increase of **9%** compared to 2023

126 MW of **onshore wind** turbines were installed in **Greece** in **2024**, bring the **total** installed capacity to more than **5.3GW**

According to the **Greek NECP**, by **2050**, almost **17.5GW** of **batteries** will be installed for **electricity storage**

Greece's **RES share** was **25%** in **2024**, compared to **22.7%** in **2023**

The EU27 achieved a **9% reduction in CO_2 emissions** in 2023 compared to 2022, while Greece accomplished a reduction of 14%

Solar **PV installed capacity increased by 12%** in **2024** compared to 2023, reaching a new peak of **18.9 GW**

PPAs in **2024** followed a downward trend amounting only to **15.2 GW**, compared to **2023** with **17.1GW**

The **number of issued storage licenses** in Greece reached **1189,** covering projects with a total capacity of **57.36 GW**

Overview

In the path towards net-zero the efforts of decarbonization have set the bar high for incorporating RES in the energy mix, and making the energy mix greener. Finaly after the downfall of Covid19 and the Russo-Ukrainian war the installed capacities in the EU27 rose by 1.49% in 2023, and by 1.16% in 2022 compared to the previous year.

A record fall in CO_2 all around the EU27 member states, with a 9.3% in the EU27. Bulgaria particularly dropped the CO_2 emissions in the country by 30.6% in 2023 compared to the previous year, Greece followed with a 14.18% decrease. These results are expected as the installed capacities in all the EU27 member states have been accelerating since 2017, though Greece seems to follow a more aggressive tactic compared to the EU27 showcasing the need for new technologies that with a focus on energy storage.

Capture prices for RES technologies, especially wind and hydropower are low, especially compared to conventional generation. Alone this is signifying low energy prices but brings to the surface the problem of remuneration of these technologies as they tend to by rather costly during the installation phase. To solve this, the Special Purchase Price, published by DAPEEP monthly keeping the annual average price at around 95€/MWh for each of the RES technologies. The same is happening for storage technologies, especially green hydrogen that has been under the microscope lately.

Wind and Solar generation in the EU penetrated the electricity mix by 17.5% and 11.05% respectively, with Denmark once again holding the first place (with almost 70%) and Greece following close by in the 7th place with 43.27% of RES penetration to the electricity mix. For Greece, the RES penetration to the energy mix overall dropped compared to the previous year, partially due to rise in electricity demand and partially to RES curtailments.

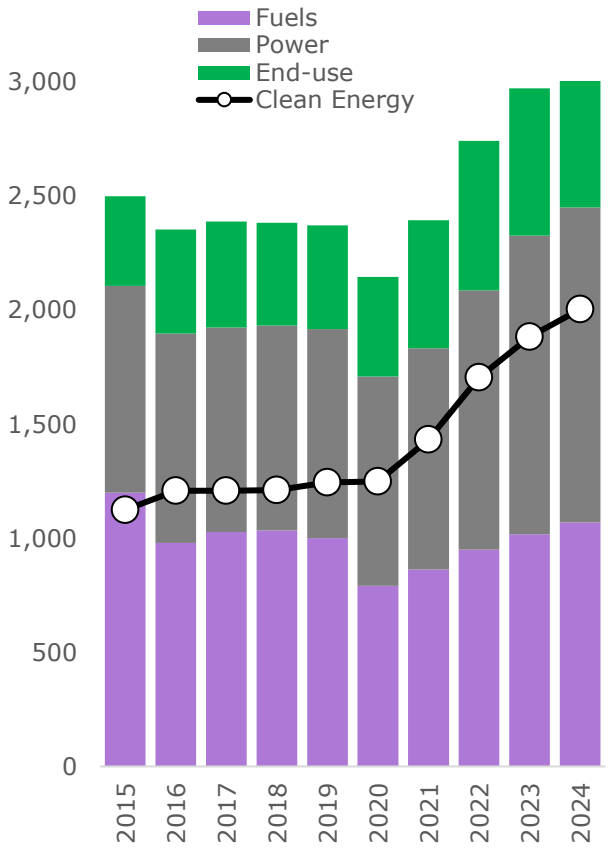
The upper price limit for the renewable generation in the electricity mix set at 85 €/MWh, was lifted in the end of 2023. Since then, the prices for each generation type have been growing and being rather volatile during the year of 2024.

The EU27 currently has 426 GW of Solar PV and Wind turbines installed, Greece has 14.22 GW of the same technologies, with Solar PVs outgrowing Wind Turbines. Even though the premises of Greece have yet to be exploited to their full potential in RES installation the system today calls for means of storage, the Greek NECP calls for 17.47 GW of batteries only for electricity storage needs, while RAEWW has issued in total 57.36 GW of battery licenses since 2011.

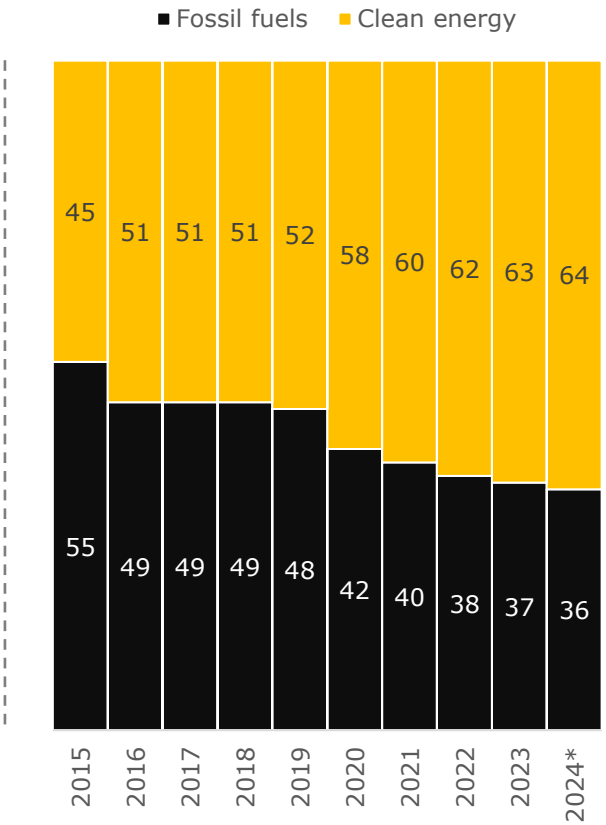
At the technology cost both for pack and cell (for li-ion batteries) has been steadily dropping down making them more accessible and less risky in implementation. To further support the RES technologies PPAs also should gain some ground as the disclosed traded volumes in 2024 are lower compared to the previous year.

2024 delivers a sharp acceleration in clean energy investment and a clear sectoral shift toward power and end-use efficiency

Global Energy Investments per Type (billion $), [2015-2024]



Global Fossil Fuel and Clean Energy Shares of Total Energy Sector Investment (%), [2015 – 2024]



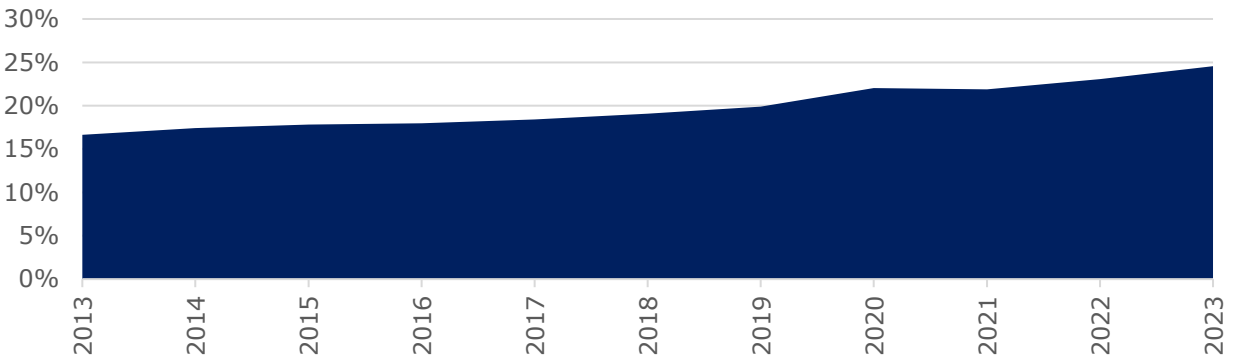
Source: IEA, HAEE analysis

Highlights

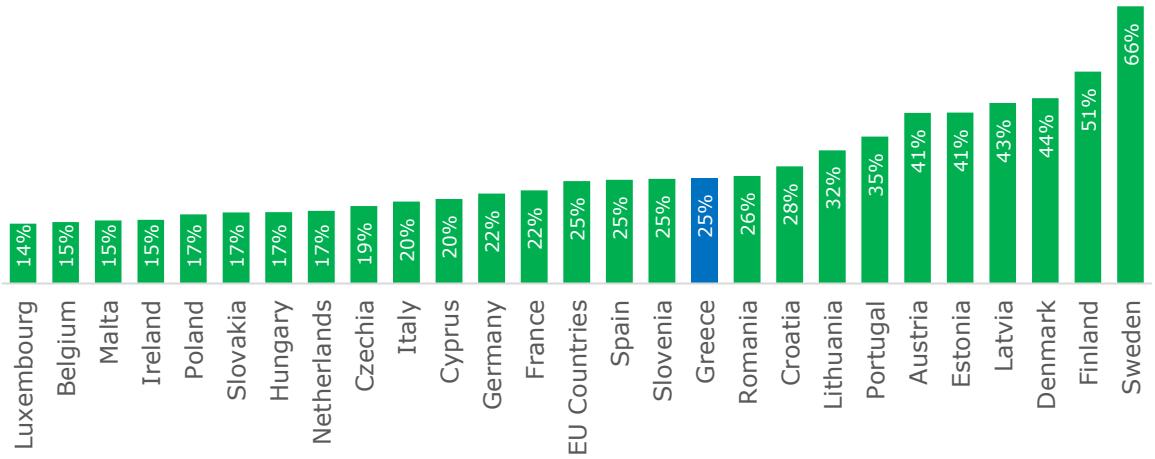
- Total global energy investment grows by $154bn from 2023 to 2024, reaching the largest y-on-y increase since 2021.
- Clean energy investment rises by $73 bn in a single year, from $1,309B in 2023 to $1,382B in 2024, pushing its share to 64% of total energy investments.
- Power sector investment alone increases by $24 bn y-o-y, reinforcing its role as the fastest-growing category, up nearly 10% since 2022 and totaling $689B in 2024.
- Fossil fuel investment still rises, but its share of global energy investment drops to just 36%, continuing a steady multi-year decline.
- Cumulative investment in clean energy over the last 3 years (2022–2024) exceeds $3.8 trillion, compared to just over $3 trillion in fossil fuels over the same period.

Following a decline of RES share in Europe during 2021, in 2023 we observe a steady growth for a second consecutive year

EU-27 RES Share Evolution in the Energy Mix (%), [2013-2023]



Share of Energy from RES in the EU27 Member States in the Energy Mix (%), [2023]

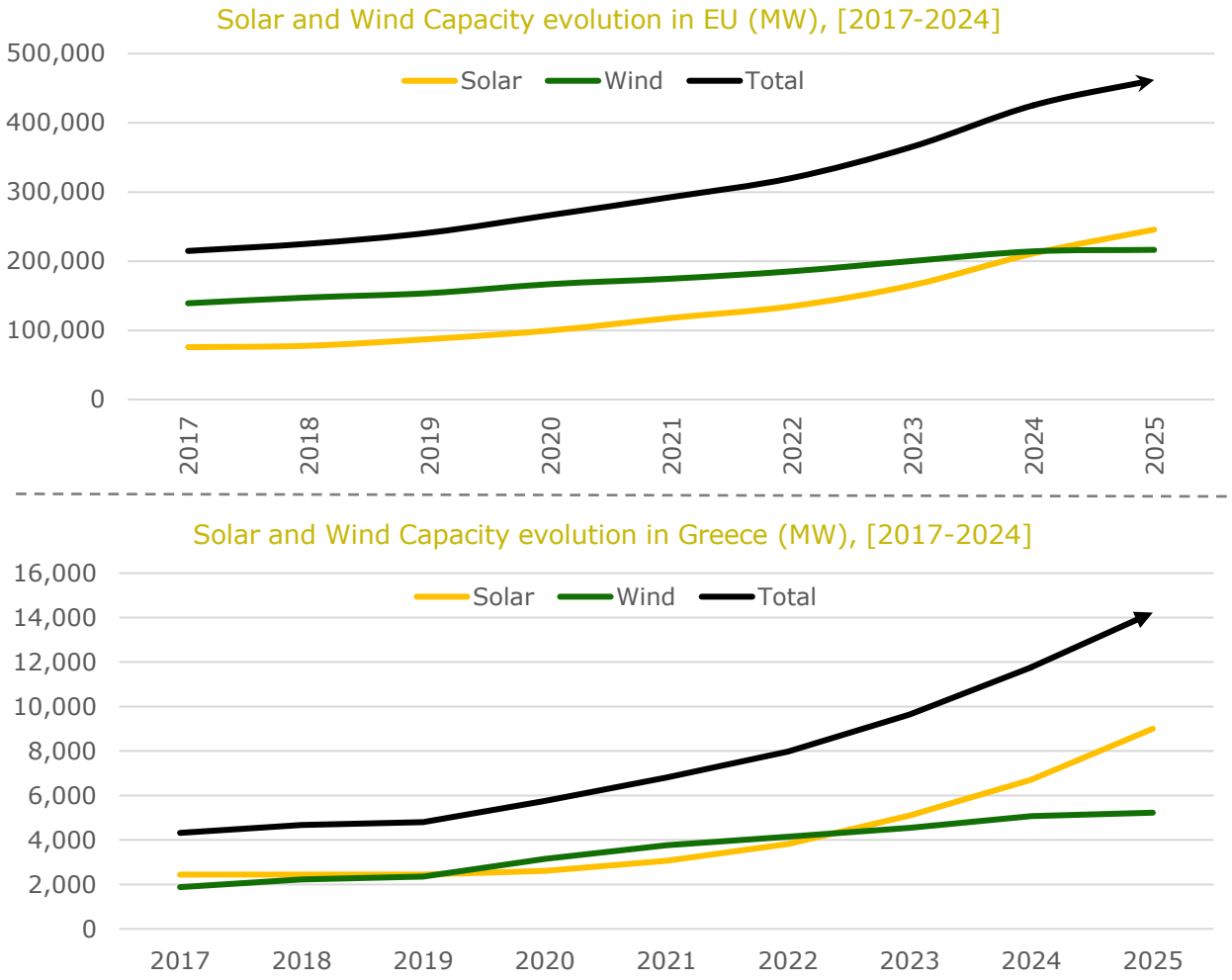


Source: Eurostat, HAEE' analysis

Highlights

- The EU27 in the last 10 years has increased its RES share in the energy mix by 7.89% coming closer to the 2030 target of at least 42.5%
- Sweeden once again had the highest RES share in its energy mix for 2023, reaching up to 66.3%.
- Greece came to the 11th place in RES share in its energy mix for 2023, surpassing the 25% benchmark and surpassing the RES share in EU.
- Luxemburg and Belgium are the Member States with the lowest RES penetration in their energy mix having 14.35% and 14.74%.
- The EU27 has set a target of 42.5% of RES share in 2030 but aiming for a rather optimistic goal of 45%.

The trend of RES installed capacities in Greece is more aggressive compared to the trend of the EU member states cumulatively



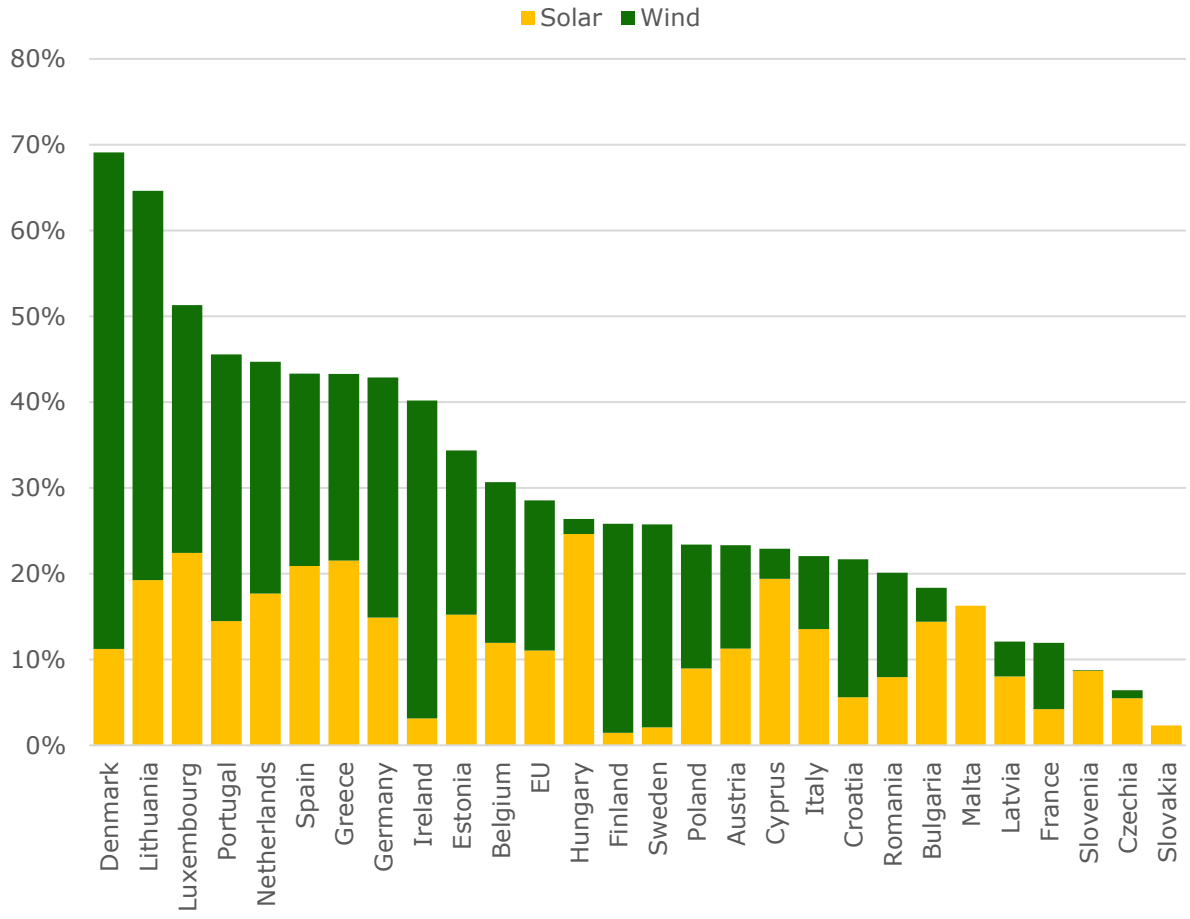
Source: ENTSOE, HAEE's analysis

Highlights

- Form 2023 and onwards, solar PV installed capacities are overtaking the installed wind capacities.
- Onshore wind capacities in Greece follow a steady growth trend, but their potential is not completely exploited domestically.
- Total RES capacities both in Greece and EU27 have accelerated with the path towards decarbonization.
- The trend in EU27 is different from Greece regarding the installed RES capacities, EU27 was leaning towards Wind installations.
- In 2024 the EU27 surpassed the installed capacities in Solar PVs compared to both Offshore and Onshore Wind installations.

Greece is ranked 7th in the EU27 in terms of energy from renewable sources and 3rd in EU-27 in terms of solar penetration

EU Member States Penetration of Solar and Wind Generation in the Electricity Mix (%), [2024]



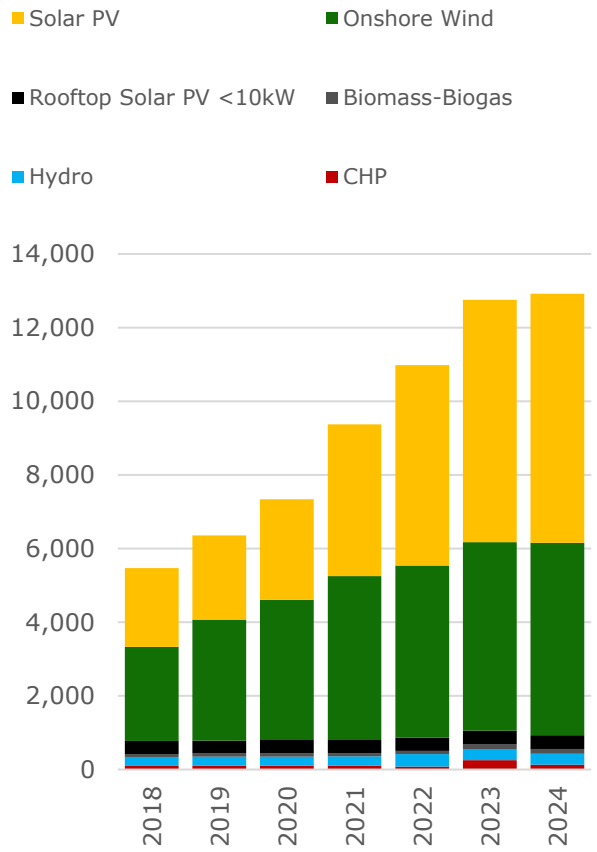
Source: Ember, HAEE' analysis

Highlights

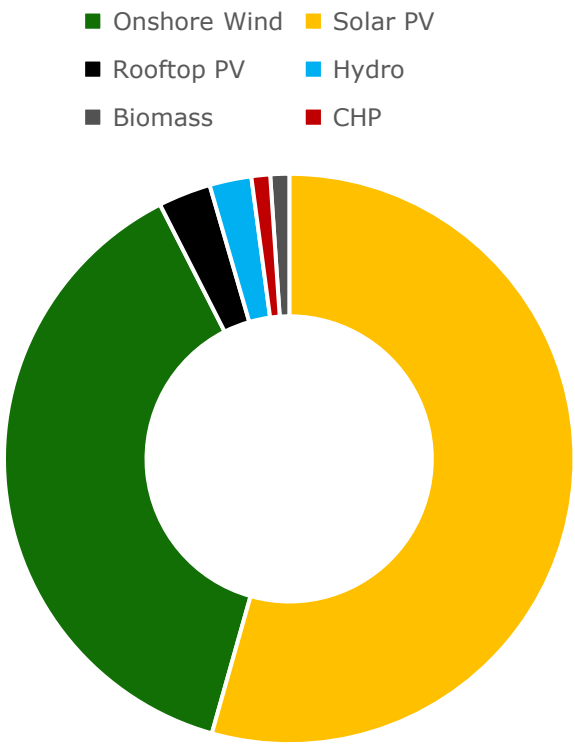
- Denmark leads in wind energy penetration, reaching approximately 57%, while its solar energy penetration is over 10%.
- Greece has a notable contribution both form solar and wind energy, at approximately 21% for both technologies.
- In Greece, the penetration of solar energy increased by 3%, while penetration of wind energy remained at approximately the same levels.
- Slovakia, Czechia and Slovenia being the lowest in renewable energy penetration in 2024, are mainly focusing on solar energy.
- In EU27, solar and wind energy penetration has reached 28.5% steadily aiming for the 2030 target of 42.5%.

Solar PVs and Onshore Wind dominate the RES installations in Greece, with a remarkable growth during the recent years

Installed Capacity of RES by Type in Greece (MW), [2021 – 2024]



RES Share by Type in Greece (%) [2024]



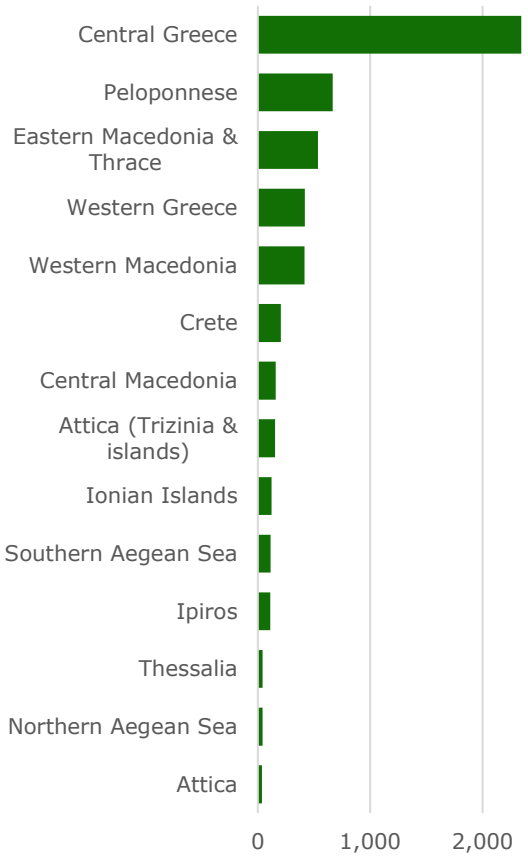
Source:DAPEEP, HAEE's analysis

Highlights

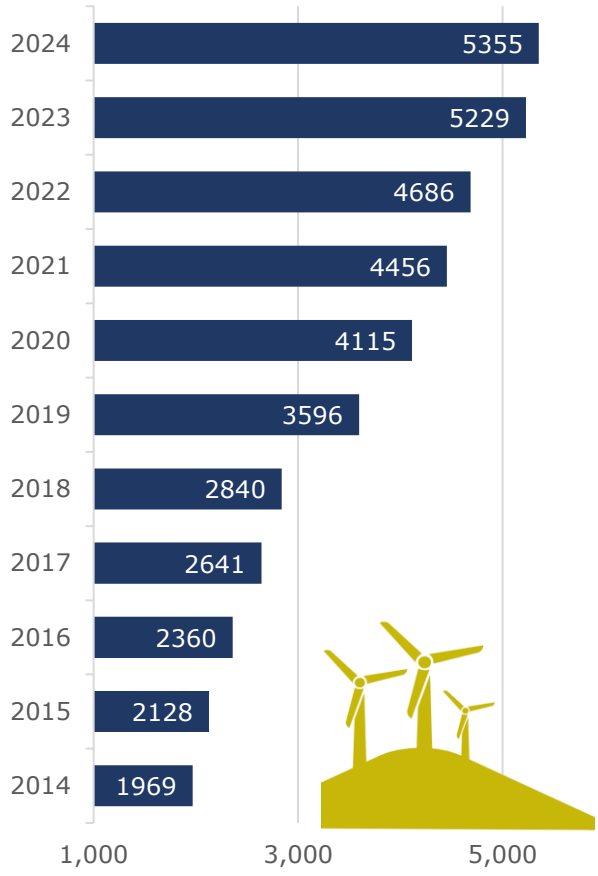
- Solar PVs hold the greatest share of installed capacities in Greece, exploiting the high irradiation, with Wind Turbines coming close behind for the last 4 years.
- In 2024 Solar PVs and Onshore Wind combined hold over the 88% on the installed RES capacities in Greece.
- After 2021 Solar PVs installation surpass massively the Onshore Wind installation, with a steady growth domestically.
- Solar PVs hold over 50% of the installed RES capacities, with Onshore Wind following with 38% of the share.
- In 2024 the growth of the installed RES capacities was not as sharp, indicating a saturation of the system.

Steady growth in Onshore Wind capacities installations over the past decade in Greece presenting a 270% increase

Wind Capacity by Region (MW), [2024]



Installed Wind Capacity (MW), [2024]



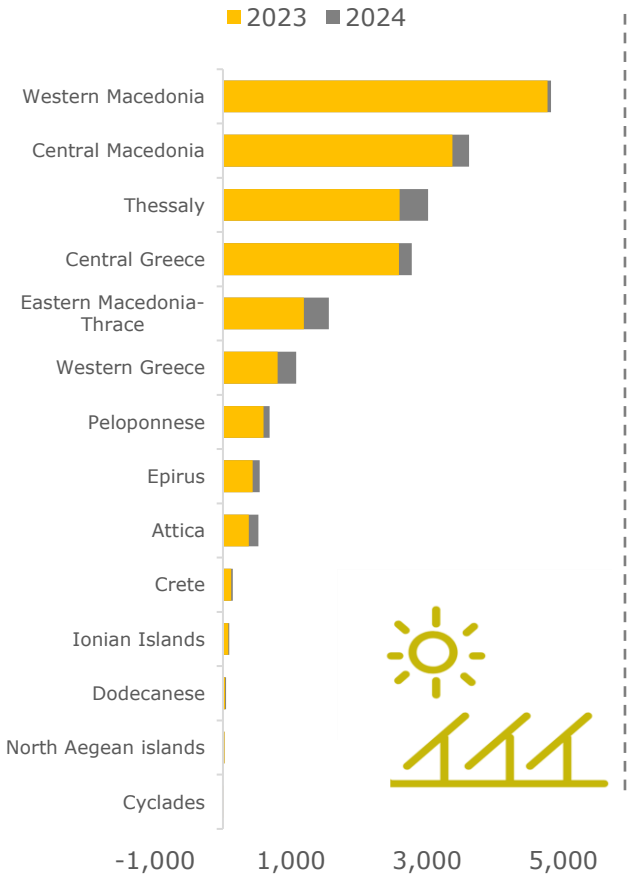
Source: HWEA, HAEE's analysis

Highlights

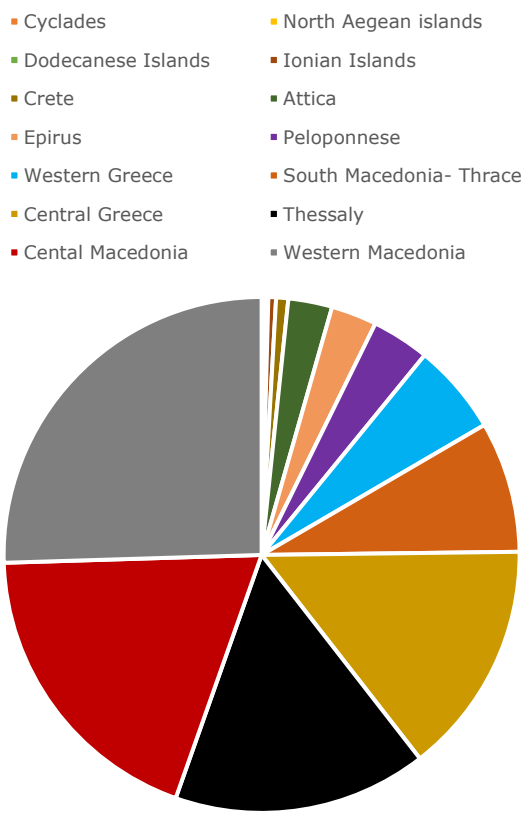
- The greatest share of installed Onshore Wind capacities is in Central Grece, holding over 43% of the total installed capacities.
- Peloponnese, Easten Macedonia & Thrace are following behind with over 22%, or 1200 MW installed.
- Northern Aegean has minor Wind Turbine installations, despite the great potential of the area, both for Onshore and Offshore wind.
- In 2024 Greece had a 2.5% increase in installed Onshore Wind capacities, although not as remarkable as 2023.
- In 2024 an additional 126 MW of Onshore Wind technologies were installed, but the dynamic of North Aegean island remains unused.

Greece added almost 2000 MW in Solar PV installed capacity in 2024 compared to 2023, amounting in a 11% annual increase

Solar Capacity by Region (MW), [2023- 2024]



Installed Solar PV Capacity (%), [2024]



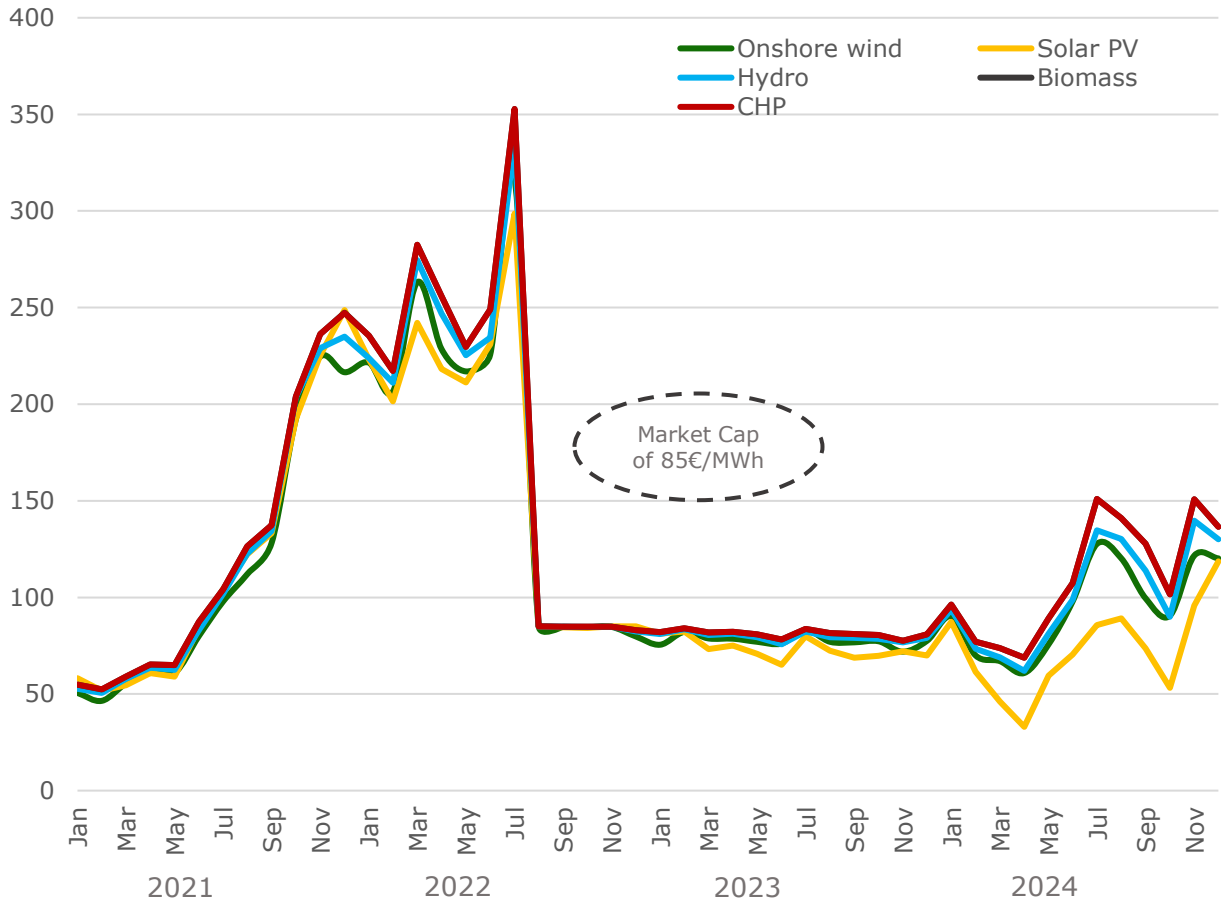
Source: IPTO, HEDNO, HAEE's analysis

Highlights

- Most Solar PV installed capacities are once again installed in Western Macedonia, with Central Greece following close behind.
- Dodecanese islands in the Aegean see had the most YoY increase in installed Solar PV capacity, an astonishing 39%.
- Attica follows close behind Dodecanese islands with an increase of 37%, and installed capacity of 520.8MW in total.
- Cyclades and Western Macedonia on the other hand had the least increase in installed capacity, summing up to only 1% each of them.
- The overall installed PV capacity in Greece came up to by almost 19000MW for 2024, with an increase of 11%.

Special Market Prices for RES technologies in 2024 show increased volatility with Solar PV capturing significantly lower prices

Special Market Price (SMP) in Greece for RES (€/MWh), [2021-2024]



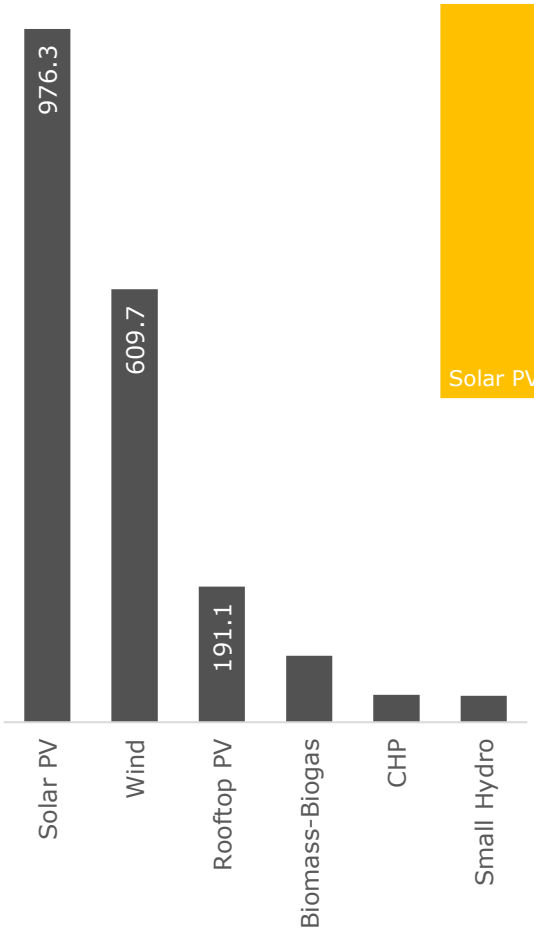
Source: DAPEEP, HAEE's analysis

Highlights

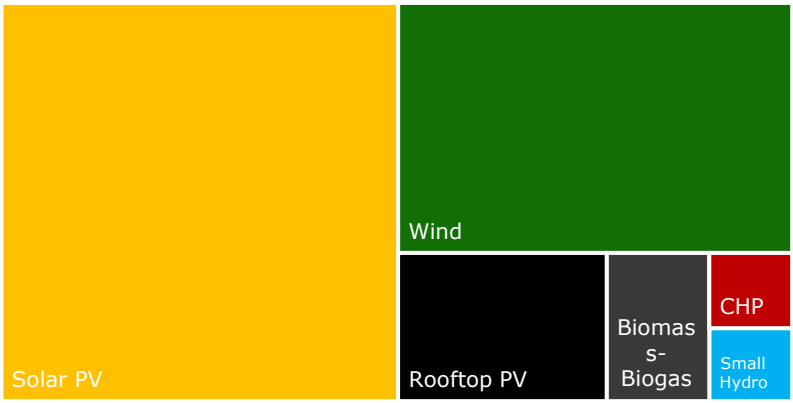
- The Market Cap of 85€/MWh was introduced in July 2022, and lifted in December 2023, bringing back lower the SPP again.
- All SPPs are being rather volatile with a gradual increase in 2024, compared to 2023 where a Market Cap was implemented.
- CHP has the highest SPP compared to all other RES technologies, with peak during the summer months.
- The overall trend in SPPs indicates high volatility throughout the year, with a notable low in September followed by high increase towards the end of 2024.
- In 2024, SPPs exhibit a gradual upward trend, with volatility and an increase towards the end of the year, reflecting market adjustments after the Market Cap removal.

Rapid growth of clean electricity led by cheap solar and wind is replacing fossil fuels in the power sector, and beyond through electrification

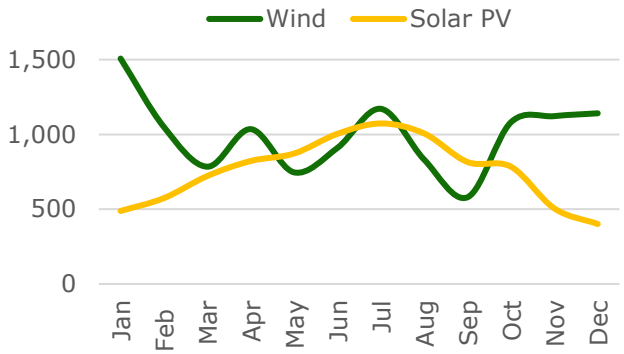
Revenue per RES Technology in Greece (mill €), [2024]



Revenue Share per RES Technology in Greece (%), [2024]



Production of Wind and Solar in Greece (GWh), [2024]



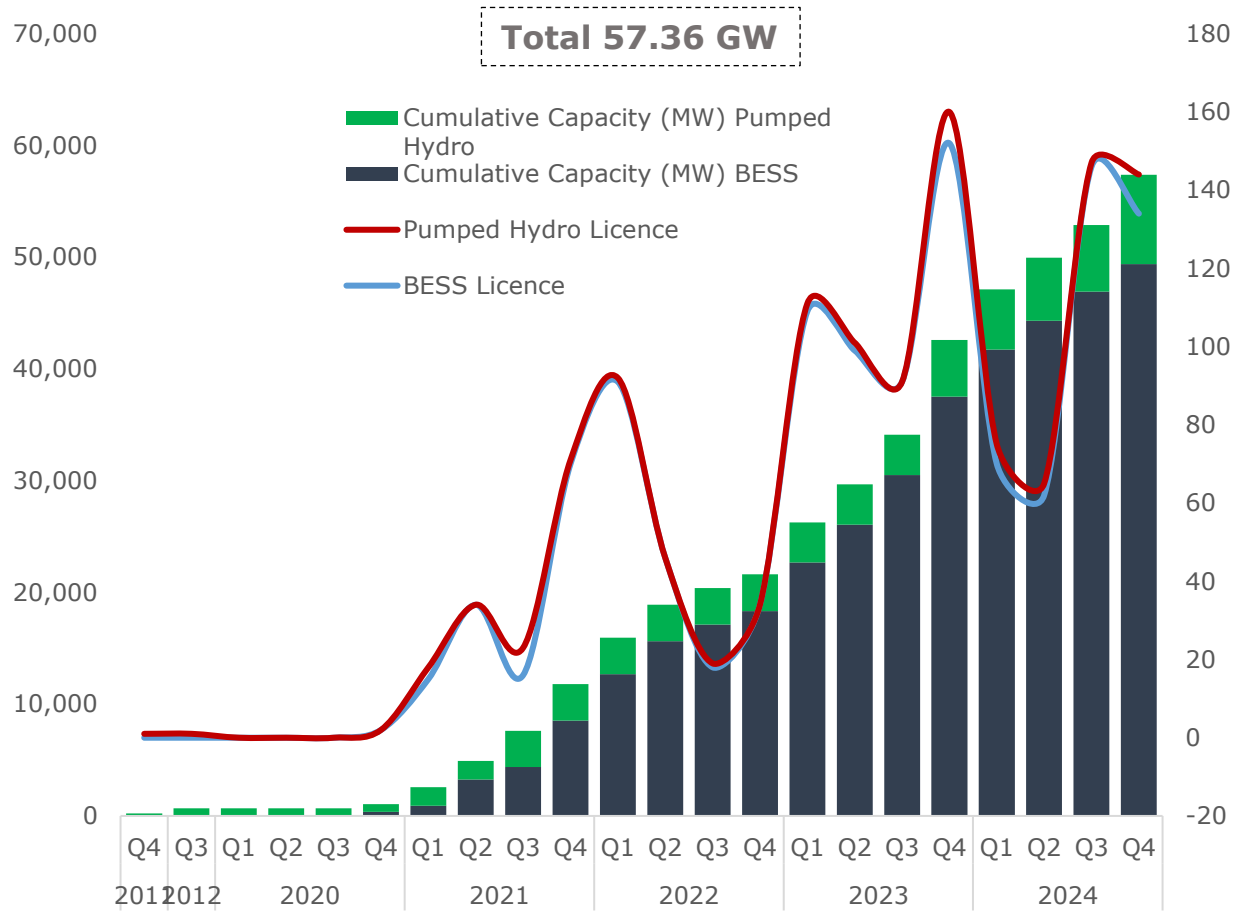
Source: IPTO, DAPEEP, HAEE's analysis

Highlights

- Over 50% of the revenues from renewable energy technologies in 2024 was due to Solar PV, with Onshore wind following in second place.
- Small Hydro and CHP hold the smallest share in the revenues from RES technologies, summing up to 75.9mil € for 2024.
- The Solar PVs production Pattern follows the same distribution throughout the day and the year.
- Wind Turbines have a greater production rate during winter months, contrary to Solar PVs.
- From the RES technologies, Rooftop PVs have the third place in the revenues acquired by technology, with Biomass-Biogas following.

In 2024 alone in Greece, over 14 GW of storage technology licenses were issued with focus on BESS technology

Storage Capacity Licensed and Producer Certificates in Greece (MW), [Q1 2021 – Q4 2024]



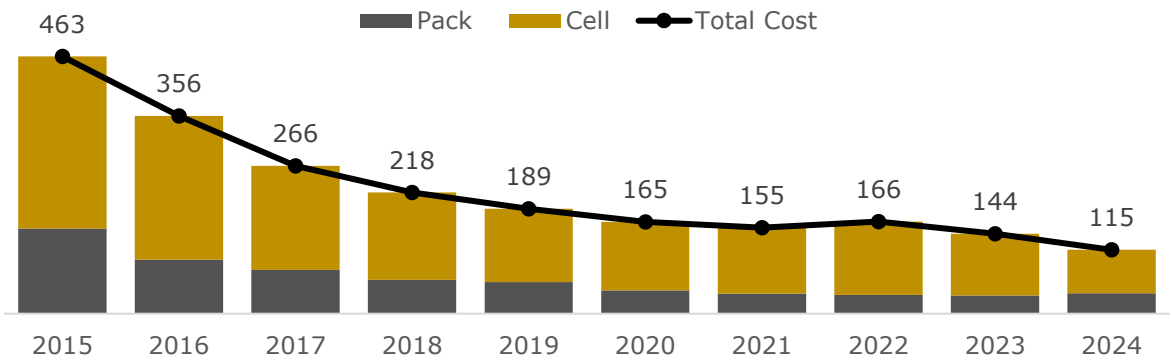
Source: RAEWW, HAEE Analysis

Highlights

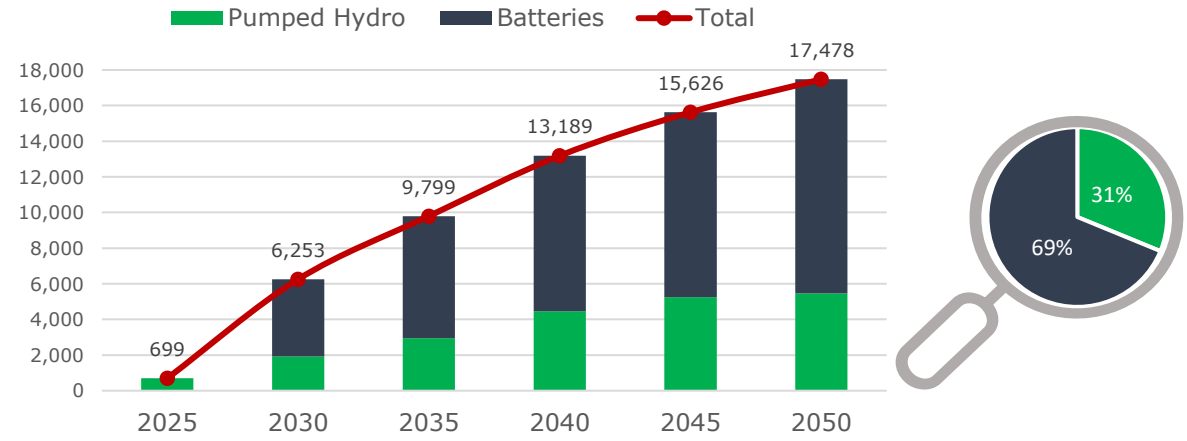
- In the way of achieving net-zero by 2050, Greece has a strong focus on BESS and Pumped Hydro technologies, as green hydrogen is still too expensive.
- Volatility in the number of licenses issued each quarter can be observed over the past 4 years. Mainly due to government auctions.
- The growth in Pumped Hydro compared to BESS technology is much slower and makes for 20% of the total capacity.
- In the third quarter of 2024, almost 3 GW of BESS and Pumped Hydro storage licenses were approved.
- In 2024 in Greece 431 licenses were given for storage technologies, 412 for BESS and 19 for Pumped Hydro.

As batteries are becoming more accessible and economically viable, RES technologies combined with storage will lead the way to decarbonization

Li-ion Battery Cost ($/kWh), [2018-2024]



Storage Capacities Projections in Greece for Electricity Storage (MW), [2025-2050]



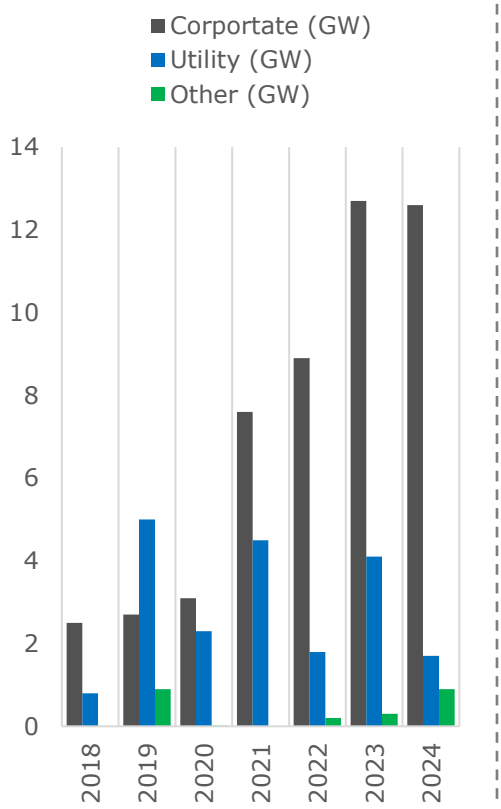
Highlights

Source: Bloomberg, Greek NECP, HAEE analysis

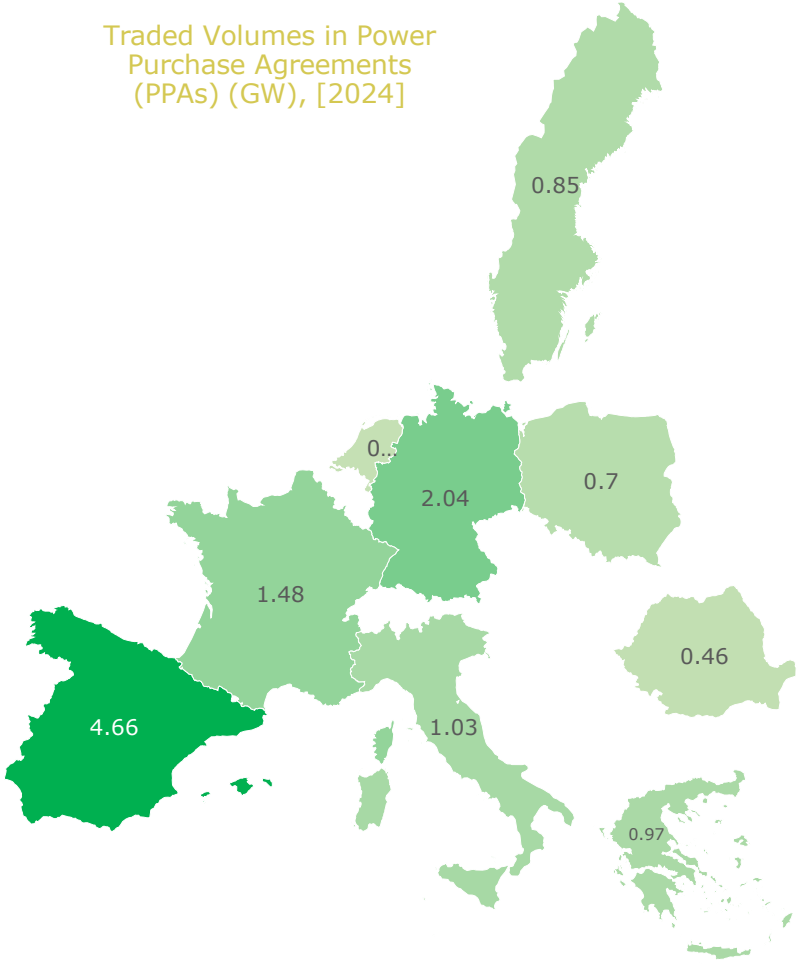
- Cost of Li-ion batteries has been dropping significantly in the past 10 years, making the technology more accessible.
- Following the downward trend, it is expected for Li-ion battery cost to drop down to 112 $/kWh, mainly coming from pack prices.
- As per the Greek NECP, the country will have 6.2 GW of storage in 2030, and almost 17.5 GW of storage by 2050.
- By 2030 it is estimated for Greece to have 1.9 GW of pumped hydro and 4.3 GW of battery storage.
- Batteries will allow for renewable energy participation in the balancing market, increasing further the renewable energy in the electricity mix.

Even though PPAs achieved their peak in popularity and traded volumes in 2023, 2024 shows a decrease in volumes, but not trades

Deal Flows (GW) and Number of Disclosed PPAs (%), [2018-2024]



Traded Volumes in Power Purchase Agreements (PPAs) (GW), [2024]



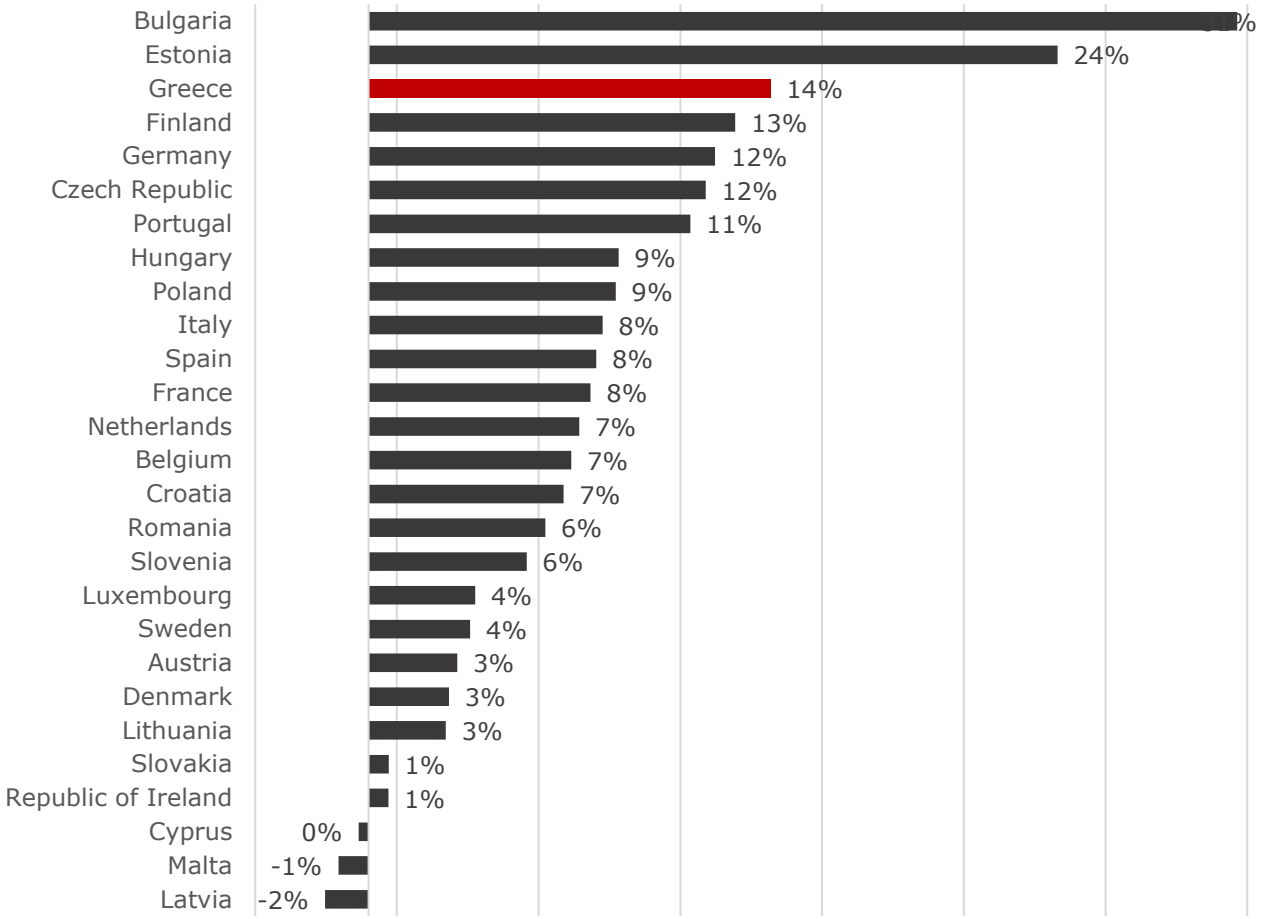
Source: PexaPark, HAEE's analysis

Highlights

- In 2024 15.2 GW of PPAs were disclosed in Europe, with 316 deals representing these volumes.
- France increased its PPA volumes traded in 2024 from 2023 by a stunning 127%, while Spain decreased the PPA traded volumes by 55%.
- Spain was the country with the most traded volumes in disclosed PPAs with 4.66GW, and Netherlands the country with the least volumes traded with 0.39GW.
- In 2023 270 disclosed PPA deal were conducted, compared to 2024 where 316 deals were conducted with 17.1 GW and 15.2 GW, respectively.
- Traded volumes in PPAs, 8 GW in Solar energy, 3.1 GW and 0.9 GW in Onshore and Offshore Wind Energy respectively, and 2.7 in a mix of Solar and Wind power.

The EU27 accomplished a 9% reduction in CO_2 emissions in 2023 compared to 2022, while Greece followed with a 14% reduction

YoY change in CO_2 emissions in EU27 (%), [2022-2023]



Source: Eurostat, HAEE's analysis

Highlights

- Across all EU27 member states, Germany was had the most CO_2 emissions, reach an astonishing 477,174,998 tones in 2023.
- Bulgaria had the greeted decrease in CO_2 emissions across all EU27 member states, with a 31% reduction.
- Following Bulgaria came Estonia and Greece with a 24% and 14% reduction, placing them in the top 3 countries.
- On the contrary Latvia and Malta had a 2% and 1% increase in 2023 in CO_2 emissions.
- Cumulatively EU27 had 2,088,657,364 tones of CO_2 emissions in 2023, while in 2022 2,303,466,818 tones of CO_2 emissions.

5. Natural Gas

Contents

Highlights

The EU27's total **natural gas demand** in 2024 was 363.9 bcm—about **15% below** the 2019–2022

Greece's **demand is on the rise,** while Eu remains stable

LNG auctions for Greece predict a **stable future of the market**

Dutch TTF falls by about to **35 euros/MWh**, extending the concerns over the market's future

Greece's **LNG imports dropped by 35% in 2024**; meanwhile, US-sourced LNG increased by 25%

The **EastMed pipeline** project aims to expand **Greece's gas portfolio**, reinforcing Europe's gas network

Chevron is set to survey **the east Mediterranean seabed this summer** as part of plans to construct a pipeline

Natural gas **imports from Russia continued to rise** in 2024, averaging 635 mil m^3

Significant **drop in the natural gas price** is expected in **upcoming years** in Greece

Overview

Europe's natural gas market has experienced notable shifts in recent years. Between 2019 and 2023, gas demand in the region contracted by approximately 15% relative to the 2019–2022 average, even as global consumption rebounded amid dynamic market conditions. European gas flows have undergone significant realignments, with pipeline supplies averaging 8,522 GWh per day in 2024. The North Sea continues to be the largest contributor with 2,634 GWh/d, while LNG arrivals average 3,166 GWh/d, underscoring Europe's growing reliance on flexible shipment options. Eastern flows, at around 1,059 GWh/d, further highlight the diversification away from traditional suppliers such as the Caspian and UK routes.

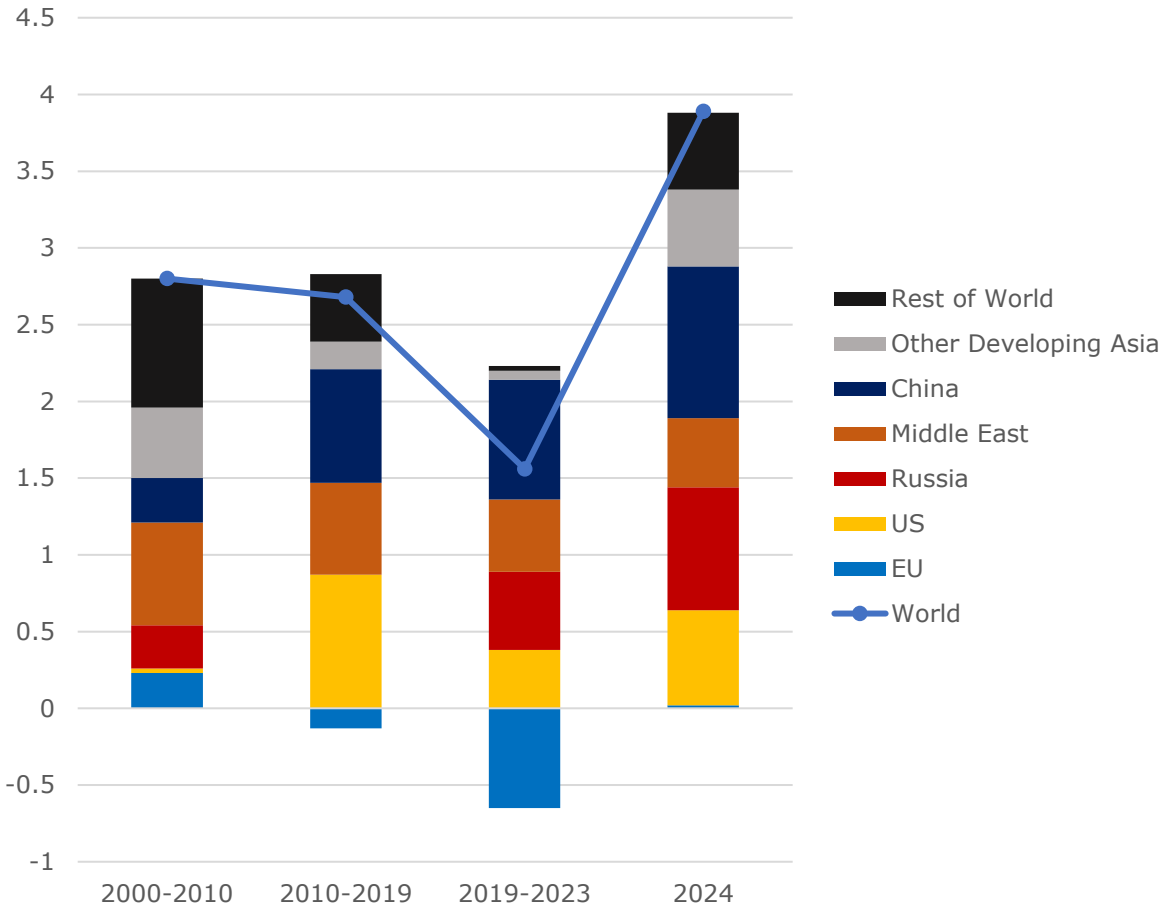
In contrast, Greece exhibits distinct trends that mirror broader European dynamics while also presenting unique characteristics. Greek natural gas consumption is on an upward trajectory, with demand approaching 7,000 GWh by the end of 2024, even as overall EU demand remains subdued. This increase reflects both a rising domestic appetite and the country's ongoing reliance on natural gas as it navigates the transition toward a more diversified energy mix. News reports reveal a significant restructuring of LNG imports in Greece: volumes fell by 35% from 28.52 TWh in 2023 to 18.69 TWh in 2024. Notably, U.S. supplies have surged by 25%, positioning the United States as a key partner, while Russian LNG imports have plummeted by 66%, signaling a decisive shift amid persistent geopolitical tensions.

Price dynamics have also been in the spotlight. Following record highs in 2022—with the JKM and Dutch TTF indices peaking near 350 € and spreads reaching over 100 €—markets have gradually stabilized. By 2024, the weighted natural gas import price in Greece had descended sharply from 175.58 €/MWh to about 33.53 €/MWh. This normalization reflects both a recovery from the energy crisis and a broader recalibration of global supply-demand fundamentals.

Moreover, the evolution of European gas flows underlines the importance of policy and market signals in driving decarbonization. Future scenarios predict a significant decline in gas flows, potentially dipping below 40,000 GWh/d by 2030 under accelerated net-zero pathways. In Greece, diversification efforts, such as LNG auctions and strategic import contracts, are paving the way for a more resilient energy system. Together, these developments in Europe and Greece underscore an evolving natural gas landscape that is increasingly defined by diversification, stabilization, and a concerted push towards a low-carbon future.

Global natural gas demand shifts highlight evolving energy trajectories and regional growth differences

Change in Natural Gas Demand (EJ) by Region, 2000-2024



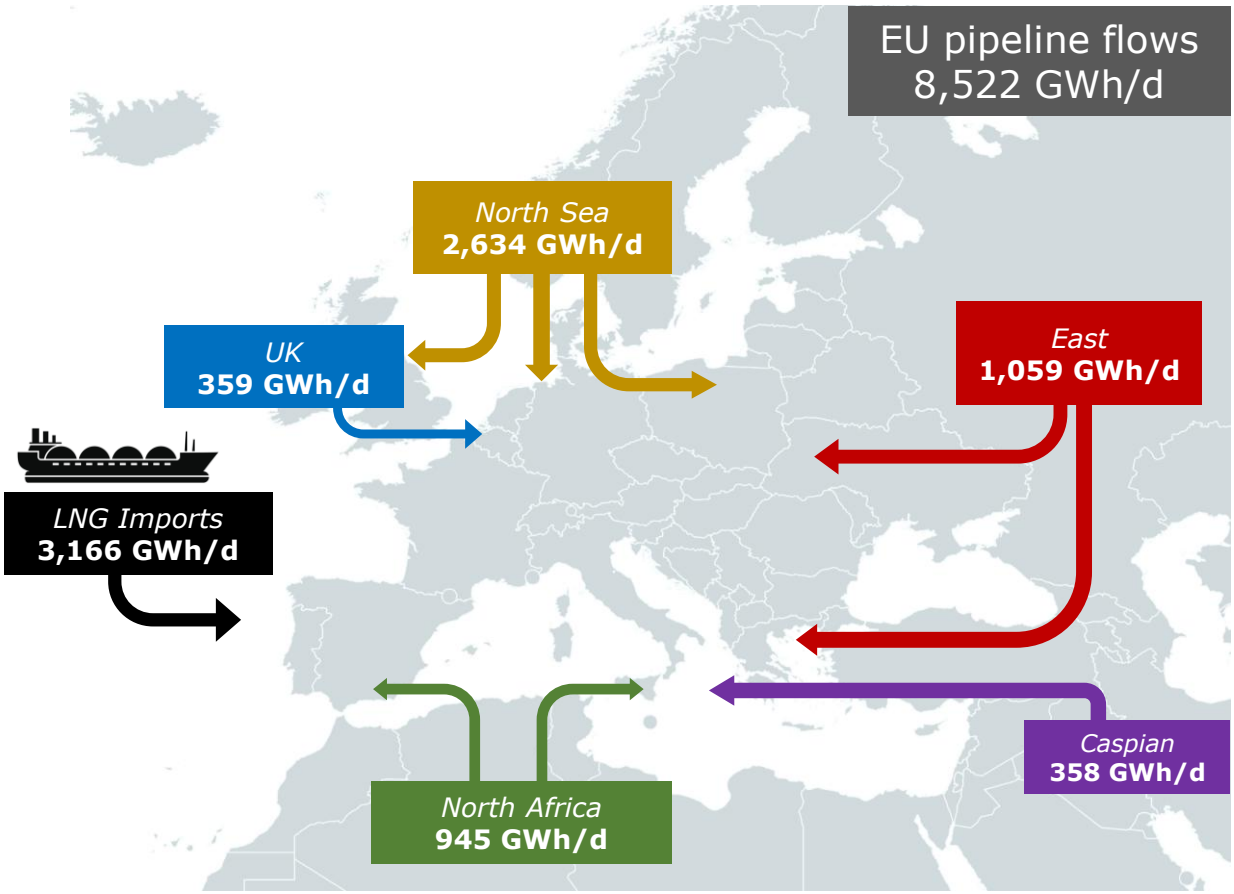
Source: IEA, HAEE analysis

Highlights

- Europe's demand shrinks from 2019 to 2023, offset by expansions across Asia and Middle East.
- China emerges as a key driver, with incremental demand surpassing multiple other regions combined significantly.
- Global natural gas demand rebounds post-2023, reaching 4.0 EJ increase by 2024 amid market conditions.
- Other developing Asia significantly boosts consumption, reflecting rapid industrial expansion and growing household energy requirements.
- Russia's incremental growth contrasts Europe's decline but remains overshadowed by gains in China and Asia.

Overall, Europe's gas flows show shifting balances among pipeline sources and LNG, reflecting ongoing diversification

Average Physical Gas Flows to EU-27 (GWh/d), [2024]



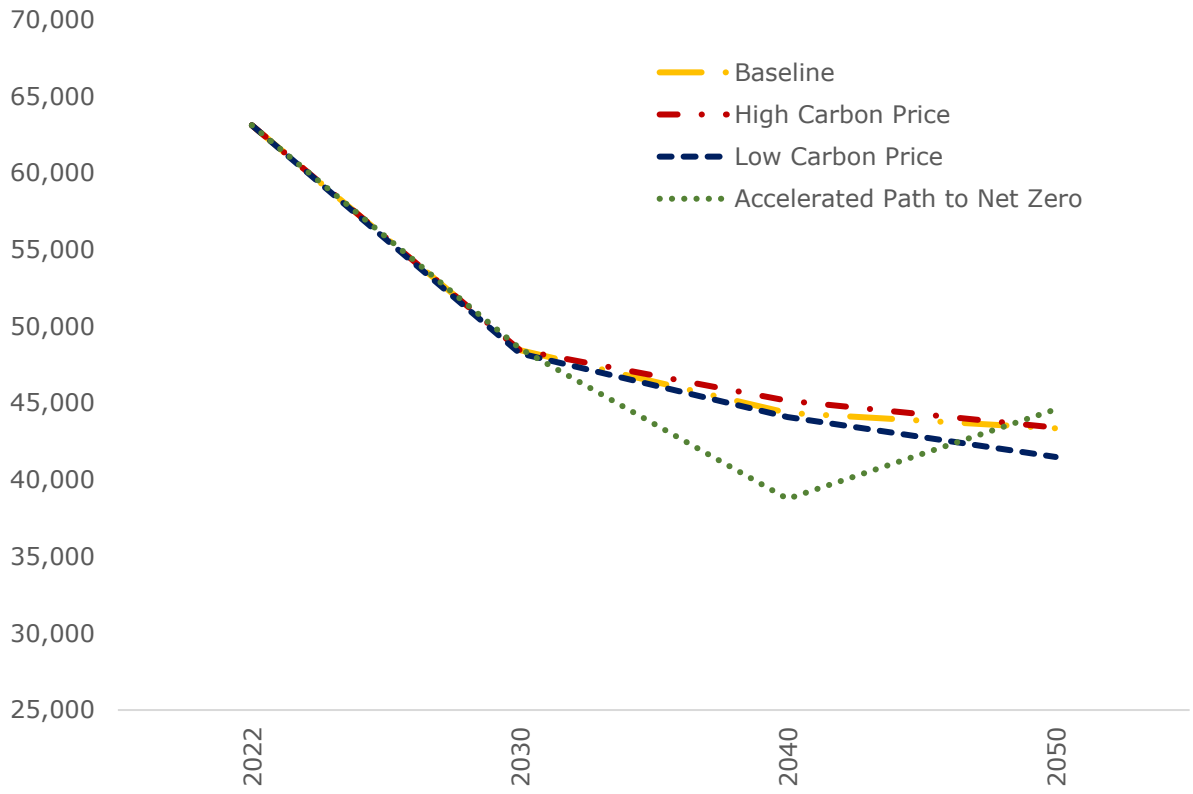
Source: ENTSOG, HAEE analysis

Highlights

- Pipeline flows total 8,522 GWh/d in 2024, reflecting Europe's sustained reliance on diverse external suppliers.
- North Sea supplies remain Europe's largest source, providing 2,634 GWh/d, surpassing imports from other corridors.
- LNG arrivals average 3,166 GWh/d, reflecting global liquefaction capacity and Europe's appetite for flexible shipments.
- Eastern flows measure 1,059 GWh/d, outstripping Caspian (358 GWh/d) and UK (359 GWh/d) route contributions.
- North African gas flows, totalling 945 GWh/d, supplement Europe's energy mix, underscoring diversification beyond suppliers.

Comparing divergent decarbonization scenarios reveals Europe's future gas flow decline and climate policy implications

Projected Energy Demand (PJ) in EU, [2022-2050]



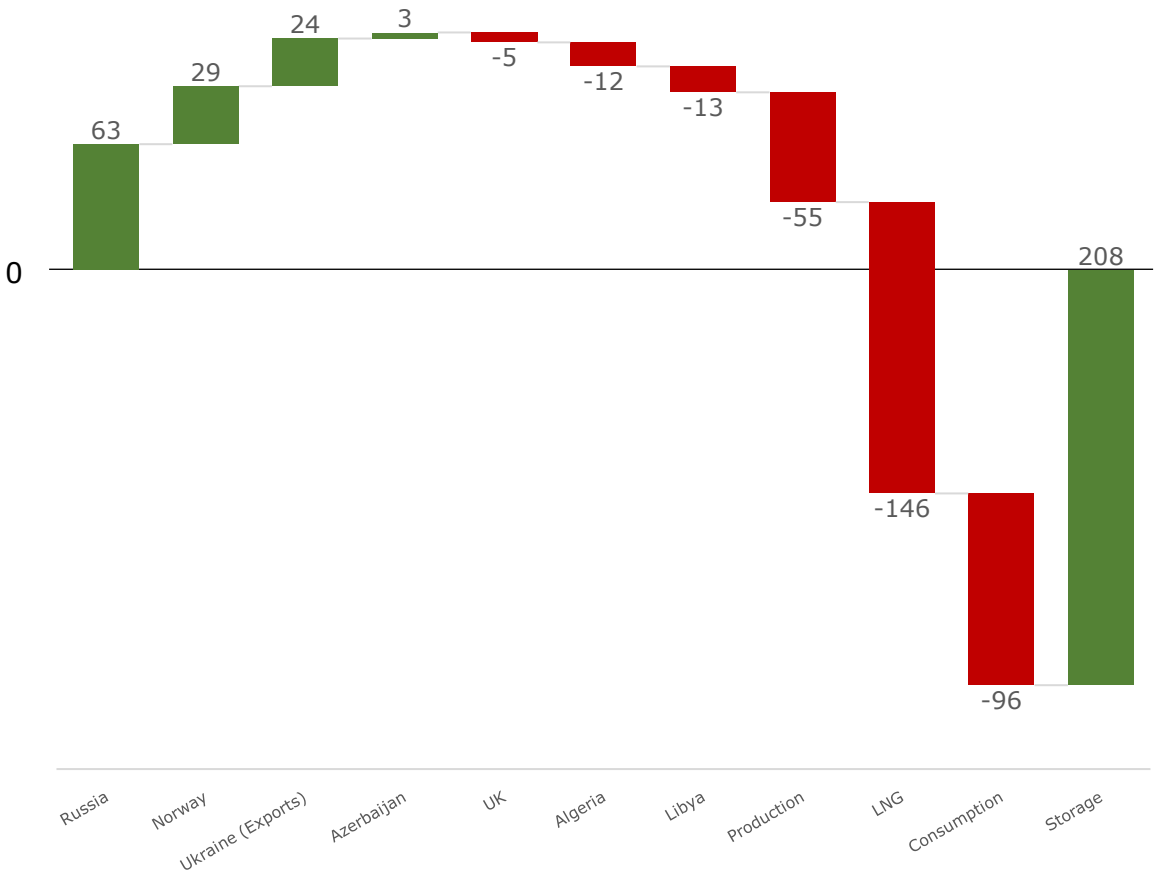
Source: The Oxford Institute for Energy Studies, HAEE analysis

Highlights

- All future scenarios show significant gas flow declines from 2022, bottoming around 40,000 GWh/d by 2030.
- Accelerated net-zero path dips below 40,000 GWh/d early, rebounding by 2050, diverging from baseline trajectories.
- High carbon pricing drives reductions by 2050, surpassing the baseline scenario in decarbonizing gas flows.
- Low carbon price prolongs fossil reliance, maintaining higher flows than advanced decarbonization pathways throughout mid-century.
- All pathways underscore policy relevance in shaping Europe's future gas consumption, production, and climate commitments.

Rising Russian, Norwegian, and Ukrainian supplies contrast reduced EU production, culminating in significant storage gains

Year-on-year changes for gas supply and demand (TWh) in the EU-27, [2024]



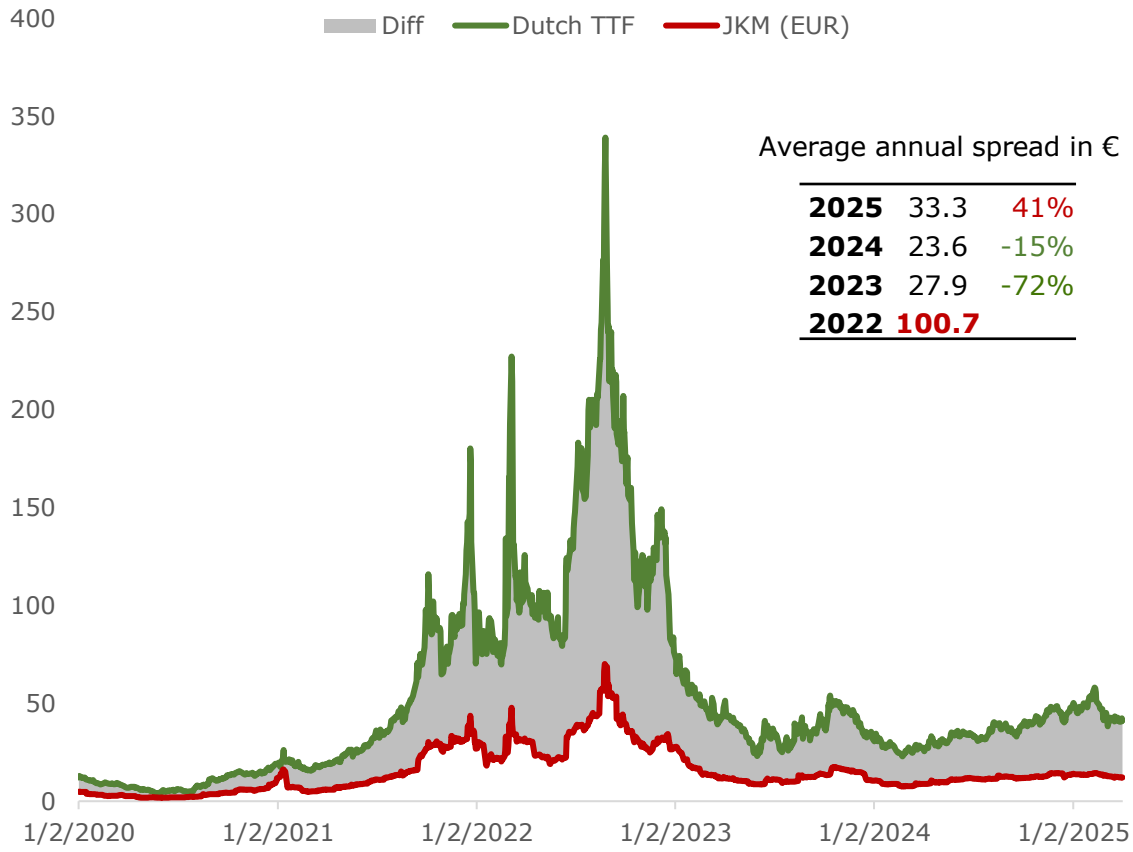
Source: ACER, HAEE analysis

Highlights

- Russia's supply gains 63 TWh, indicating partial recovery despite enduring political tensions affecting energy markets.
- Norway and Ukraine each contribute significant increases, collectively adding over 50 TWh of additional supply.
- Algeria, Libya, and UK volumes decline slightly, reflecting broader shifts in Europe's changing import dependencies.
- EU domestic production drops by 55 TWh, underscoring limited local extraction amid intensifying sustainability efforts.
- The massive 146 TWh LNG reduction is offset by 208 TWh storage growth, balancing supply-demand dynamics.

Price spreads between natural gas and LNG prices have decreased and relatively stabilized over the past year

JKM, Dutch TTF Indices (€/MWh) and Price Spread, [Jan 2020 - Mar 2025]

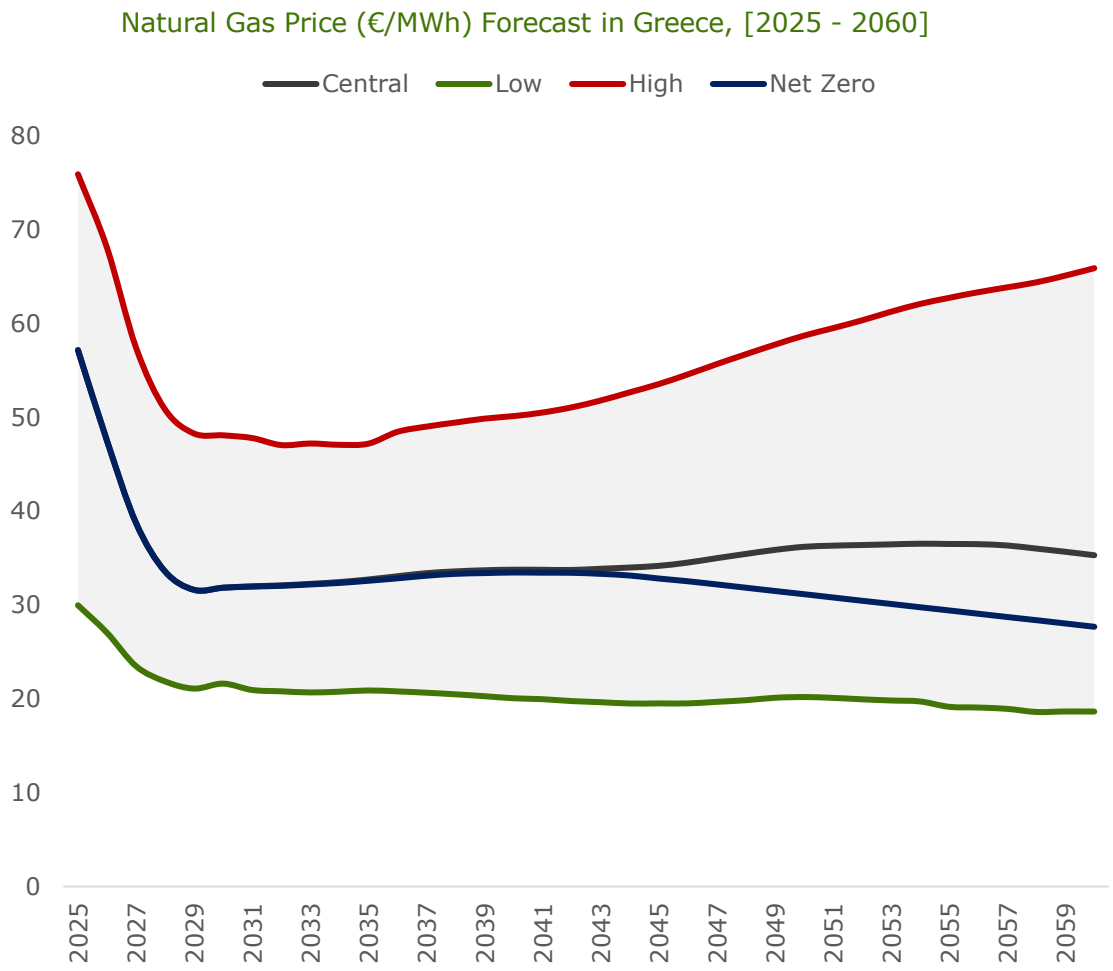


Source: Trading Economics, HAEE analysis

Highlights

- JKM and Dutch TTF soared in 2022, reaching record levels near 350 € before retreating dramatically.
- Spread peaks at 100.7 € in 2022, then plunges 72% by 2023, demonstrating heightened price volatility.
- After 2023, market spreads hover around 23-33 €, reflecting gradual partial normalization of global gas pricing.
- JKM prices trail TTF post-2022, reflecting evolving Asian-European LNG trade dynamics and shifting import requirements.
- Rising 2025 spread so far of 32.6 € suggests continued interregional pricing disparities amid uncertain global fundamentals.

Natural Gas prices are expected to drop significantly shortly before stabilizing at around 30-35 €/MWh



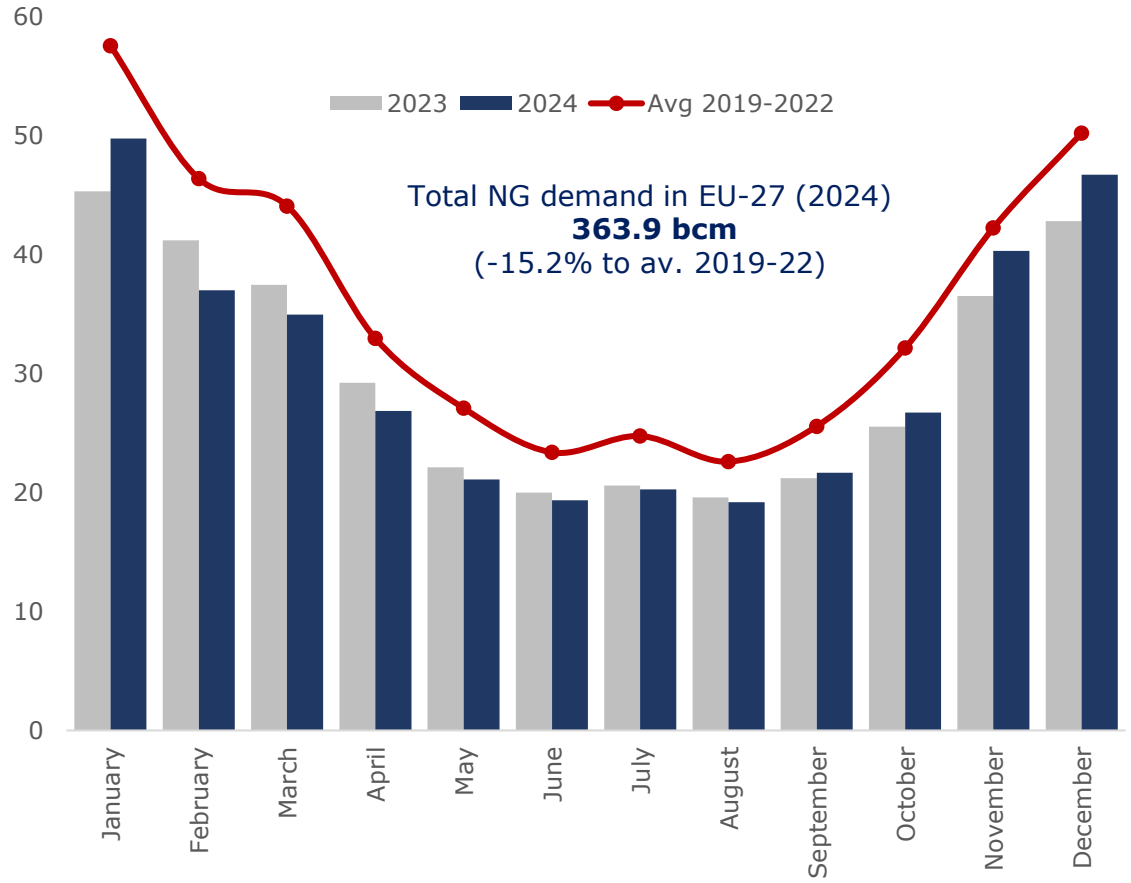
Source: Trading Economics, HAEE analysis

Highlights

- Natural gas prices drop sharply post-2025, stabilizing around 30-35 €/MWh in the central scenario.
- Under high-price scenarios, prices initially decline but gradually rebound, reaching nearly 70 €/MWh by 2060.
- Low-price scenario forecasts consistent, minimal fluctuation, maintaining around 20 €/MWh through the entire forecast period.
- Net-zero scenario shows prices steadily declining, converging toward lower boundaries close to 30 €/MWh by 2060.
- Long-term forecasts indicate significant uncertainty, highlighting varying price trajectories based on climate and policy scenarios.

Overall, natural gas demand in EU stays well below the average of past years for another consecutive year

Monthly Natural Gas Demand in EU27 (bcm), [Av. 2019-22 vs 2023, 2024]

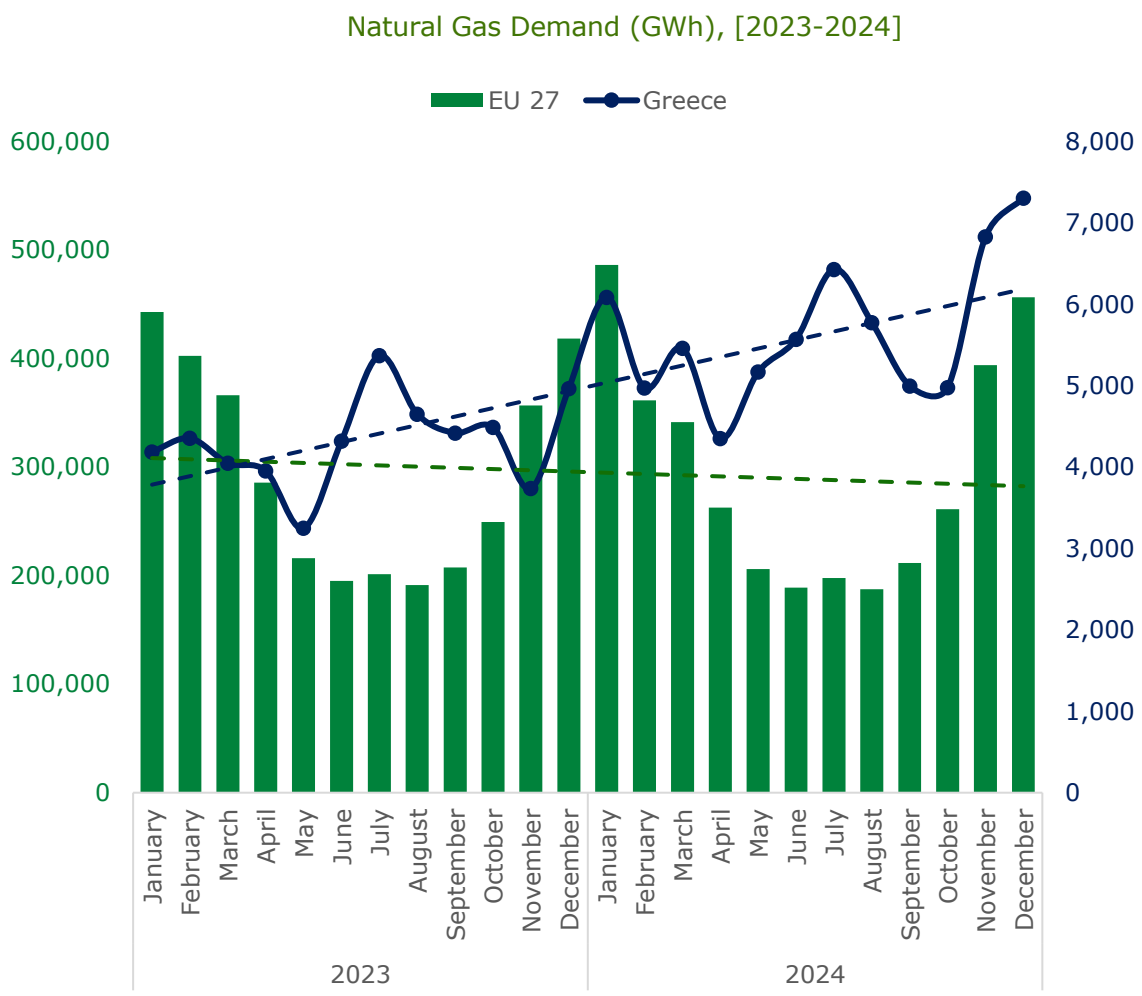


Source: Eurostat, HAEE analysis

Highlights

- Monthly natural gas demand in the EU27 dips during summer, then rebounds strongly towards year-end, following its seasonal patterns.
- Natural gas consumption for 2024 of 363.9 bcm remains approximately 15% below the 2019-2022 baseline average volume.
- January's natural gas demand peaks around 50 bcm, declining until a trough emerges in summer.
- Bimonthly consumption growth starts late-summer, with monthly demand surpassing 40 bcm again by September's end.
- Forecasted winter recovery indicates higher consumption patterns during Q4, driving overall annual volumes despite reductions.

While natural gas demand in EU remains at the same levels between 2023 and 2024, Greece's demand has a noticeable increase



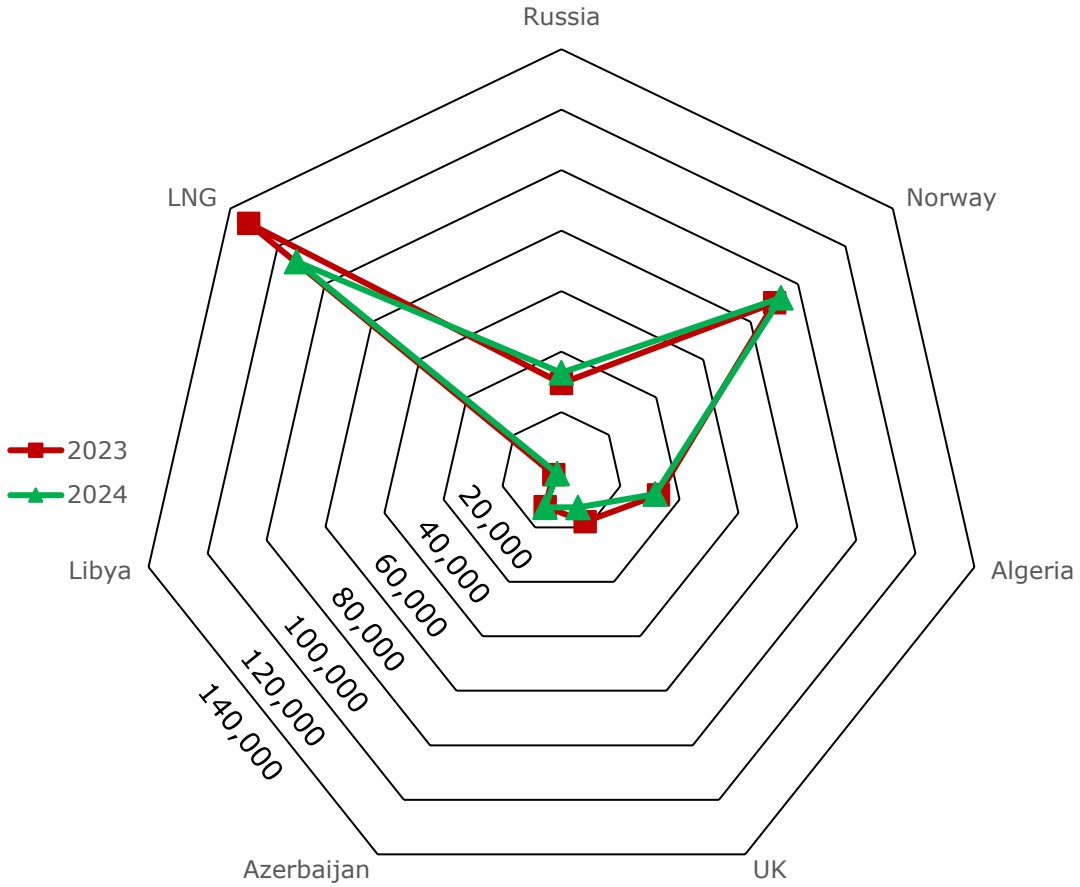
Source: Eurostat, HAEE's analysis

Highlights

- EU27 demand starts near 500,000 GWh in January 2023, then gradually dips before recovering.
- Greek consumption rises steadily during 2024, approaching 7,000 GWh by year-end, following long-term upward trends.
- EU27 trajectory exhibit summer troughs, with rebounds into autumn and winter seasons, while Greece exhibits inverse patterns.
- Projected monthly EU27 volumes hover between 300,000 and 450,000 GWh, reflecting moderate seasonal consumption swings.
- Rising Greek demand highlights ongoing dependence on natural gas, underscoring potential for further diversification strategies.

Natural gas imports in EU remained relatively stable between 2023 and 2024 with a noticeable decrease in LNG imports

Natural Gas Imports in EU 27 by Origin (mcm), [2023-2024]



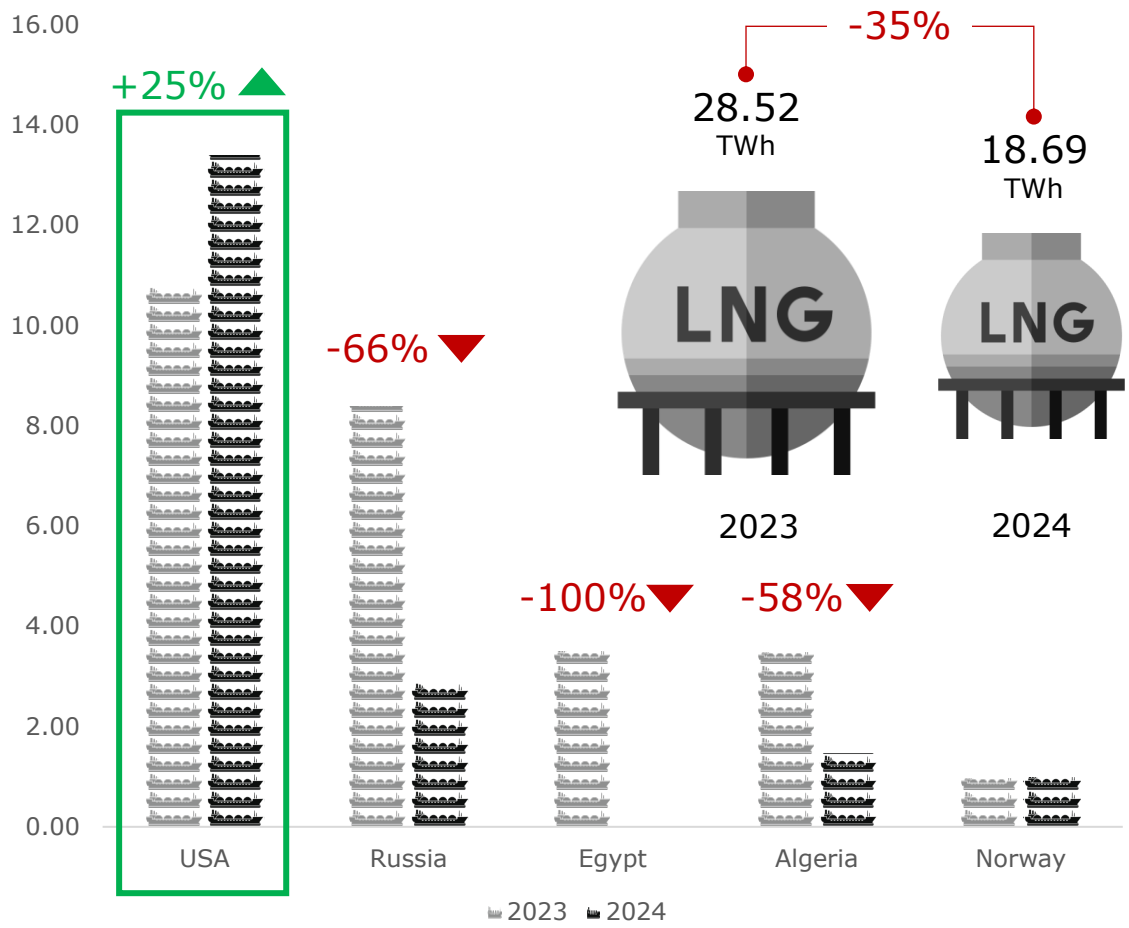
Source: Bruegel, HAEE Analysis

Highlights

- Liquefied natural gas imports lead EU27 portfolio, showing steady expansion from 2023 to 2024 across volumes.
- Norway remains a key supplier, showing slight growth in 2024 volumes relative to current deliveries.
- Russian imports continue shrinking, reflecting geopolitical constraints and further diversification of EU27's natural gas sources.
- Algeria's export volumes see moderate uptick into 2024, suggesting growing significance in regional energy mix.
- Libya and Azerbaijan maintain smaller shares yet display year-over-year increases consistent with import diversification efforts.

LNG imports in Greece witness a further decline of 35% compared to 2023, with USA standing as the major source

LNG Imports in Greece (TWh), [2023-2024]



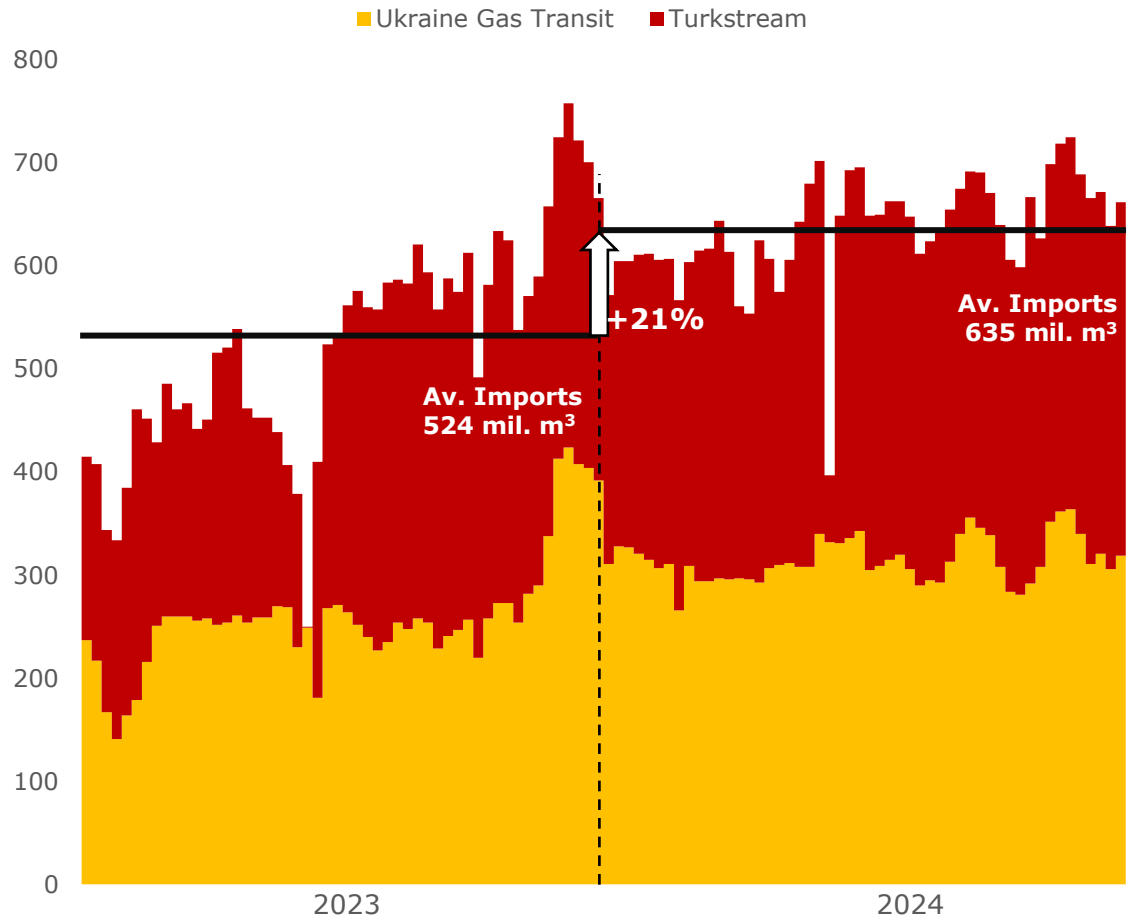
Source: DESFA, HAEE's analysis

Highlights

- Greek LNG imports drop significantly from 28.52 TWh in 2023 to 18.69 TWh in 2024, a drop of 35%.
- United States supplies surge by 25%, becoming the largest contributor among Greece's LNG import sources.
- Russian LNG imports plummet 66% in 2024, reflecting shifting European strategies towards more diversified suppliers.
- Egypt's share disappears entirely (down 100%), highlighting dynamic trade changes across Mediterranean regional energy relationships.
- Algeria and Norway also register declines exceeding 50%, indicating reduced reliance on these LNG sources.

A further increase in Russian gas flows is evident in 2024, with Ukrainian Gas Transit and Turkstream as the sole corridors

EU27 Natural Gas Imports from Russia's Exporting Routes (mcm), [2023-2024]



Source: Bruegel, HAEE Analysis

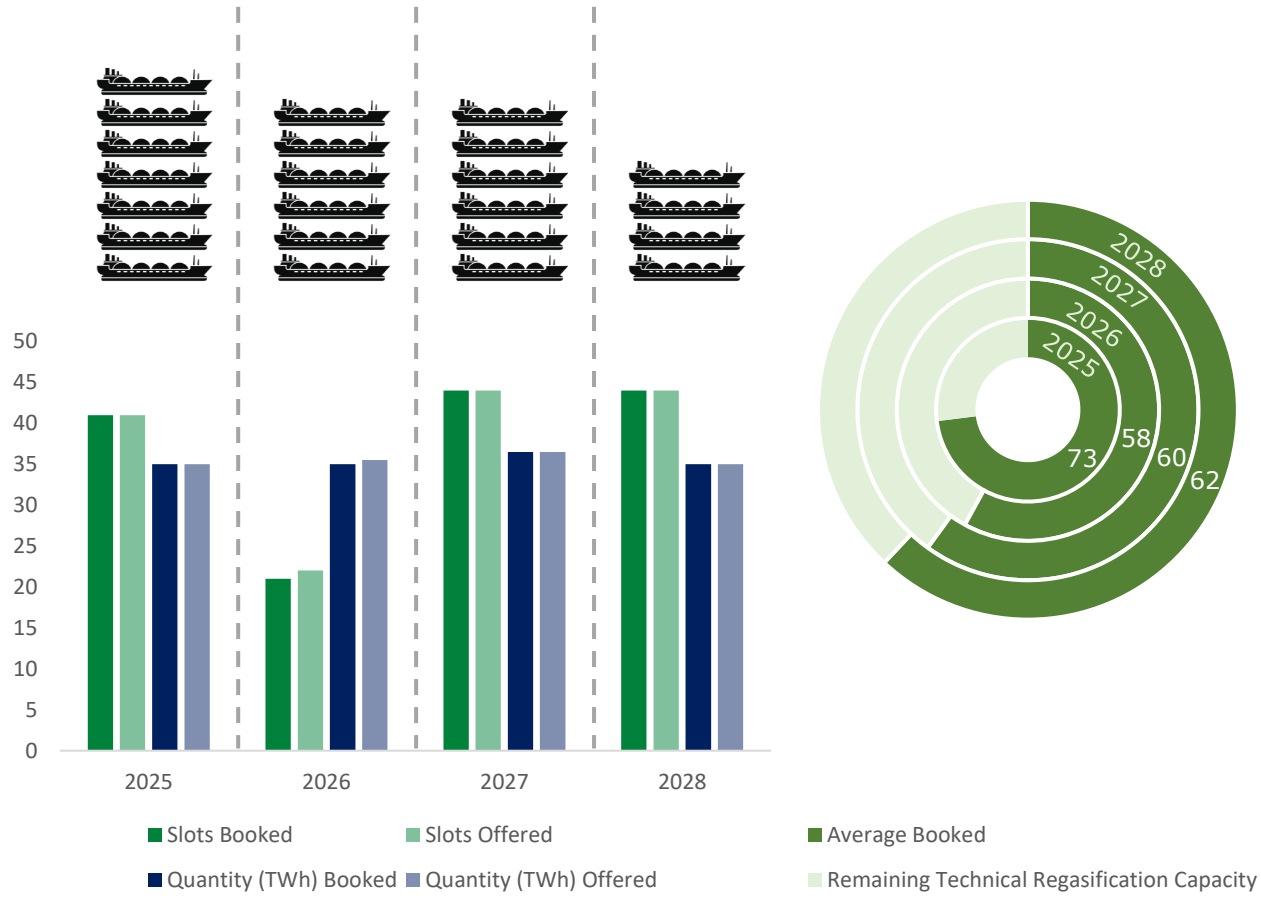
Highlights

- Russian natural gas imports rise from 524 million m³ in 2023 to 635 million m³ in 2024, indicating an increase of 21%.
- Turkstream volumes dominate total imports, accounting for the largest share overall within 2023-2024 supply routes.
- Ukraine transit flows persist, although overshadowed by Turkstream's higher capacity and gradual growth after mid-2023.
- Total volumes fluctuate seasonally, peaking above 700 million m³, then retreating before another wintertime rebound.
- Elevated Russian supply levels highlight ongoing reliance, effectively contrasting broader European efforts toward diversification initiatives.

Strong market interest in Greek gas network operator's LNG Auctions, highlighting Europe's evolving import dynamics through 2025–2028

LNG Auctions: Slots and Capacity (TWh) Offered, Number of Vessels in Greece, [2025-2028]

Percentage (%) of Booked and Technical Regasification Capacity in Greece, [2025-2028]



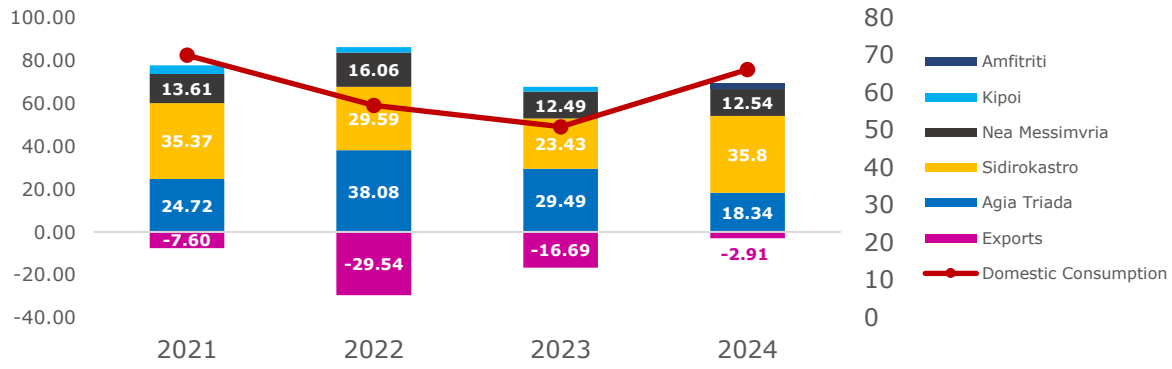
Source: DESFA, and HAEE analysis

Highlights

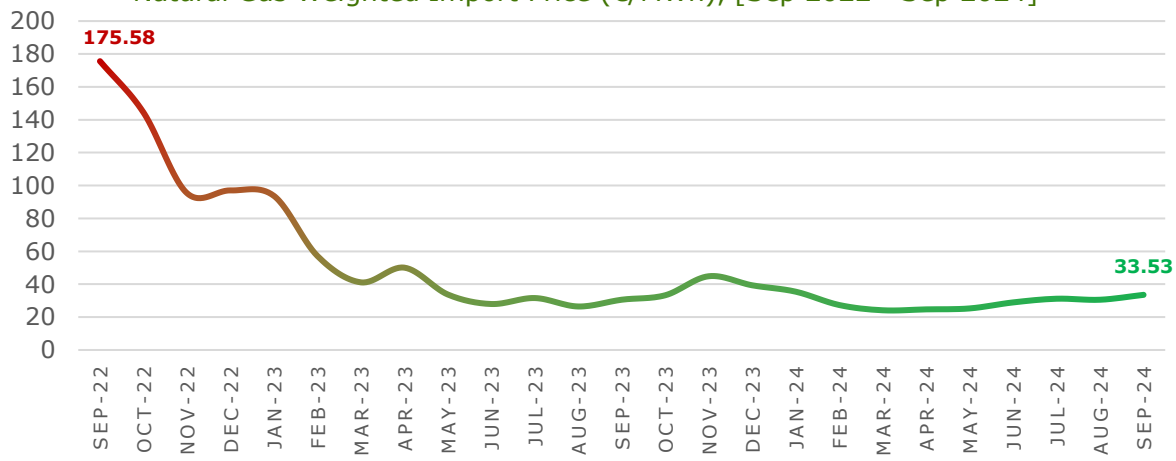
- 2025 sees 40 TWh offered, with 35 TWh booked, reflecting strong initial LNG demand signals.
- 2026 offers fewer slots, driving moderate declines in TWh booked amid shifting European gas landscape.
- Growth resumes by 2027, with increased capacity and vessel arrivals meeting Europe's rising LNG requirements.
- By 2028, booked TWh nearly matches offered levels, underscoring robust consistency in global LNG trading.
- Regasification utilization hovers between 58% and 73%, reflecting available slack for supply expansions beyond bookings.

With natural gas prices having been stabilised after the energy crisis of 2022, an increase in imports is also evident for 2024

Natural Gas Imports/Exports in Greece by Entry Points (TWh), [2021-2024]



Natural Gas Weighted Import Price (€/MWh), [Sep 2022 - Sep 2024]

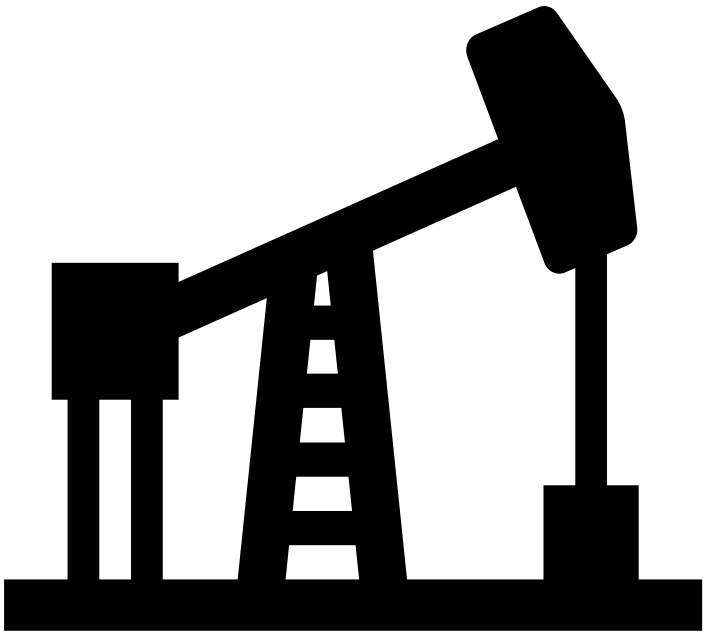


Source: DESFA, RAE and HAEE analysis

Highlights

- Greek gas imports stay high, although 2023 volumes dip, stabilizing near 12.5 TWh in 2024.
- Export flows remain negative yet diminish yearly, indicating reduced outflows amid growing domestic consumption patterns.
- Sidirokastro remains a major import route, consistently delivering large volumes from 2021 to 2024.
- Weighted import prices descend sharply from 175.58 €/MWh in late 2022, stabilizing around 33.53 €/MWh by 2024.
- Price declines improve competitiveness, yet they may signal broader volatility influenced by global market fundamentals.

6. Oil & Refining



Contents

Highlights

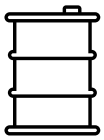
Brent crude prices closed **3% lower** in 2024 than their 2023 year-end level

Fuel demand in Greece in 2024, **rose 3.4%** driven by higher **gasoline (+2.1%)** and **diesel (+4.5%)** consumption

Russian crude exports **rose 7%** in October 2024, reaching 3.74 mb/d — the third monthly increase since July's 11-month low

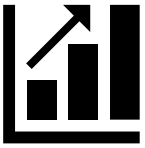
In 2024, the **shadow fleet** accounted for approximately **17% of the global oil tanker fleet** with a total dead-weight tonnage of 111.6 million

In 2023, Greece's top crude petroleum **imports** were from: **Iraq** ($5.18B), **Kazakhstan** ($3.07B), **Libya** ($2.05B), **Saudi Arabia** ($698M), and **Egypt** ($674M)



2024 underperformed compared to recent years, but strong growth potential remains. **10B boe in total reserves**, **1.5B boe commercially viable**

The **global oil** exploration and production **market** was valued at **$3.59 billion in 2024** and is projected to grow to **$5.12 billion by 2031**



Upstream investment must rise by $135 billion, reaching a total of **$738 billion by 2030** to ensure sufficient supply

Oil companies shift focus to **upstream**, with BP directing 75% of capex to oil/gas, Equinor cutting renewable spend by 50%, and TotalEnergies reducing low-carbon investments by $500M

Overview

In 2024, oil continues to be a central pillar in the global and regional energy landscape, with its pricing stabilizing following a period of extreme volatility. Brent crude has averaged around $83.5 per barrel in the first five months of the year, marking a modest rise from $81.0 in the same period of 2023, yet significantly below the $101.6 average of 2022. These more moderate prices reflect both demand-side adjustments and supply-side resilience, even as global trade patterns adapt to new challenges.

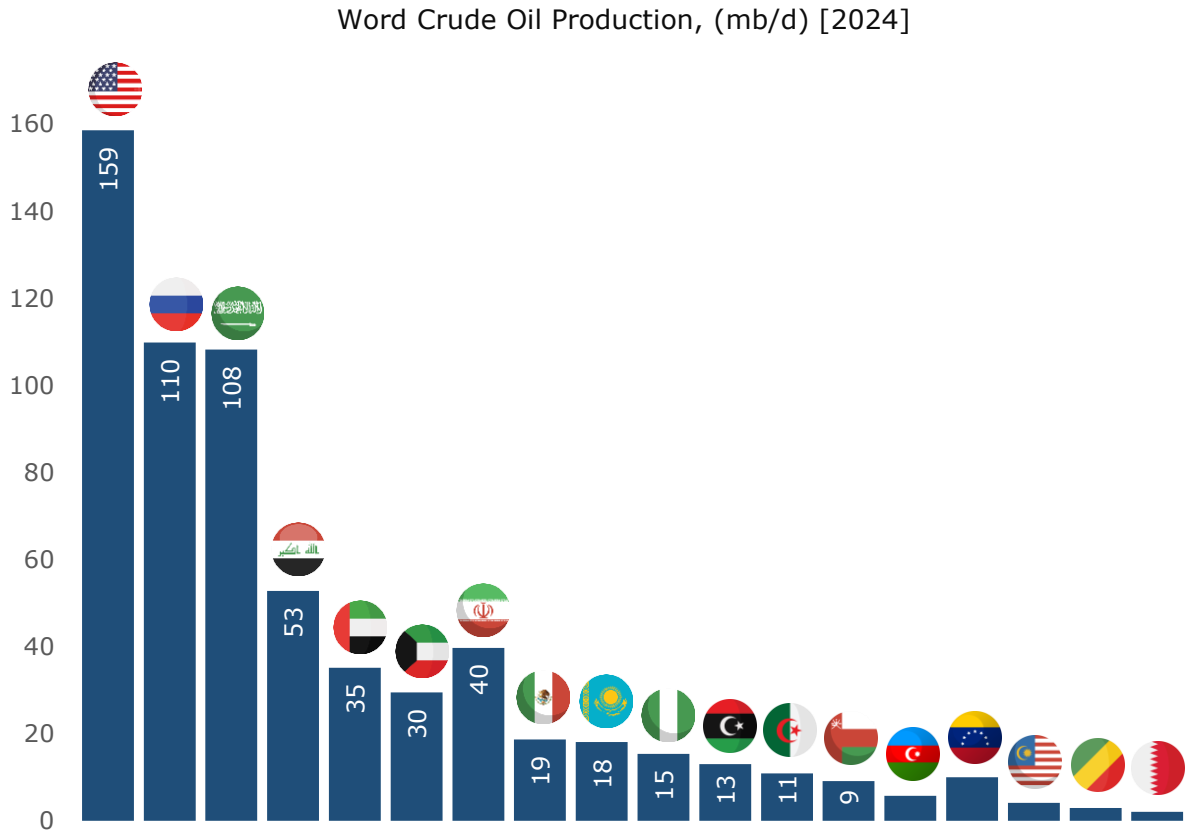
Europe's crude oil imports from Iraq remained steady in early 2024, with Greece, Italy, Turkey, and the Netherlands making up 70% of these flows. However, volumes are still 400,000 b/d below the 2023 average, largely due to geopolitical disruptions in the Red Sea. Tankers increasingly avoid this route delaying deliveries and increasing costs. Meanwhile, India's imports of Iraqi oil surged to 1.15 mb/d in January 2024, the highest level since April 2022.

In 2023, Greece's oil trading sector faced a downturn, with total consumption of petroleum products declining by 3.3% compared to 2022, according to ELSTAT data. This drop aligned with reduced sales value and volume due to lower prices and demand. While there were consumption increases in gasoline, low-sulfur fuel oil, diesel, and LPG significant drops were seen in heating oil (–32.9%) and high-sulfur fuel oil (–13.6%). The sector's revenue decreased to €14.8 billion, and net profits fell sharply to €23.9 million, driven by lower gross margins and steady operating expenses. Despite this, total investments rose, particularly in safety and environmental initiatives. Operational performance improved with higher average fuel sales per station and expanded storage and logistics capacity.

In 2025, major energy companies are shifting back toward oil and gas investments to prioritise profitability amid market uncertainty. BP is allocating 75% of its capex to upstream oil and gas while cutting energy transition investments. Equinor is also reducing its renewables budget by 50% and boosting oil and gas output by over 10% through 2027, focusing on low-cost, low-emission projects. Despite scaling back, both companies maintain long-term commitments to carbon capture and emission reductions. Norway is set for record hydrocarbon investments in 2025, expected to reach $24.7 billion, driven by new drilling activity and production expansion.

Meanwhile, Brent and WTI prices have stabilized, supported by lower-than-expected U.S. crude inventories and anticipated economic stimulus in China, which could boost demand. Despite global consumption reaching record highs in 2024, demand growth may struggle to keep pace with supply increases, especially if OPEC+ fails to effectively manage production levels.

In 2024, OPEC+ announced multiple delays to production increases, but the rising output from non-OPEC+ members offset these cuts



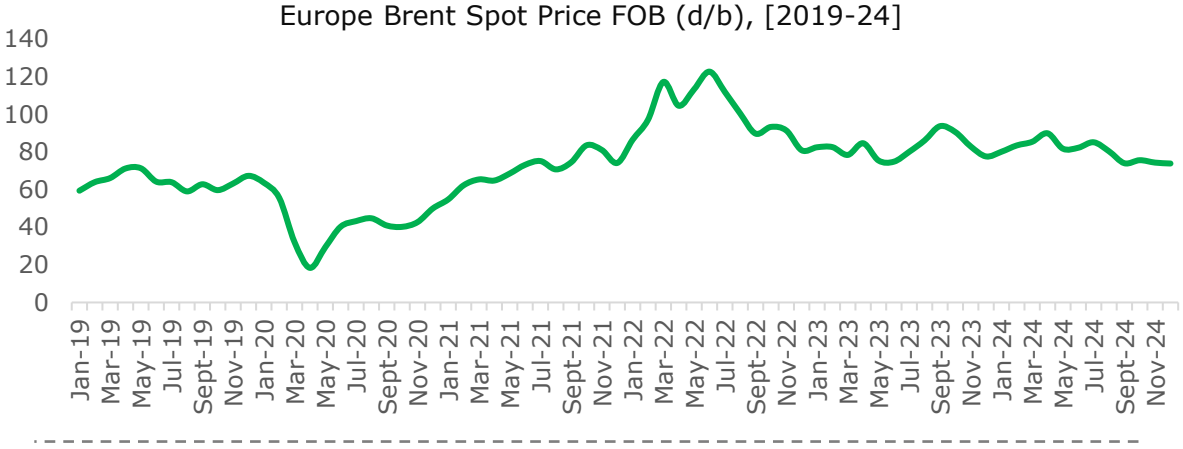
Source: EIA, HAEE's analysis

Highlights

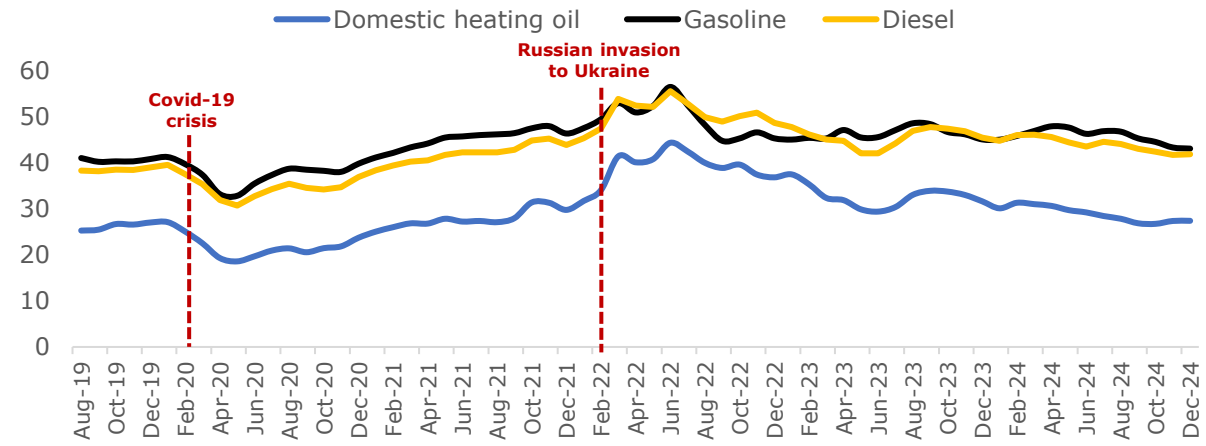
- U.S. crude oil production hit a record of 13,491 mb/d in December 2024, surpassing November's 13,314 million and October's 13,436 million, previous highest.
- In 2024, crude oil production decreased around 2.8% from 2023, with Russia, Kazakhstan, and Iraq working to improve compliance with OPEC+ quotas.
- Global oil inventories rose by 12.2 mb in November 2024, while OECD industry stocks fell by 20.1 mb, 118.3 million below the five-year average, since August 2022.
- Diesel stocks in Europe's ARA refining hub dropped by 12% since early 2025, remaining, though, 6% above the five-year average.
- Non-OPEC+ producers, primarily from the US, Brazil, Guyana, Canada, and Argentina are expected to add 1.5 million b/d in 2025, matching 2024 levels.

Oil prices dropped by 3% in 2024, marking a second year of decline due to weak demand, and rising output from non-OPEC producers

Europe Brent Spot Price FOB (d/b), [2019-24]



EU Monthly Oil Prices ($), [2019-2024]



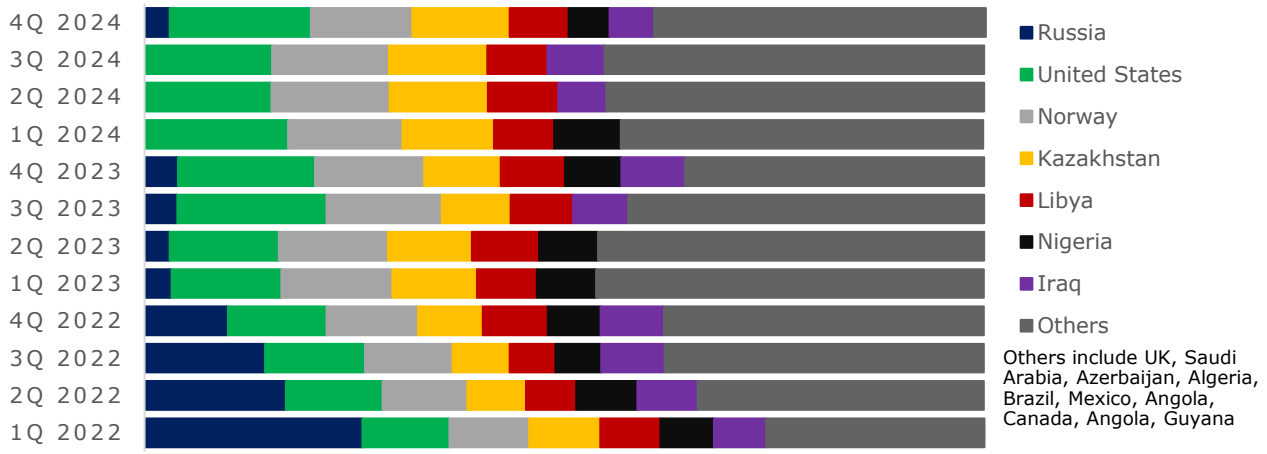
Source: EIA, IEA, HAEE's analysis

Highlights

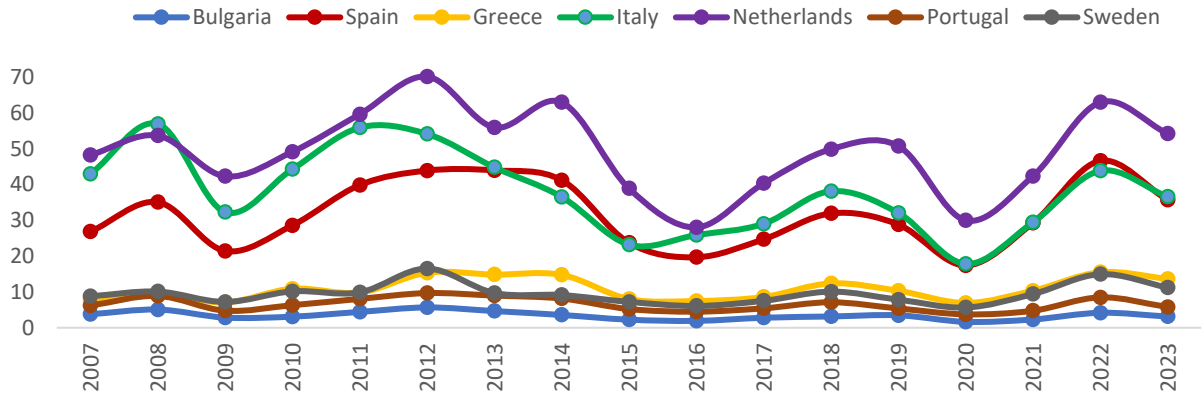
- 2024 marked one of the most stable years for oil prices in 25 years, with Brent crude averaging between $74 and $90 per barrel amidst market challenges.
- OPEC+ production cuts raised Brent crude prices from $78 in December 2023 to a peak of around $90 in April 2024 amid regional tensions impacting global supply.
- Brent crude futures settled at 65 cents, at $74.64 a barrel, marking the last trading day of 2024. U.S. WTI crude closed with a gain at $71.72 a barrel.
- U.S. diesel refining margins are around $25 per barrel, below the $32 five-year average. In northwest Europe, margins are 22% lower at $16.4 per barrel.
- The price of gasoline decreased by 3.50% and the price of diesel by 9.46% at the end of 2024 compared to the same period in 2023.

Sanctions cut Russian crude revenues by 6% in year three rerouting oil via shadow tankers as US and Norway boost supply

Extra-EU Imports of Petroleum Oil, Shares (%) of Main Trading Partners, [2022 – 2024]



Top Importers EU Countries of Petroleum Oils, Crude by Percentage of Total Imports, (Trade Value ($Bn) [2007-2023]]



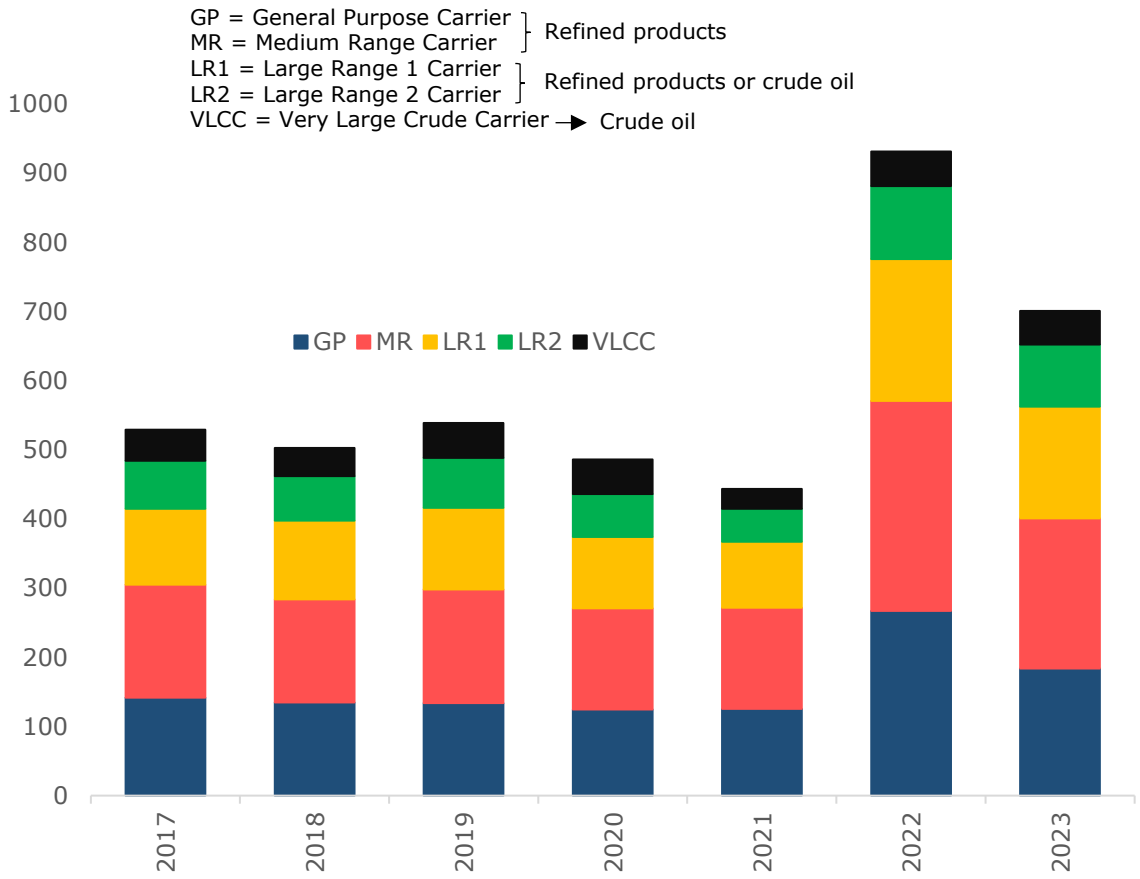
Source: Eurostat, OEC, HAEE's analysis

Highlights

- In 3Q2024, the EU imports in energy products decreased significantly compared to 3Q2023, both in value and net mass by 10.2% and 7.6%, respectively.
- The EU banned seaborne imports of Russian crude oil in 2022, and refined oil products in 2023, removed Russia from the top seven partners in 2024.
- In 3Q2024, U.S. (15.2%), Norway (13.9%), and Kazakhstan (11.7%) were the top importers, with Kazakhstan seeing the largest increase (+3.5 pp) from 3Q2023.
- "Shadow" tankers transported 38% of all Russian oil exports (47% of crude and 27% of oil products) since the embargo and price cap was imposed until 5/11/2023.
- Greece is the 4th country in EU with the higher imports of petroleum oils and crude, in relation to total imports, with an average growth rate of 8.01%.

China's limited demand for oil, especially from the Persian Gulf, is exerting downward pressure on tanker freight rates

Average Spot Freight Rates by Vessel Category, (% of World scale), [2017-2023]

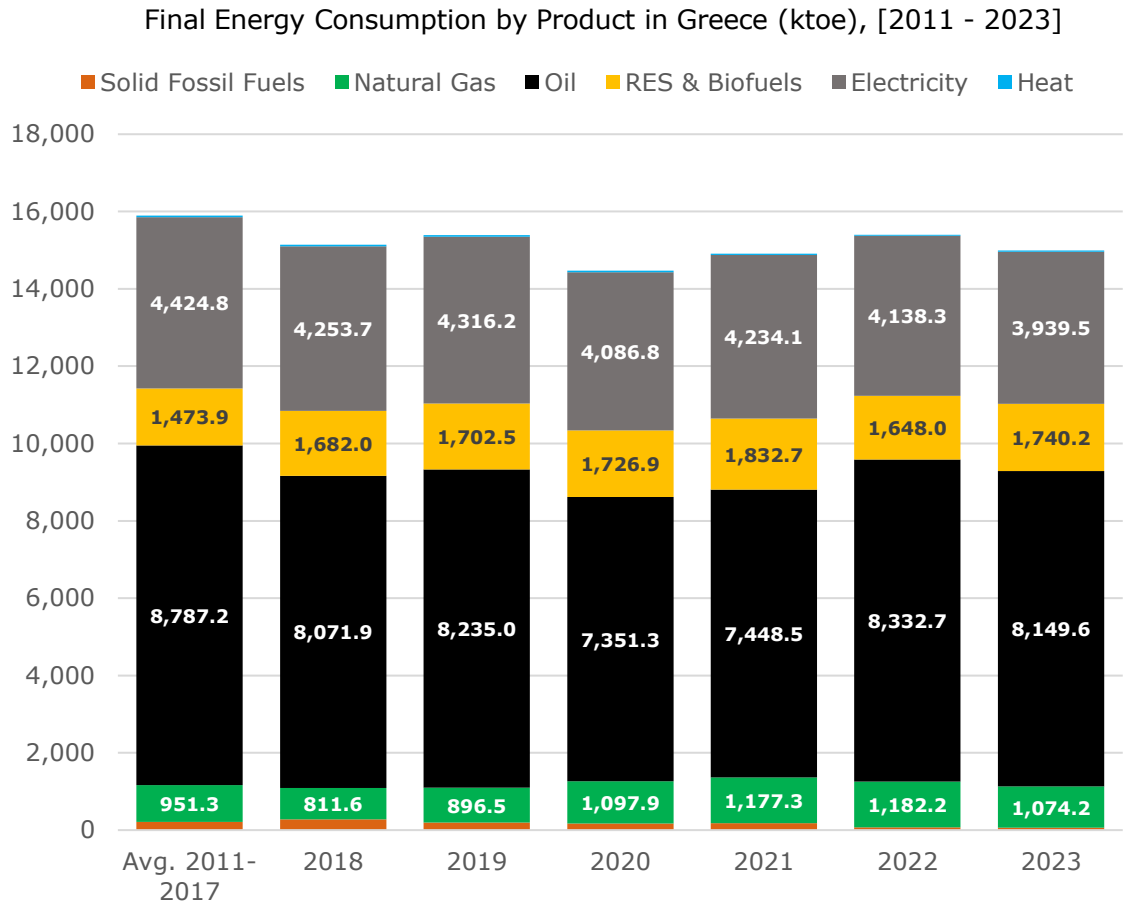


Source: OPEC, HAEE's Analysis

Highlights

- In 2023, there was a decrease in the spot freight rates and in 2024 are expected to remain low due to slower growth in China's oil consumption and overall trade.
- In 2024, 43 supertankers shifted to clean products due to higher LR freight rates from Red Sea attacks, causing LR rates to drop by 50% since April 2024.
- The MR fleet's participation in the Russian diesel trade fluctuates based on earnings and demand, with only 26% of MRs consistently lifting Russian cargoes.
- Most MRs engage flexibly, carrying Russian diesel between 33% and 67% of the time, reflecting low sanctions enforcement risk for clean tankers.
- The Platts Global VLCC Index averaged $22,849 per day in Q3, a drop of one-third from the previous quarter.

Greece’s final energy consumption still relies heavily on oil, mainly due to the non-interconnected system



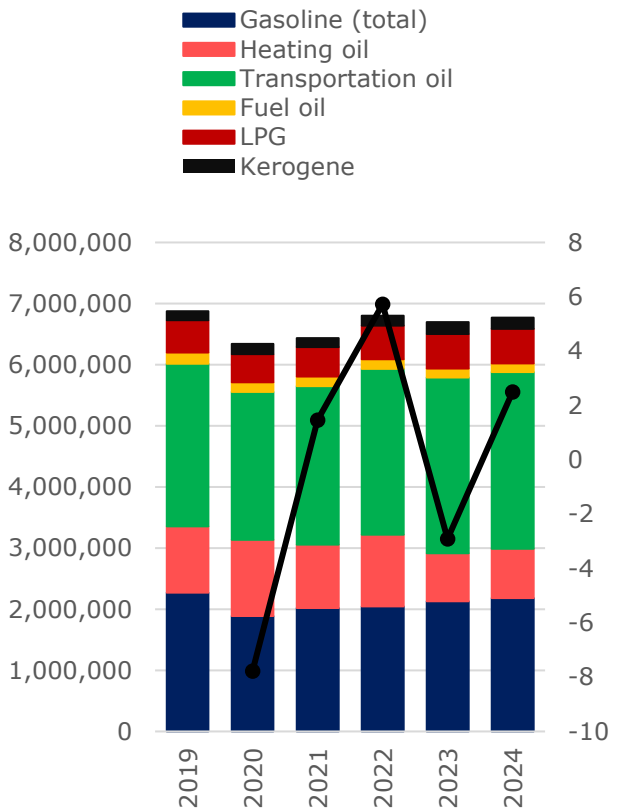
Source: Eurostat, HAEE analysis

Highlights

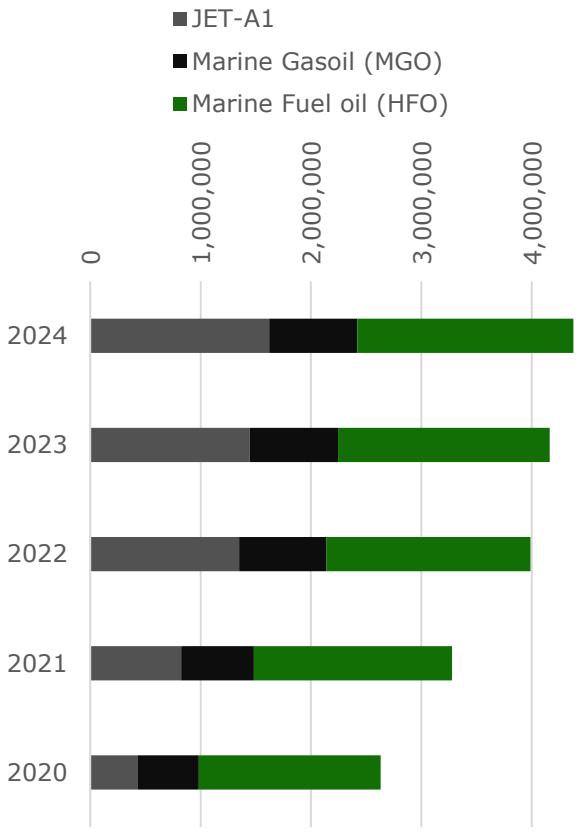
- Oil consistently dominates Greece’s final energy consumption, though it generally demonstrates slight year-to-year demand fluctuations.
- Natural gas usage expands steadily, reflecting broader diversification and partial displacement of higher-emission energy alternatives.
- Renewables, including biofuels, show noticeable growth, reinforcing national commitments to greener, more sustainable energy sources.
- Electricity consumption remains substantial, underscoring rising electrification trends and Greece’s increasing reliance on modern grids.
- Total consumption levels drop post-2020, suggesting shifting energy habits and economic influences amid decarbonization measures.

The ongoing cap on gross profit margins limits profitability due to inflation's impact on wages is a major challenge of the oil product sector

Petroleum Product Consumption (metric tonnes) in Greece and Annual Growth Rate (%), [2019-2024]



Petroleum Product Consumption (metric tonnes) Globally [2020-2024]

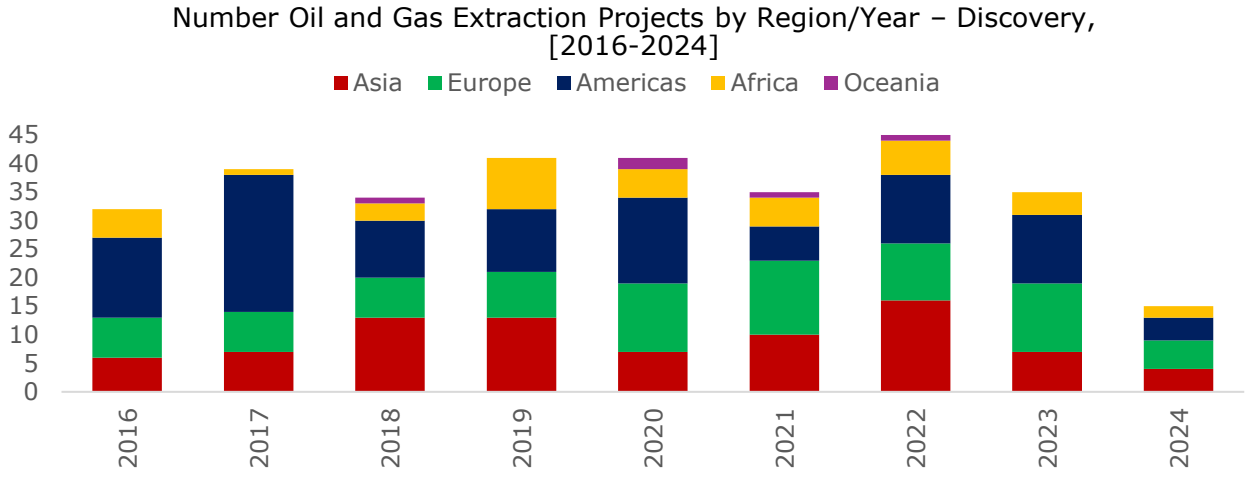


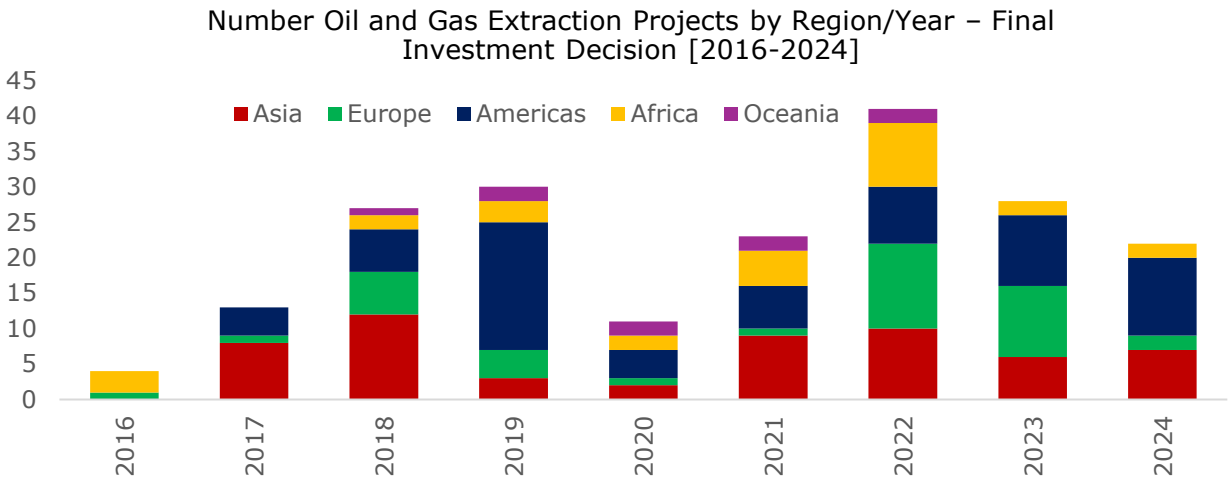
Source: ELSTAT, SEEPE, HAEE's analysis

Highlights

- In 2024, total petroleum product consumption increased by 3.5%, due to 5.1% rise in the International Market and secondary increase of 2.5% in the Domestic Market.
- The increase in 2024 in the international market's consumption is due to a rise in aviation fuel by 175 thousand tons and marine fuel oil by 41 thousand tons.
- International consumption of aviation fuels in 2024 rose by 12.1%, marine fuels by 2.1%, with marine diesel down 0.3% and marine fuel oil up 2.1%.
- The increase in the market was due to increased tourism and lower gasoline prices, to pre-Ukraine invasion levels, and lack of fuel reserves in dwellings from spring.
- The sales value of companies in the petroleum products trading sector declined significantly in 2023, falling to €14.8 billion from €17.7 billion in 2022.

It is estimated that rising demand will drive a 22% increase in upstream oil investment needs by 2030





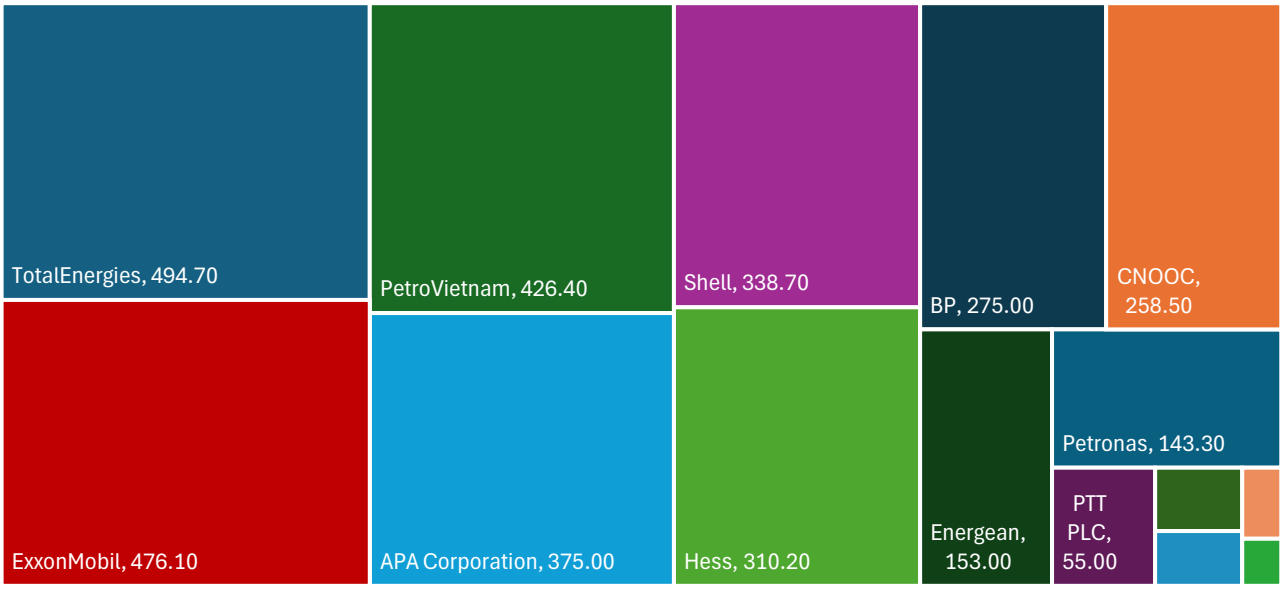
Source: Global Energy Monitor, HAEE's analysis

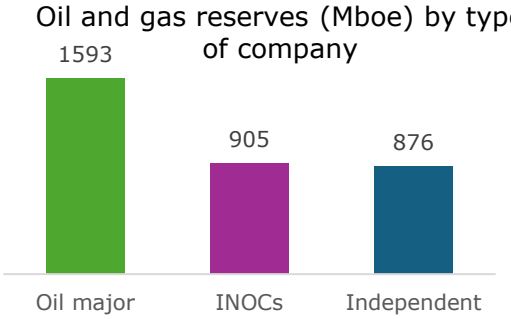
Highlights

- In 2024, a total of at least 9.4 billion barrels of oil equivalent (bboe) were discovered, with 3.8 bboe approved for development.
- In 2023 and 2024, Guyana, the UAE, the United States, and Libya saw the highest number of new projects approved based on resource volumes.
- In 2023, 28 oil and gas extraction projects received investment out of the 35 that were discovered, while in 2024, 15 fields were discovered and 22 were financed.
- By the end of 2024, Norway had 94 active fields in production and 78 discoveries under consideration for development, mostly as satellites to existing fields.
- Kuwait, China and Namibia were the top 3 countries in Oil & gas discoveries for 2024 with 2,947, 1,863 and 1,500 mboe, respectively.

Oil majors and NOCs continue to dominate the push for new fields, with upstream investments steadily growing since 2021

Oil and Gas Reserves (Mboe) Sanctioned by Company [2024]





Oil major
TotalEnergies, ExxonMobil, Shell, BP, ENI

INOCs
PetroVietnam, CNOOC, Petronas, PTT PLC, Equinor

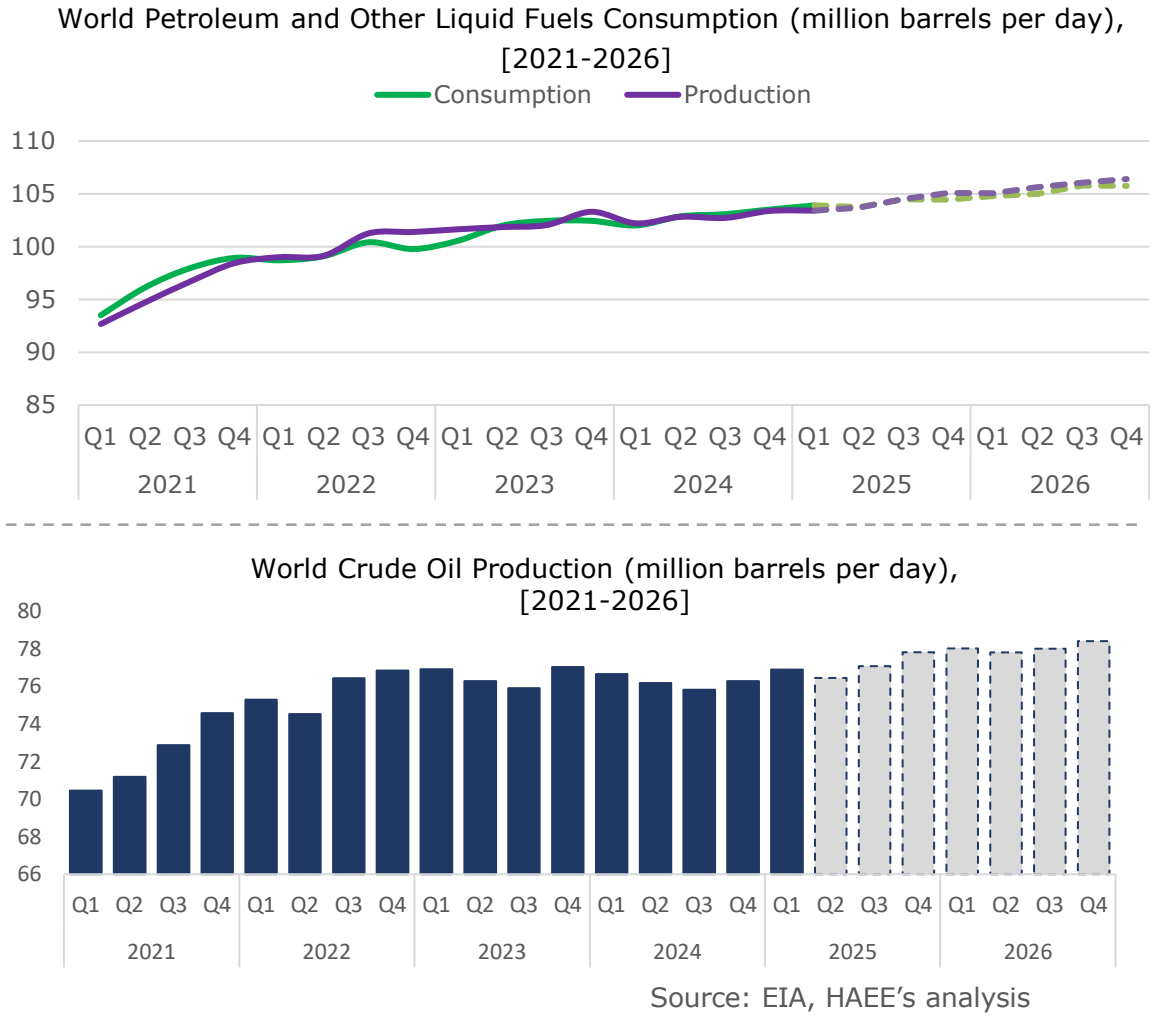
Independent
APA Corporation, Hess, Energean, Kosmos Energy, Red Willow Production

Source: Global Energy Monitor, HAEE's analysis

Highlights

- In 2024, Russia's oil reserves increased by 31.4 billion tons, including a 592-million-ton increase in oil and condensate.
- Libya's National Oil Corporation achieved a new production record, with daily output of 1,386,030 barrels of crude oil and condensates. ENI and BP are to return to Libya.
- Oil majors and International National Oil Companies (INOCs) account for most of the approved resources, with 42.5% and 24.2%, respectively.
- Shell expects an 85% reserve replacement ratio (RRR) for 2024, with a three-year RRR forecasted at 108%.
- In 2024, oil and gas exploration investments remained at $3.3 billion, while federal budget revenues in January 2025 saw a 16.9% increase from the previous year.

OPEC projected that global oil demand will increase by 1.45 million bpd in 2025 and by 1.43 million bpd in 2026

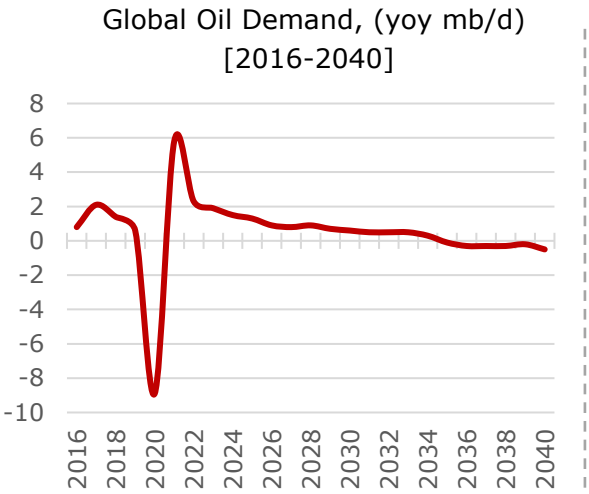


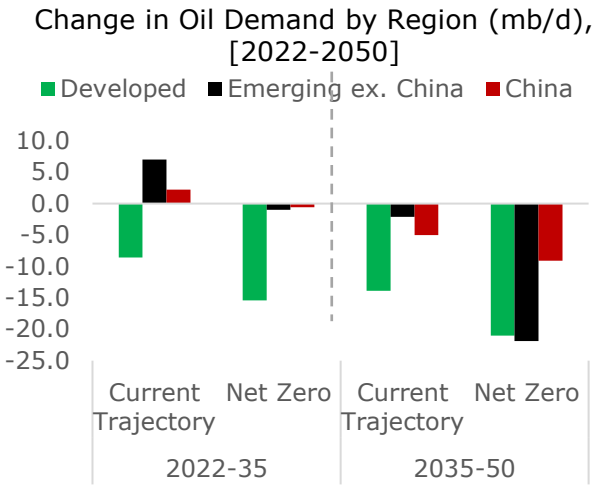
Source: EIA, HAEE's analysis

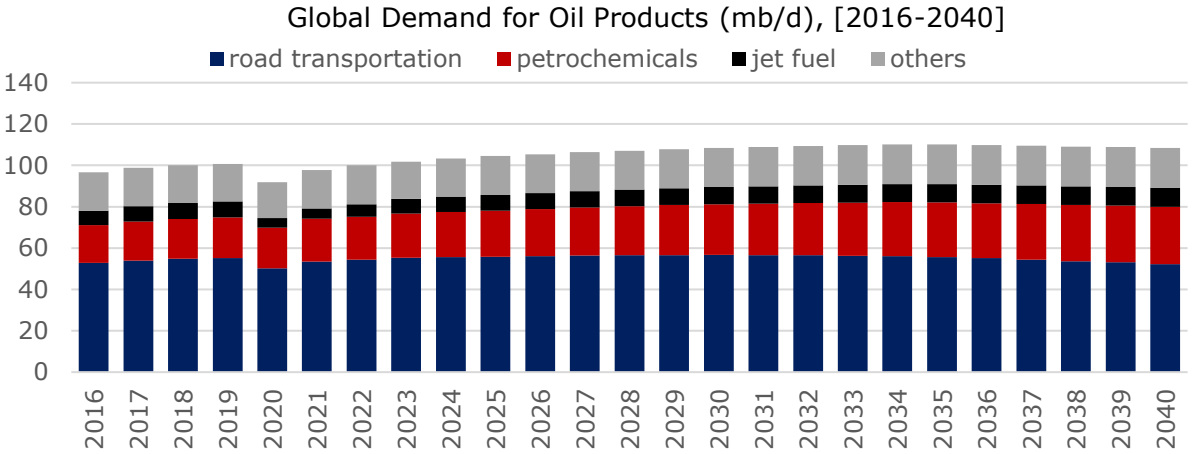
Highlights

- OPEC+ crude oil production is expected to grow by under 0.2 million b/d in 2025 after a 1.3 million b/d decline in 2024, with a 0.5 million b/d increase in 2026.
- Non-OPEC+ oil production is projected grow, rising by 1.2 million b/d in 2025 and 1.0 million b/d in 2026, driven by the U.S., Canada, Brazil, and Guyana.
- Global liquid fuels production is set to rise by 1.4 million b/d in 2025 and 1.6 million b/d in 2026, driven by OPEC+ increases and non-OPEC+ growth.
- Global oil inventories are set to start building in 3Q25, following draws until mid-2025, impacted by sanctions on about 1.5 million b/d from Iran and Venezuela.
- Brent prices are forecasted to average $74/b in 2025, rising to $75/b in 3Q25 due to tighter market balances.

Oil demand is expected to peak at 110 mb/d by 2034 but could rise to 113 mb/day by 2040 with slower EV adoption







Source: BP, Goldman Sachs, HAEE's analysis

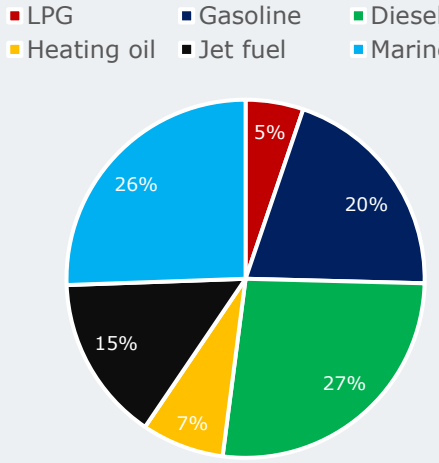
Highlights

- The decline of oil demand in the developing countries is expected to range between 20 and 7 mb/d by 2050 in the two scenarios while in China it is expected after 2030.
- Road transportation demand is set to peak at 55.7 million barrels per day in 2035, whereas the demand for other oil products is expected to hit its peak in 2040.
- The International Energy Agency expects oil production to peak by the decade's end, while OPEC forecasts growth until at least 2050.
- Equinor plans to increase oil and gas production by over 10% by 2027, raising its 2030 production target to 2.2 million barrels per day.
- BP announced its return to its core business, the production of oil and gas, as opposed to investments in RES (with a plan to increase production by 2030).

HELLENiQ and Motor Oil invest in renewables and low-carbon technologies to drive Greece's energy transition and reduce emissions

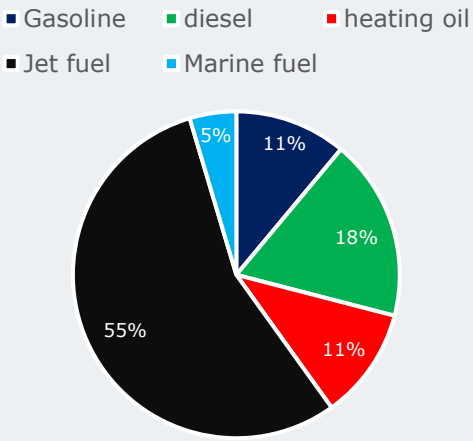
MOTOR OIL

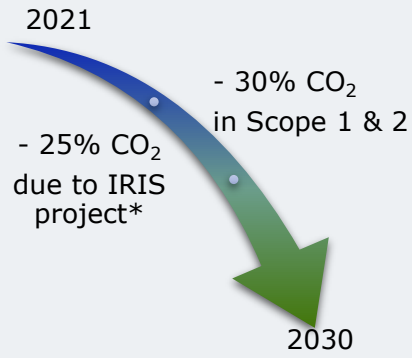
Fuel consumption in Greece (%), [2024]



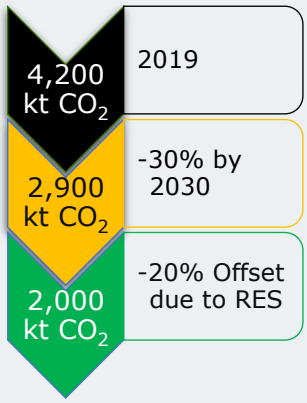
HELLENiQ ENERGY

Fuel consumption in Greece, (%) [2024], (EKO & BP)

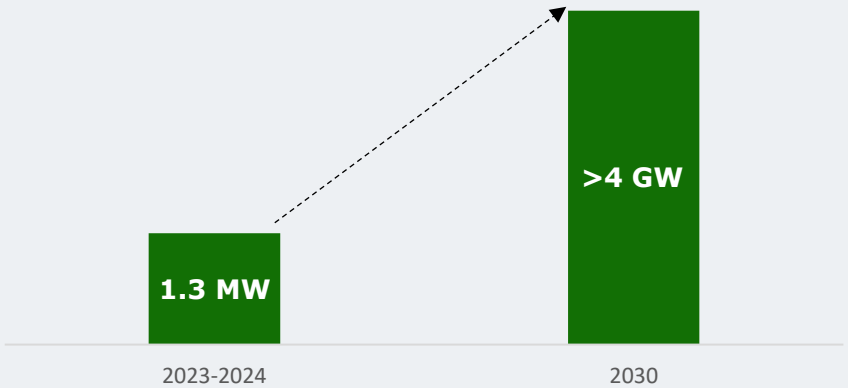




* EU IF project on Capture of Carbon Dioxide from the hydrogen production unit of the Motor Oil refinery



Target RES installed capacity, GW (Motor Oil & HELLENiQ combined)



7. Investments

Contents

Highlights

EU accounts for approximately **18.04%** of **global energy investment** in **2024**

Europe launched **2,438 sustainable funds** between 2020–2023, or over **75%** of the **global total**

Clean energy investment rises by **$73 bn in a single year**, pushing its share to 64% of total energy investments

With **investments** surpassing **$400bn**, **2024** marks the **EU's** strongest **commitment** yet to **low-carbon electricity** and **grid modernization**

Over **€436 Billion Investments for** Cost Reductions and Grid Decarbonization planned **by 2050**,are included in **Greece**'s NECP Targets

2024 sets a new benchmark with **€3.2bn in energy and RES**, marking a historic pivot in **Greece's M&A landscape**

In **2024**, **Greece** secures the **highest RRF allocation** relative to its GDP, reaching **16.6%**, which is significantly above the EU average of approximately 4–5%

Energy accounted for **€9.6m** (5.0%) of **total transaction value in the EU**, with a single deal representing **5% of all transactions**

The average ESG score of **Greek-listed companies** is **57.3**, while the share of high ESG-performing companies rose by **144% compared to 2020**

Overview

In 2024, global clean energy investment reached $1,382 billion, up by $73 billion year-on-year, bringing clean energy's share of global energy investments to 64%. Total global energy investment rose to $2,790 billion, with a cumulative $3.8 trillion invested in clean energy between 2022 and 2024 alone. The power sector continued to drive the surge, with investment reaching $689 billion, while renewable generation hit $771 billion, nearly doubling since 2015. Battery storage investments grew by 18% year-on-year, reaching $78 billion, and power grid investment climbed to $398 billion. Fossil fuel investments rose slightly but fell in relative share to 36%, marking a continued global pivot toward electrification and system-wide decarbonization.

In terms of energy transition leadership, China remained dominant in clean tech manufacturing, producing over 80% of solar modules and batteries. However, the U.S. led investment in 2024, committing $303 billion, followed by China ($254B) and Germany ($93B). The EU invested $341 billion, maintaining strategic strengths in heat pumps (25.3% of global production) and electrolyzers (17.4%), but lagging in battery and solar manufacturing. Greece, as part of this broader EU effort, achieved a national investment record in energy and RES M&A, reaching €3.2 billion in 2024 — the highest sectoral concentration (over 70%) in a decade.

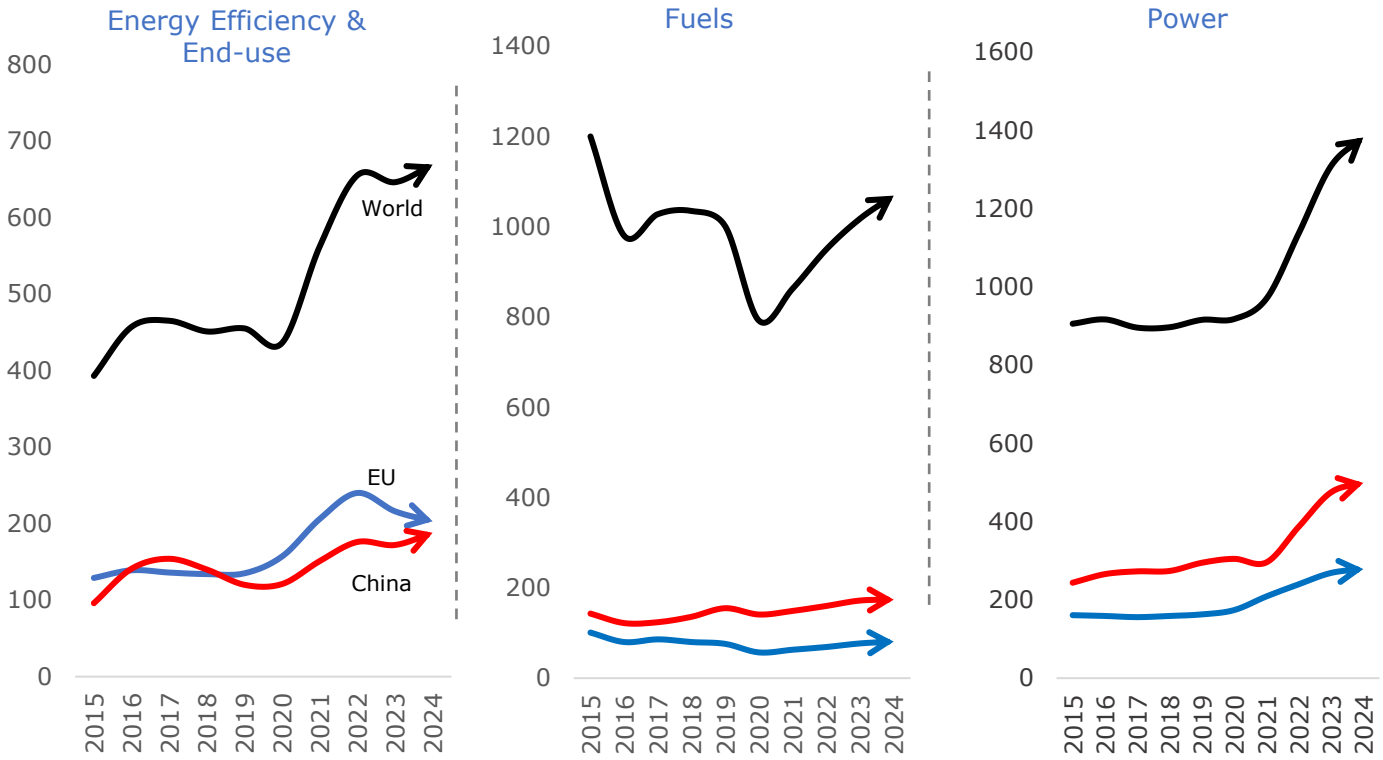
The EU's long-term budget, RRF mechanisms, and national funding tools like REPowerEU and the Social Climate Fund remain key levers for channeling green finance. Greece continues to lead in RRF allocation relative to GDP (16.6%), with a heavy focus on energy efficiency, sustainable mobility, and renewables, which together absorb nearly 90% of its green RRF budget. Greece also activated a wider €57 billion funding envelope through to 2030 to support decarbonization, regional equity, and energy infrastructure.

Greece's banking sector has started returning to non-crisis levels and is now being able to provide fresh credit and support the development of the economy. The Greek banking system provides more and more loans to the growing Energy sector, reaching a new record of 8,089 loans. In 2022, 13% out of total loans in the Greek banking sector correspond to the energy sector loans, while the same percentage for 2020 and 2021 was shaped in 9% and 10% respectively. It is worth mentioning that the energy sector stably remains one of the most creditworthy sectors, with a percentage of 1.1% in non-performing exposure.

In 2024, Greece's clean energy investments continued to grow, with energy sector loans rising to 10,119, and the sector accounting for 15% of total new loans, up from 12% in 2022. The new National Energy and Climate Plan (NECP) sets an investment trajectory of €436 billion by 2050, targeting CO_2 emissions cuts of 55% by 2030. This includes €7 billion in wind power investment (especially on islands), and €5.3 GW of storage capacity, up from just 1 GW today. Electricity costs are projected to decline from €145/MWh in 2025 to €95/MWh by 2050, driven by RES deployment and grid modernization.

In 2024 there is a sharp global rise in power and efficiency spending, while China focuses on fuels, and the EU on end-use efficiency

Global Energy Investment Vs Chinese and European Energy Investment (billion $), [2015-2024]



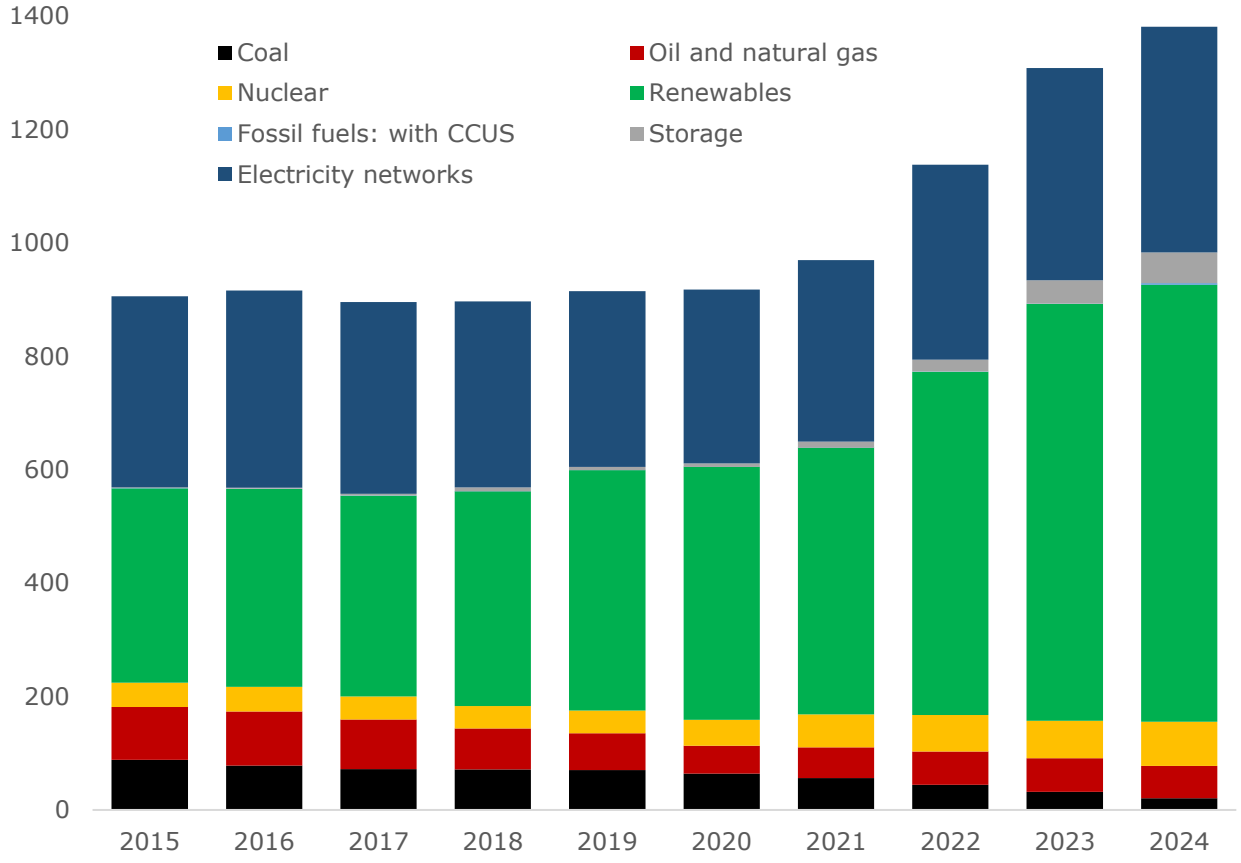
Source: IEA, HAEE analysis

Highlights

- Global power investment surged by approximately 50.54% from 2020 to 2024, showing a shift towards electrification and renewable energy.
- EU investments in efficiency & end-use are rising steadily by around 1.46% between 2021-2024, surpassing China, reflecting pushes towards decarbonization.
- China continues to prioritize fuel investments, showing a consistent upward trend, unlike the EU where fuel investment remains stagnant or declining.
- Global investment in energy efficiency and end-use increased by about 3.56% year-over-year from 2023 to 2024, despite slower momentum observed in key markets.
- China's power investment exceeded that of the EU by $220 billion in 2024, with $499 billion compared to EU's $279 billion.

2024 sees unprecedented rise in renewable power and storage investment, signaling a structural shift in energy infrastructure priorities

Global Investments in Power Sector
(billion $), [2015-2024]



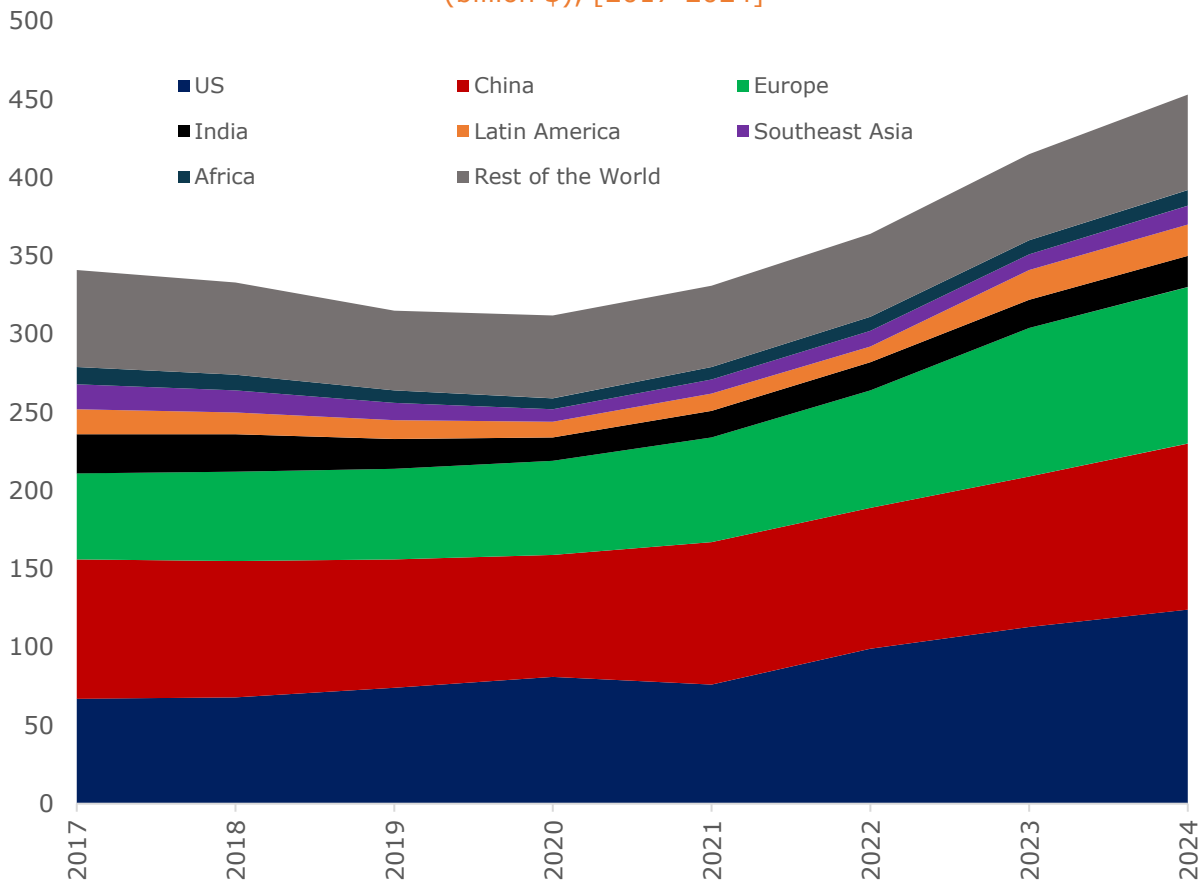
Source: IEA, HAEE analysis

Highlights

- Total global investment reaches approximately $1,344bn in 2024, marking the highest annual total, with over 57% directed toward renewables alone.
- RES dominate generation investment, hitting $771bn in 2024, a $36B increase from 2023 and more than double their 2015 level.
- Storage investments rise to $78bn in 2024, up sharply from $66bn in 2023, a 18% increase year-over-year and a nearly doubling compared to 2021.
- Fossil fuel generation continues to decline, with coal dropping to just 50bn in 2024 down from 88bn in 2015, and oil & gas at 57bn.
- Electricity networks remain stable but rise gradually, from $374bn in 2023 to $398bn in 2024, underscoring a consistent need for transmission upgrades.

The US has taken the lead in investment growth from 2022 onwards, while China has maintained a dominant position

Investment in Power Grids and Storage by Region
(billion $), [2017-2024]



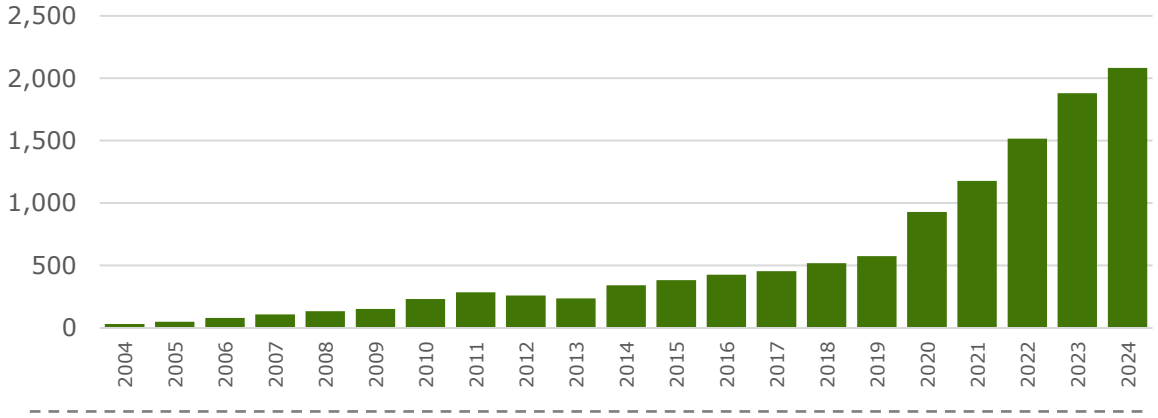
Source: IEA, HAEE analysis

Highlights

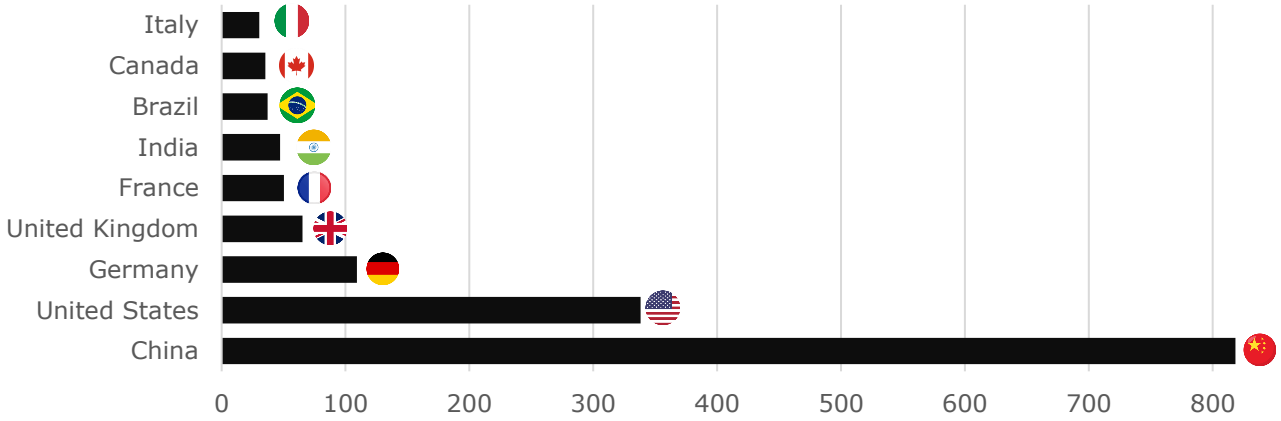
- The US has invested a total of $606bn between 2017-2024, while the growth rate was robust at 12.5% in 2018, it has significantly slowed down to 1.4% by 2024.
- China leads in global investments in power grids and storage, with a cumulative total of $725 bn from 2017 to 2024.
- EU has shown an increase in investments, totaling $616bn from 2017 to 2024. The y-o-y growth rates have remained relatively stable, with an uptick to 3.1% in 2024.
- Southeast Asia has experienced fluctuations, with growth rates peaking at 7.1% in 2018 and declining to -2.6% in 2024.
- Africa's total investment stands at $57.6bn , showing modest growth. The year-on-year growth rates have generally decreased, from 4.0% in 2018 to -4.8% in 2024.

2024 marks a record $2.1 trillion in transition technologies, with EU holding strategic strengths in niche technologies

Global Investments in Energy Transition Technologies (billion $), [2004-2024]



Energy Transition Investment by Leading Countries (billion $), [2024]



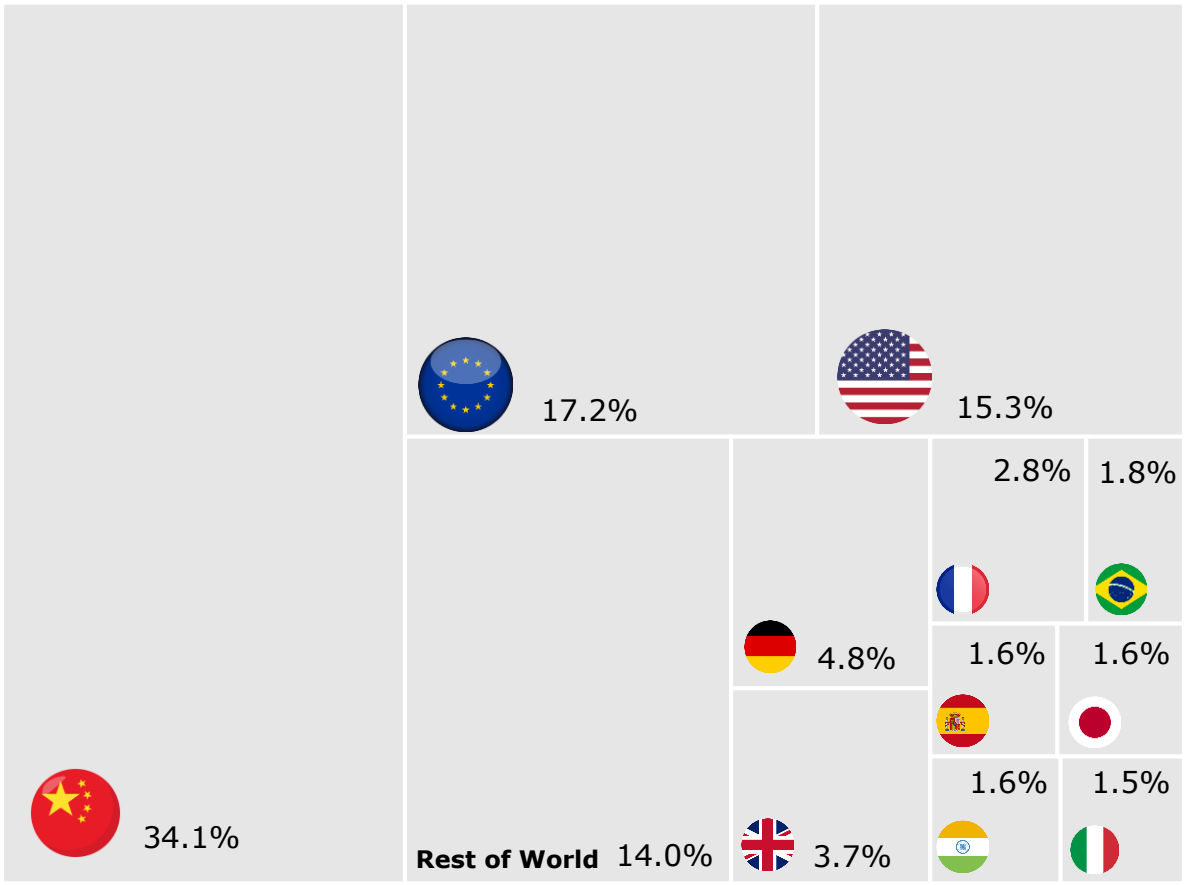
Source: IEA, HAEE analysis

Highlights

- Global investment in energy transition technologies reaches $2.08 trillion in 2024, more than six times the amount invested a decade earlier.
- China holds a commanding lead in clean energy manufacturing, producing over 80% of global solar modules and battery cells, and 64.8% of wind turbine nacelles.
- The United States leads global energy transition investment in 2024, with $303bn, followed by China at $254bn and Germany at $93bn.
- The EU's manufacturing share is strongest in heat pumps (25.35%) and electrolyzers (17.39%), but remains under 16% across all other clean tech segments.
- U.S., China, Germany) together account for over $650B — nearly one-third of total global energy transition investment in 2024.

China continues to lead the energy transition investments in 2024, although the difference is narrowing down

Top 10 Economies for 2023 Energy Transition Investment (billion $),[2024]



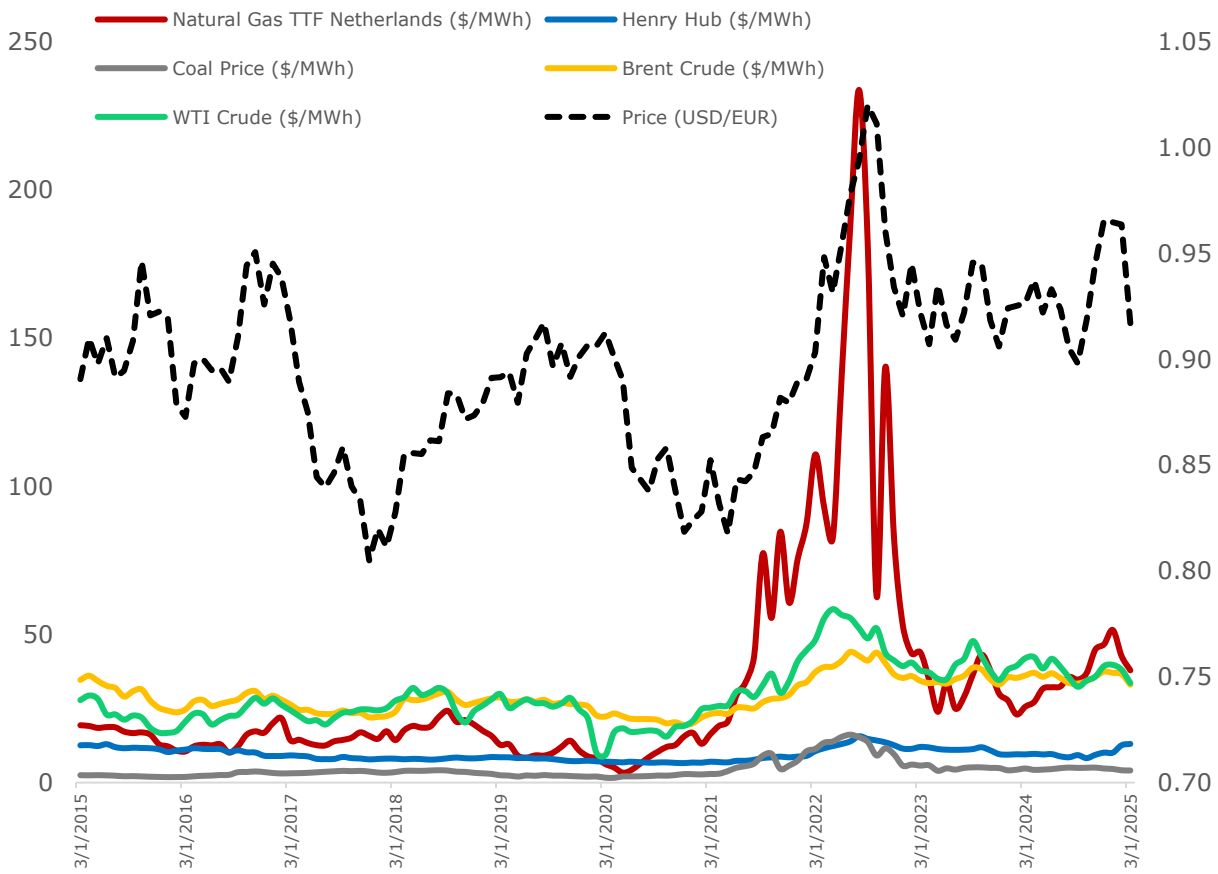
Source: IEA, BNEF, HAEE analysis

Highlights

- China monopolizes the market share for energy transition spending, reaching $676 billion in 2024. This amount corresponds to 38% of the global total.
- With $303 billion invested in energy transition technologies in the US in 2024, it is the second-largest financing economy.
- Germany continued to be the third-ranked individual economy, regarding energy transition investment, accounting 4.8% of the global total.
- Germany, France, Italy and Spain are among the Top 10 economies for 2023 Energy Transition Investment. The EU invested $341 billion in 2024.
- Brazil, Japan and India conclude the top 10, with more than $30 billion invested in each country.

After the 2022 energy crisis triggered by war and supply disruptions, since then the prices still reflect geopolitical fragmentation

Energy Commodities Historical prices & USD/EUR Exchange Rate, [2015–2025]



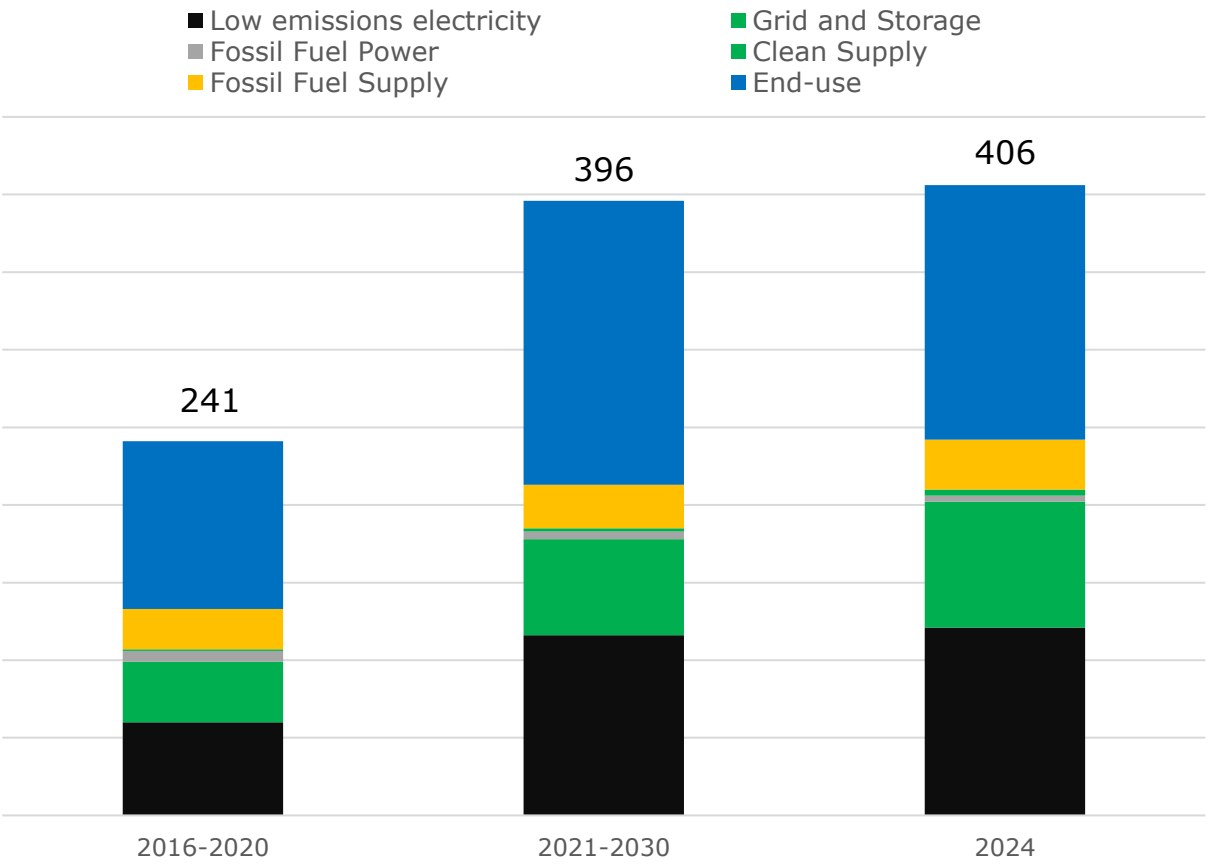
Source: IEA, IRENA, BNEF HAEE analysis

Highlights

- TTF experienced an extreme price spike in 2022, peaking above $250/MWh amid the European energy, before returning to more typical price ranges in 2023–2024.
- Brent and WTI crude prices show relative stability post-2022, fluctuating between $60–$100/MWh, suggesting rebalancing in global oil markets.
- Coal prices remained stable in 2024 compared to 2023, sustaining higher-than-pre-2020 levels, indicating its role as a fallback fuel in energy-insecure regions.
- The USD/EUR exchange rate remained elevated in 2024, hovering around 0.95, reinforcing the dollar's safe-haven status amid inflation pressures.
- Henry Hub gas prices stayed flat between 2023-2024, highlighting domestic supply resilience and muted export pressures compared to EU's volatile gas dependency.

With investments surpassing $400bn, 2024 marks the EU's strongest commitment yet to low-carbon electricity and grid modernization

Energy Investment in the European Union by Sector (billion $), [2004-2022]

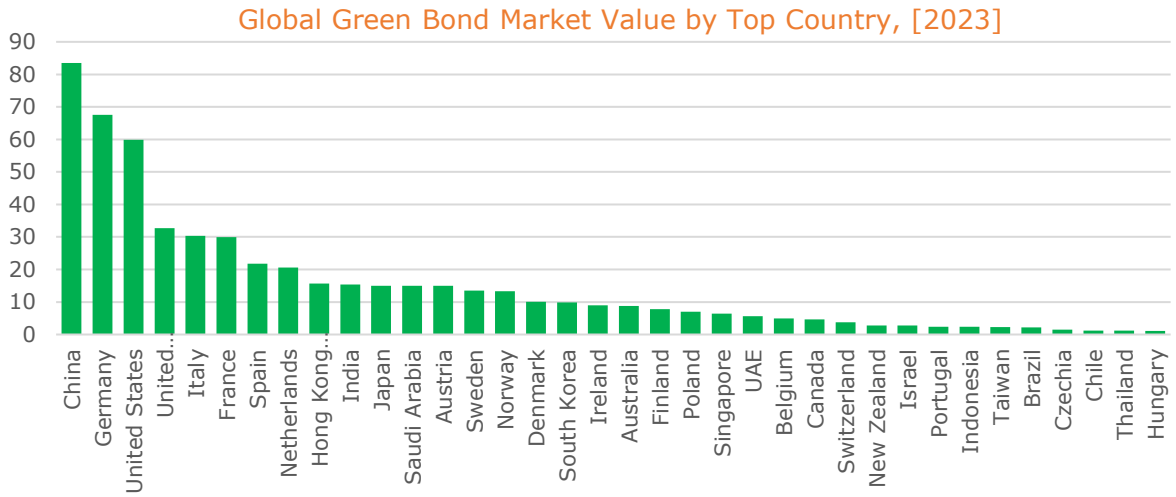


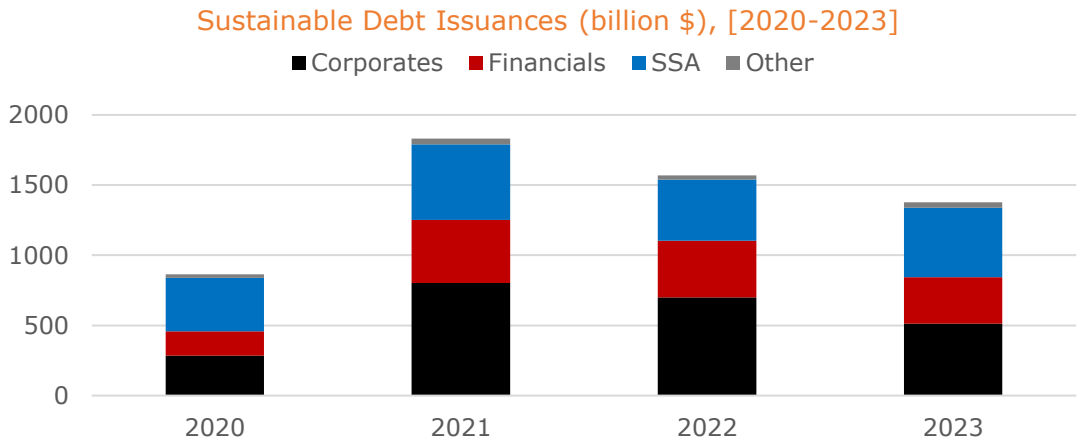
Source: BNEF, HAEE analysis

Highlights

- EU energy investment in 2024 reaches $406bn, representing a 10bn increase from the 2021–2030 annual average and a 68% jump compared to the 2016–2020.
- Low-emissions electricity investment rises to $121bn in 2024, up from $116bn the 2021–2030 average and 102% higher than 2016–2020.
- Grid and storage investment surges by $19bn y-o-y, from $62bn to $81bn in 2024, marking a 31% y-o-y increase.
- End-use investment decreases by $19B compared to the 2021–2030 benchmark, suggesting a temporary slowdown in efficiency or electrification initiatives.
- Fossil fuel power investment slightly by 14% in 2024, while fossil fuel supply remains minimal.

After a peak in 2021, global sustainable finance shows signs of maturity in 2023, with EU leading in fund activity





Source: IEA, HAEE analysis

Highlights

- Sustainable debt issuance in 2023 totaled $1.38 trillion, a 11.6% decline compared to 2022, marking the first significant contraction in issuance volume.
- Corporates led the decline, dropping from $701B in 2022 to $514bn in 2023, while SSA bucked the trend, increasing their issuance by 13.3%.
- Over the 2020–2023, total sustainable debt issuance reached $5.63 trillion, with corporates accounting for 41%, followed by SSA (33%), financial institutions (24%).
- Despite the slowdown, Europe launched 2,438 sustainable funds between 2020–2023, or over 75% of the global total.
- In the green bond market, China leads globally with ~$85bn in issuance in 2023, followed by Germany ($75bn) and the United States ($60bn).

Between 2021-2027, the EU has activated multiple funding mechanisms to support the energy transition and reduce social disparity

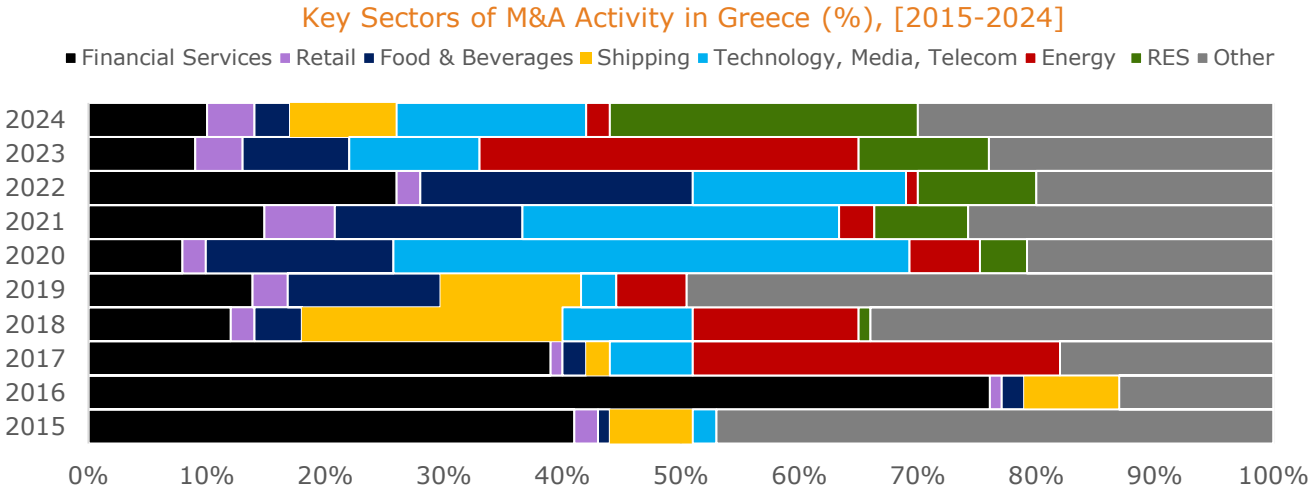
EU Funding Mechanisms and Expected Timeline, [2024]

NAME	PERIOD	BUDGET	SOURCE OF FUNDING	INVESTMENTS
RRF	2021-2026	€723.8	- Next GenerationEU - Green Bonds	- Loans - Grants
REPowerEU	2022-2026	€300	- RRF - ETS Allowances - Brexit Adjustment Reserve - Cohesion Funds	- Loans - Grants
ERDF Cohesion Funds	2021-2027	€274	- EU budget	- Grants
Connecting Europe Facility	2021-2027	€42.3	- EU budget	- EU PCIs which may apply for CEF funding
Just Transition Mechanism	2021-2027	€40	- EU budget - Private Investments	- Grants - Loans
Horizon Europe	2021-2027	€95.5	- EU budget - Next GenerationEU Green Bonds	- Grants
Invest EU Fund	2021-2027	€26.2	- EU Budget Guarantee	- Loans - Equity - Venture debt
LIFE: Clean Energy Transition	2021-2027	€5.4	- EU Budget	- Grants
Modernization Fund	2021-2030	€14	- EU Budget	- Grants

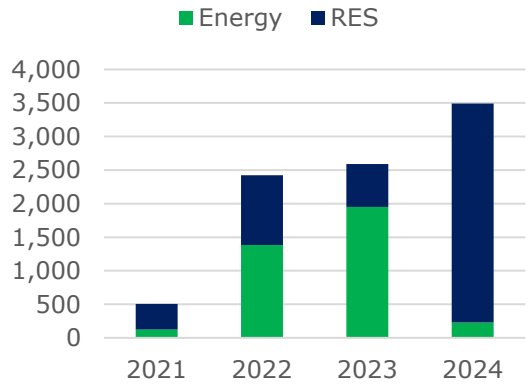
Source: European Commission, BRUEGEL, HAEE analysis

2024 sets a new benchmark with €3.2bn in energy and RES, marking a historic pivot in Greece's M&A landscape

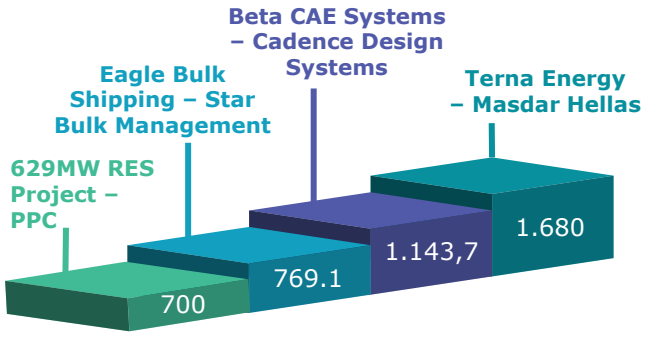
Key Sectors of M&A Activity in Greece (%), [2015-2024]



Transactions in Energy and RES (€ million), [2015-2024]



Top 4 Transactions in Greece (€ million), [2024]



Source: European Commission, HAEE analysis

Highlights

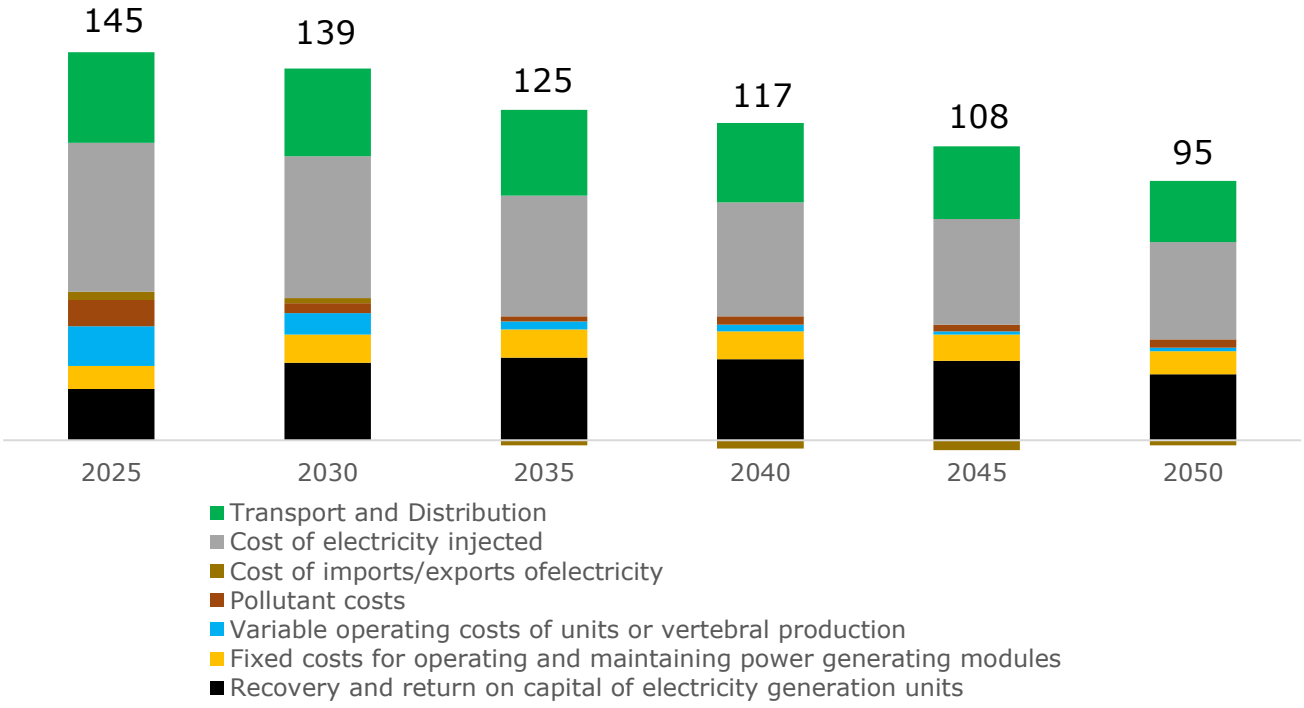
- Energy and RES (Renewable Energy Sources) combined represent over 70% of M&A activity in 2024, marking the highest concentration on record.
- Greece reached a record €3.2 billion in Energy and RES transactions in 2024, up 3.3% from 2023.
- Terna Energy's €1.68 billion deal with Masdar Hellas was the largest M&A transaction in Greece in 2024.
- Energy and RES together made up over 70% of total M&A activity in Greece in 2024, the highest sectoral concentration in the last decade.
- Despite no increase in deal count, the average deal size increased, indicating a trend toward fewer, but larger transactions across energy and infrastructure.

With Over €436 billion in planned investments by 2050, Greece's NECP targets long-term cost reductions and grid decarbonization

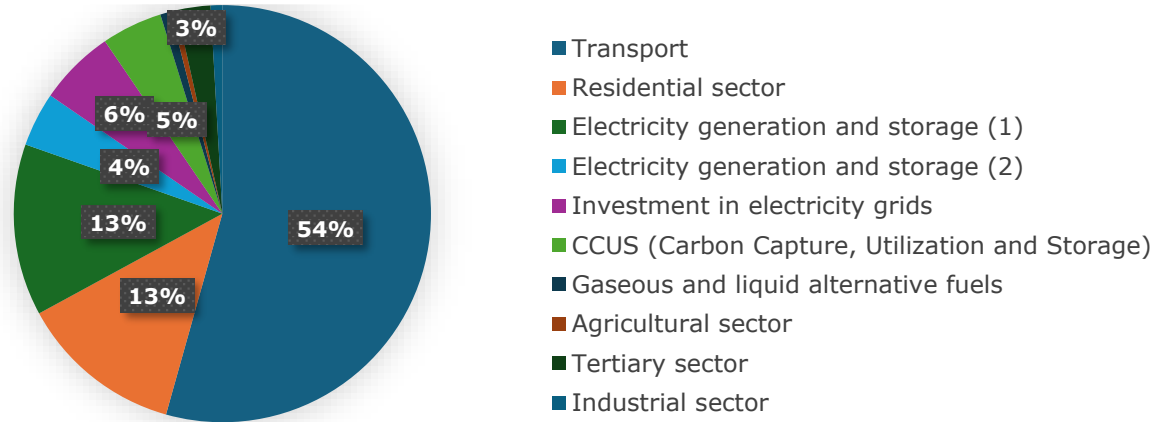
Updated NECP Total Estimated Investments (million €) , [2025-2050]

	2025–2030 (million €)	2031–2050 (million €)
Energy Demand	65,106	242,105
Energy Production	30,829	98,354
Total	**95,935**	**340,460**

Estimate of the Evolution of Average Electricity Costs (EUR/MWh), [2025-2050]



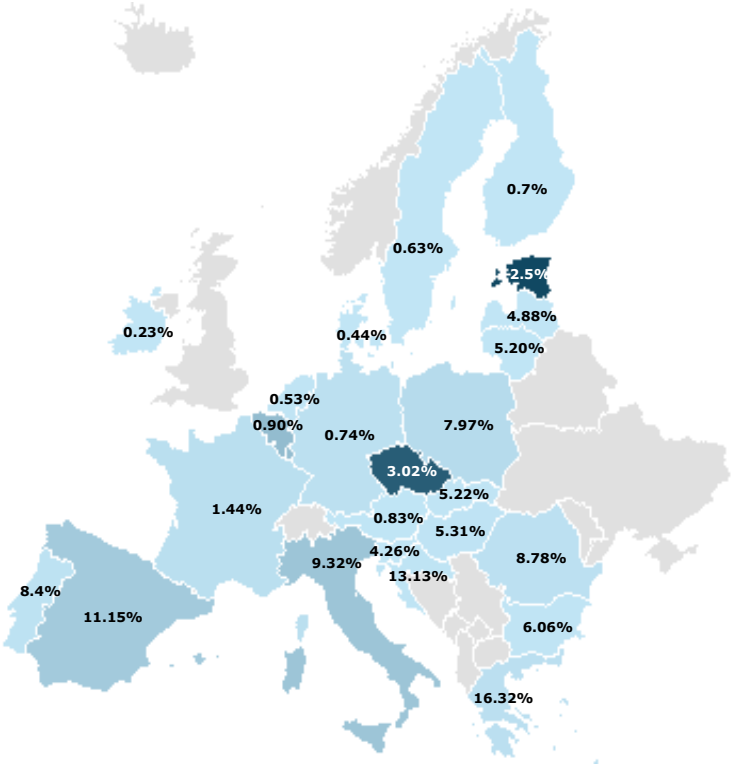
Investment estimates by sector in NECP (%), [2030-2050]



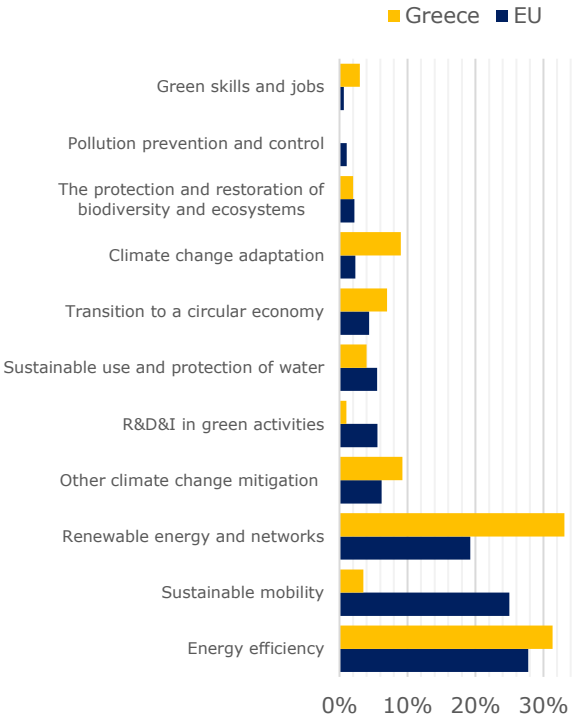
Source: NECP, HAEE analysis

Greece leads in RRF funding as a share of GDP, prioritizing energy efficiency and sustainable mobility above the EU average in 2024

RRF Allocation as Share of GDP (%), [2024]



Breakdown of RRF Expenditure Supporting the Green Transition per Policy Area in Greece and the EU (%), [2024]



Source: Financial Times, HAEE analysis

Highlights

- Greece receives the highest RRF allocation as a share of GDP (16.6%) in 2024, significantly exceeding the EU average of around 4–5%.
- RES and networks represent the largest category of RRF green spending at EU level (over 30%), more than double the EU average (~15%).
- Sustainable mobility accounts for approximately 25% of RRF green funds in Greece, compared to ~10% EU-wide, indicating a national push toward electrification.
- RRF funding for green R&D, circular economy, biodiversity, and water protection remains limited in Greece, falling below EU averages across these categories.
- While Greece allocates nearly 90% of its RRF green funds to just three areas — energy efficiency, mobility, and renewables.

Source: European Commission, BRUEGEL, HAEE analysis

With €35.9bn in RRF funding and a diverse portfolio of national and EU instruments, Greece strengthens its green agenda during 2024

Greece's Recovery and Resilience Facility (RRF) Overview, [2024]

Category	Amount (€)	Details
Total Allocation	35.9 bn	Comprising €18.2 billion in grants and €17.7 billion in loans.
Disbursed Funds	18.2 bn	As of October 2024, Greece had received €18.2 billion from the RRF.
Pending Disbursement	17.7 bn	Remaining funds to be disbursed, contingent upon meeting specified milestones and targets.
Upcoming Payment Request	3.13 bn	Submitted in December 2024; awaiting approval as of March 2025.

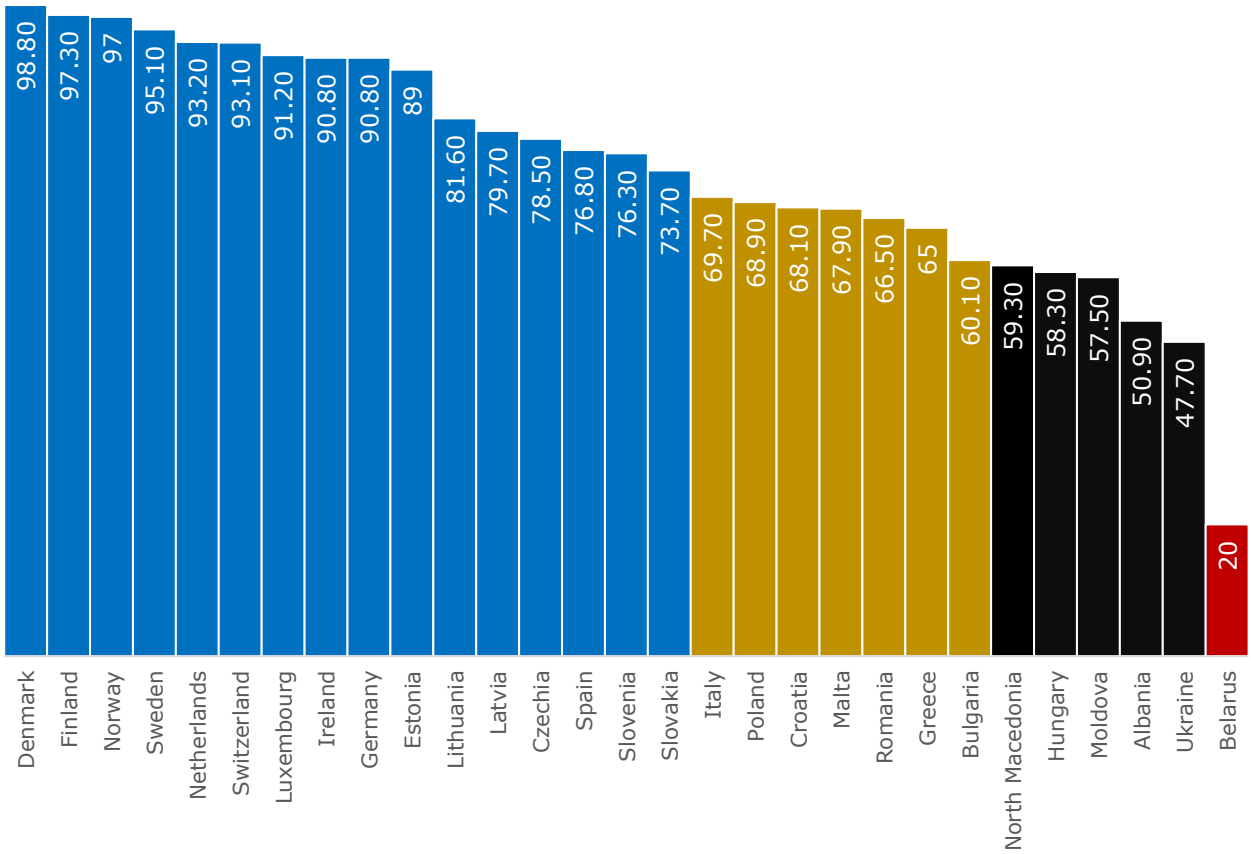
Greece's Other Available Funding Tools, [2024]

Funding Tool in GR	Available Funds (€)	Description
NSRF 2021–2027	36 bn	The Partnership Agreement for the Development Framework allocates a total of €36 billion, with a large part directed toward energy upgrades and renewable energy sources.
Islands' Decarbonization Fund	2.3 bn	Aims to reduce carbon emissions on Greek islands by funding renewable energy projects and interconnection with the mainland grid.
Just Transition Fund	5 bn	Supports workers and citizens in regions most affected by the transition.
Modernization Fund	1.85 bn	Supports energy infrastructure upgrades and the promotion of clean technologies, contributing to the green economy transition.
Social Climate Fund	3.37 bn	Aims to address the social and economic impacts of the energy transition, providing support to vulnerable households and businesses.
Energy Efficiency Program 2025	Not specified	Provides financial support to homeowners to improve energy performance, aiming to upgrade at least 11,500 homes by 2025.
European Investment Bank (EIB) Financing for 2024	2.2 bn	In 2024, the EIB provided €2.2 billion to Greece, focused on renewable energy, grid investments, and business development.
Digital Tools for SMEs Program	Not specified	Aims to support the digital transformation of SMEs through subsidies for digital tools and equipment.

Source: Financial Times, HAEE analysis

In 2024, Nordic countries dominated as Eastern and Southeastern Europe trailed behind in ESG performance

Countries by Overall ESG Ranking in Europe [2024]



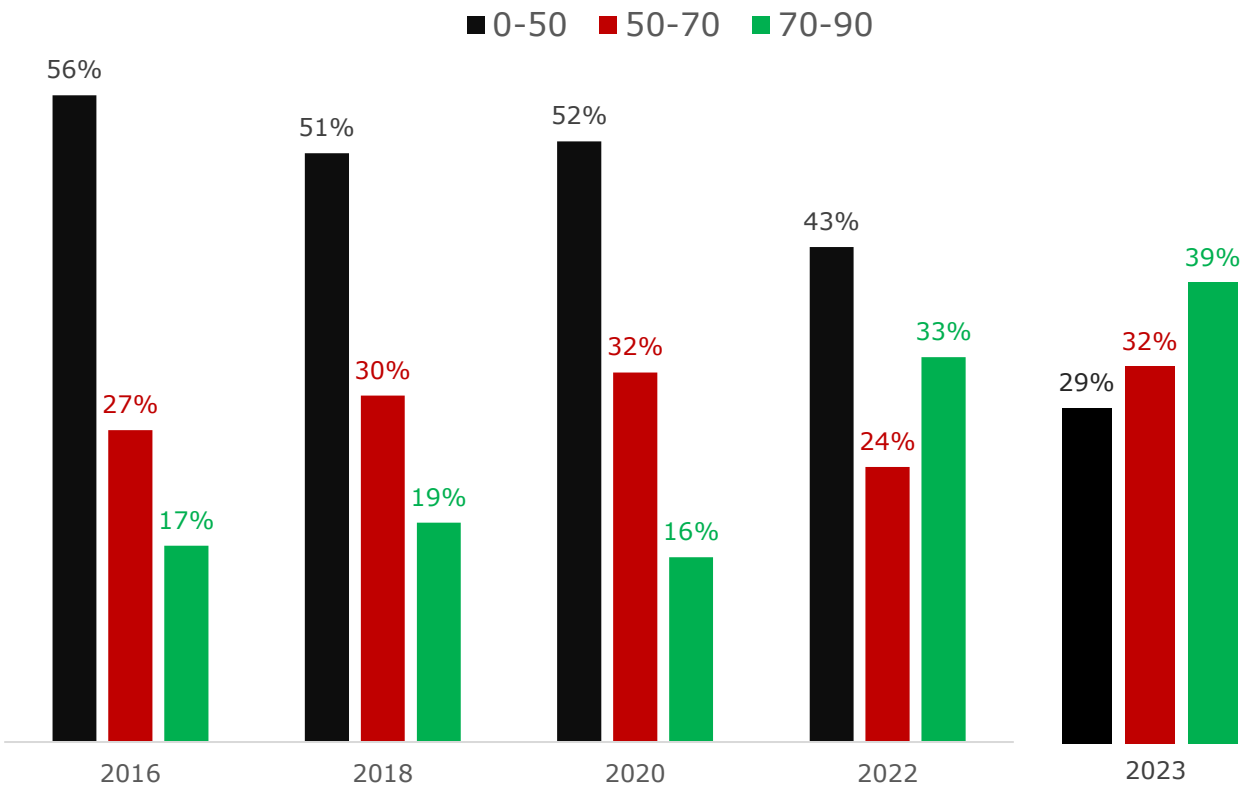
Source: Refinitiv, HAEE analysis

Highlights

- Denmark (98.8), Finland (98.7), and Norway (97.3) lead EU ESG performance in 2024, with all top 10 countries scoring above 90, forming the 'A-tier' of ESG leaders.
- Countries like Ireland, Estonia, and Lithuania fall into the 80–90 range (B-tier), showing strong but slightly more varied ESG integration and implementation.
- Greece, Romania and Bulgaria occupy the lower mid-tier (C and D), reflecting weaker regulatory enforcement, ESG reporting maturity, and institutional capacity.
- Ukraine and hold the lowest ESG scores in EU, categorized in 'E-tier', largely due to geopolitical instability, governance concerns and weak corporate practices.
- The gap between top- and bottom-performing countries exceeds 50 points, underscoring a deep East–West divide among European countries.

Greek companies show steady ESG improvement in 2023, with 40% scoring above 70 and an average score of 57.3 across the listed market

Score Distribution of Greek Companies based on their ESG Performance (%), [2016 - 2023]



Source: Refinitiv, HAEE analysis

Highlights

- The average ESG score of Greek-listed companies in 2023 is 57.3, with leading firms like PPC, Motor Oil, and OTE Group scoring well above the national average.
- 39% of companies scored between 70–90 in 2023, the highest share since 2016, while the share of low performers (<50) dropped from 56% in 2016 to 29% in 2023.
- Between 2016 and 2023, the proportion of companies in the high ESG bracket (70–90) more than doubled, from 17% to 39%.
- In 2023, the share of high ESG-performing companies continued to rise significantly, marking a 144% increase compared to 2020.
- A small group of companies still score below 30, indicating either early-stage ESG integration, lack of reporting, or sector-specific challenges.

8. Energy Demand

Contents

Highlights

Oil remains the dominant energy source in the EU27, though its share is slowly declining since 2022

The **duck curve effect is worsening** over the last few years, revealing the **need for energy storage**

Final energy use in the EU27 is forecast **to decline by 4.9% by 2030**, driven by improved efficiency measures

Greece's energy intensity is steadily decreasing as part of broader efficiency improvements

Coal consumption in the EU27 has experienced a significant **21% drop**, reflecting accelerated decarbonization efforts

In **Greece**, the **transport sector** accounts for **42%** of **final energy consumption,** taking the lead for the Greek context

In **Greece**, the **transport sector** accounts for **42%** of **final energy consumption,** taking the lead for the Greek context

Buildings drive a surge in electricity demand globally, growing four times faster than in 2023

Decoupling energy use and economic growth is a trend on the rise for many EU countries

Overview

Europe's energy landscape is evolving as consumption patterns shift, and efficiency measures take hold across the continent. Recent analyses reveal that oil remains the dominant fuel source, yet its share is gradually declining, while coal consumption has fallen sharply by 21% as nations intensify decarbonization efforts. Gas demand, too, has decreased by around 7%, underscoring the broader transition toward cleaner energy mixes. Meanwhile, renewables—especially wind and solar—are surging, highlighting an accelerated clean energy adoption that is reshaping how power is generated and consumed across Europe. Nuclear power shows a modest uptick, reinforcing its steady role in the energy mix despite the rising prominence of variable renewable sources.

In the European Union, both primary and final energy consumption are on a downward trend. Projections indicate a primary energy decline of 3.7% and a 4.9% drop in final energy use by 2030. These figures point to the success of efficiency measures and a concerted push to reduce fossil fuel dependency, a trend mirrored in Greece, where primary energy consumption is expected to fall by about 4.8%. However, Greece's final energy use exhibits a less pronounced decrease of 2.5%, revealing a continued reliance on traditional fuels amid ongoing modernization challenges.

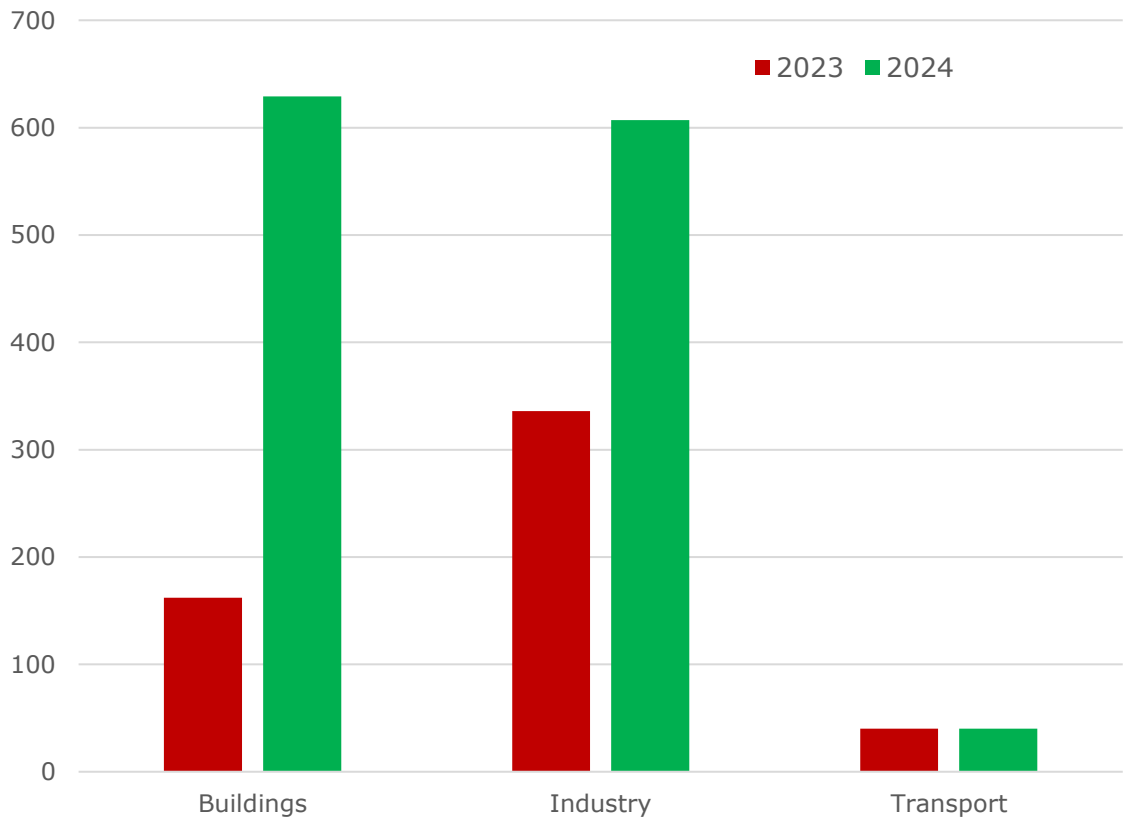
Energy intensity is another critical metric, with EU27 showing a clear downward trend driven by technological advancements and improved energy management. In contrast, Greece continues to record higher energy intensity levels, although gradual improvements suggest that efficiency measures are beginning to take effect. News from various reports indicates that while some European countries, like Ireland and Finland, have achieved remarkable efficiency gains, Southeast European nations face steeper challenges that call for enhanced policy support and infrastructure upgrades.

Greece's energy profile also reflects a unique mix of consumption patterns. The country's final energy consumption is heavily weighted toward oil, which dominates despite slight fluctuations, while natural gas usage is steadily increasing, partly offset by growing renewable inputs such as biofuels. In the transport sector, which accounts for 42% of final energy consumption, efficiency improvements are urgently needed as policymakers focus on promoting cleaner mobility solutions. Additionally, building energy consumption remains a concern, with Greece's energy poverty rate at 19.2%—nearly double the EU average—underscoring the need for measures that improve heating efficiency and reduce household energy burdens.

Overall, Europe and Greece are at a pivotal moment. Technological progress, robust policy frameworks, and targeted investments in energy efficiency are driving a steady decoupling of economic growth from energy demand across Europe. Yet, in Greece, the ongoing coupling between GDP growth and energy consumption highlights the continued importance of scaling up efficiency measures to secure a sustainable, low-carbon future.

Global electricity demand is on the rise in 2024, with the building and industry sectors driving the increase

Annual Change in Global Electricity Consumption (TWh) by Sector, [2023-2024]



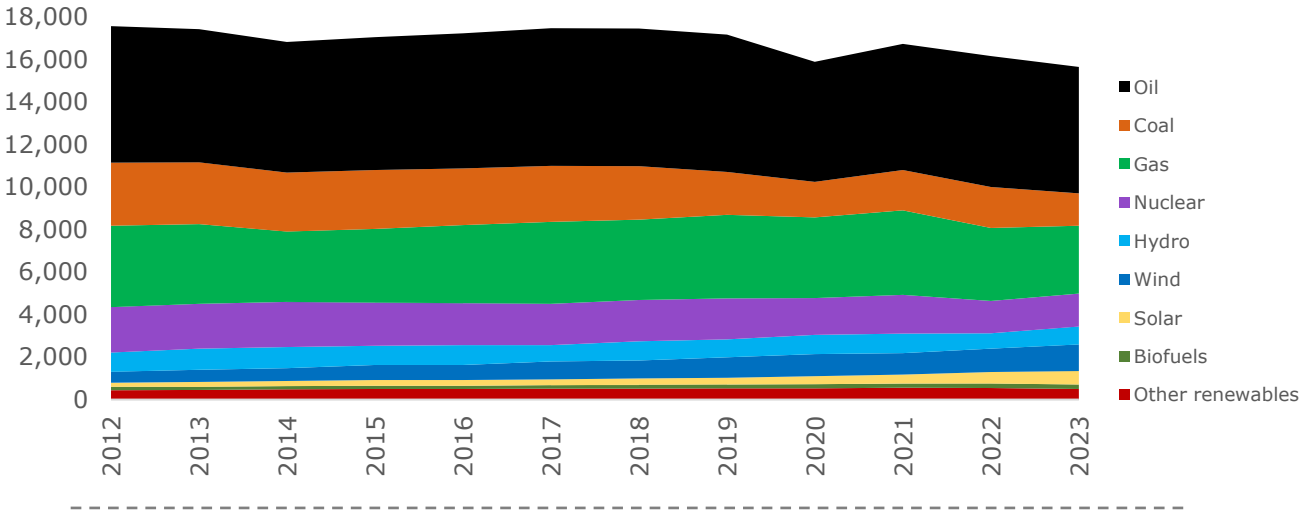
Source: IEA, HAEE analysis

Highlights

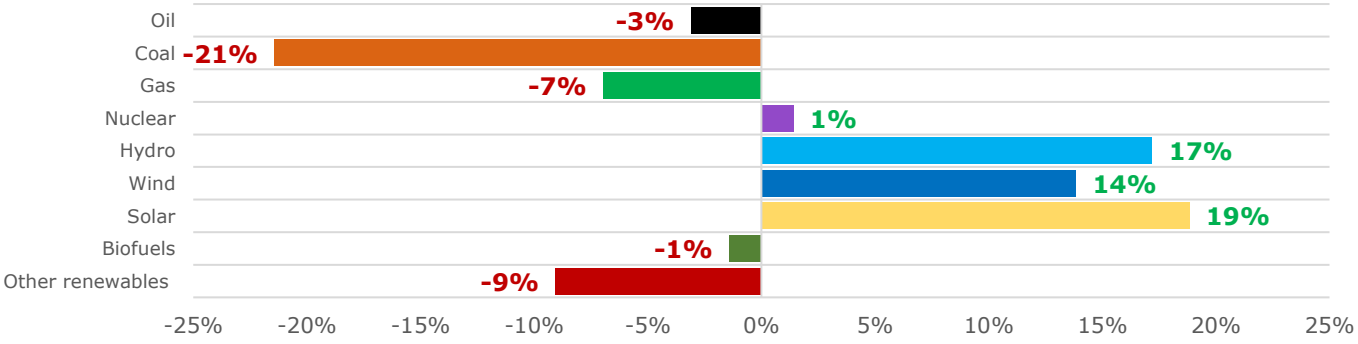
- Global electricity demand increased by 4.3% in 2024, a step change from the 2.5% growth seen in 2023.
- The buildings sector drove higher electricity demand in 2024, growing four times faster than in 2023.
- Key drivers included rising demand for air conditioning, which was bolstered by severe heatwaves in various countries.
- The industry sector made up nearly 40% of total growth in electricity demand in 2024.
- China accounted for the largest share of electricity consumption growth, but increases were seen globally.

Across Europe, energy demand continues the current trends of fuel mix with a steady decline of overall consumption

Energy Consumption by Source (TWh) in EU27 , [2012-2023]



Change in Energy Consumption by Source (%) in EU27, [2023-2024]



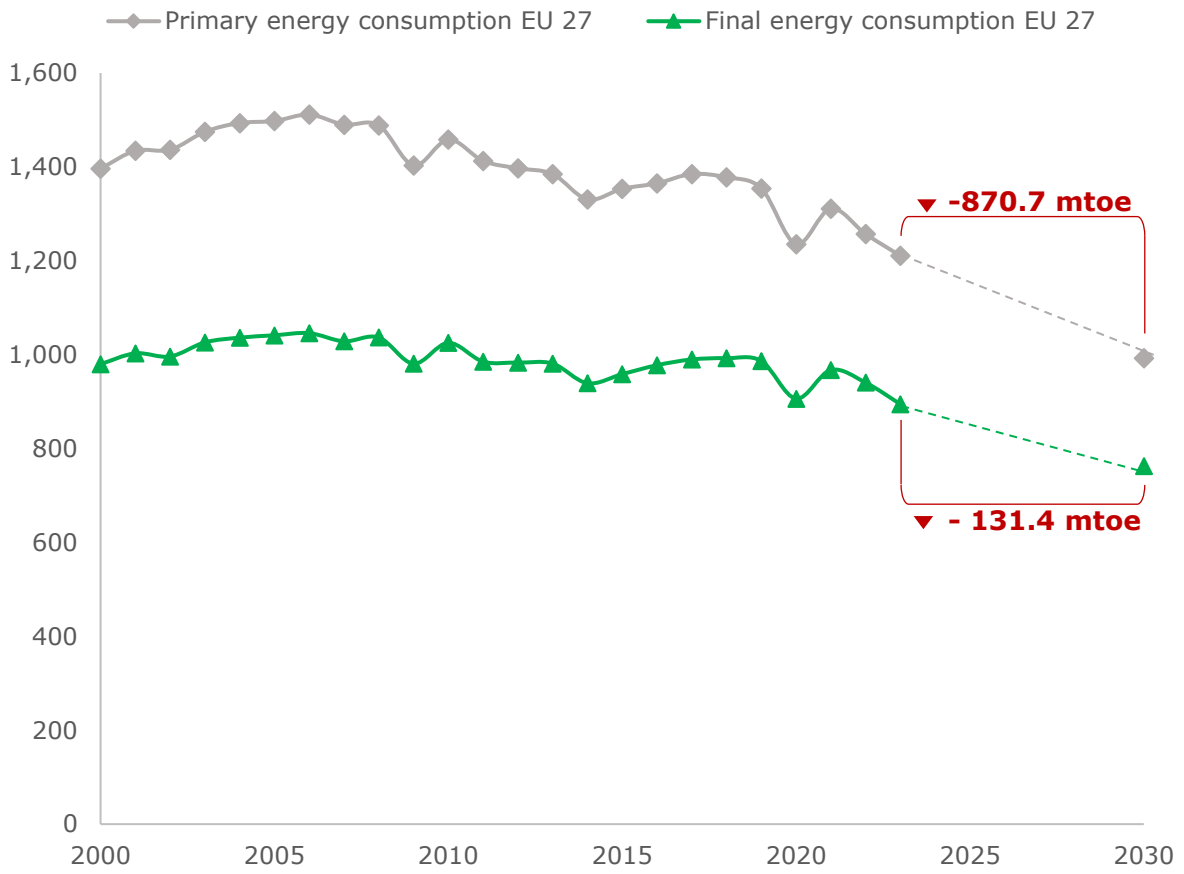
Source: OWID, HAEE analysis

Highlights

- Oil remains the dominant energy source, but its share shows a slight decline since 2022.
- Coal consumption experiences a sharp 21% drop, illustrating strengthened decarbonization efforts across the European Union.
- Gas demand decreases by 7%, reflecting energy transitions and European commitments to reduce fossil dependence.
- Renewables, especially wind and solar, register significant increases, indicating accelerated clean energy adoption within Europe.
- Nuclear's marginal uptick suggests persistence in its role, despite broader shifts towards renewable energy sources.

The decline in energy consumption, both primary and final, continues but the road lies ahead

Primary and Final Energy Consumption (mtoe) in EU 27, [2000-2030]



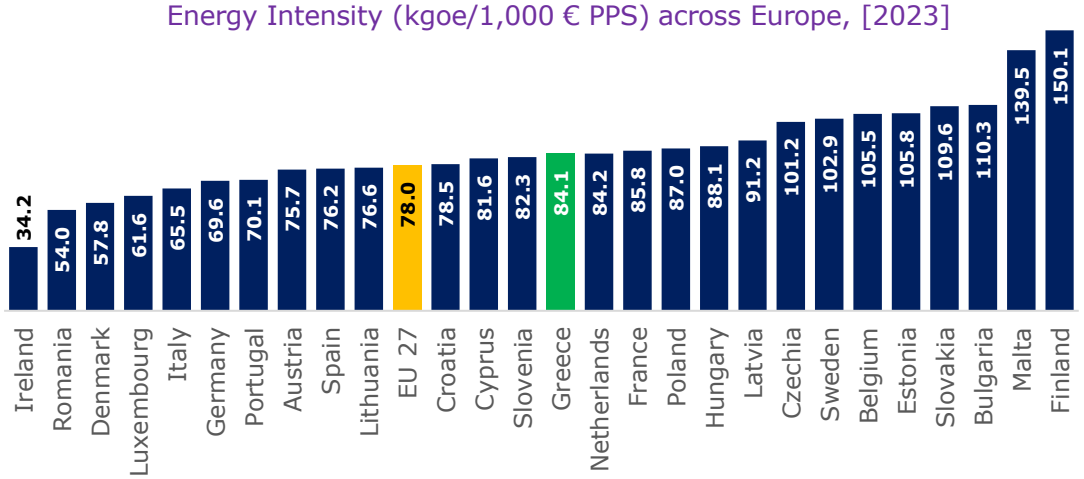
Source: Eurostat, HAEE analysis

Highlights

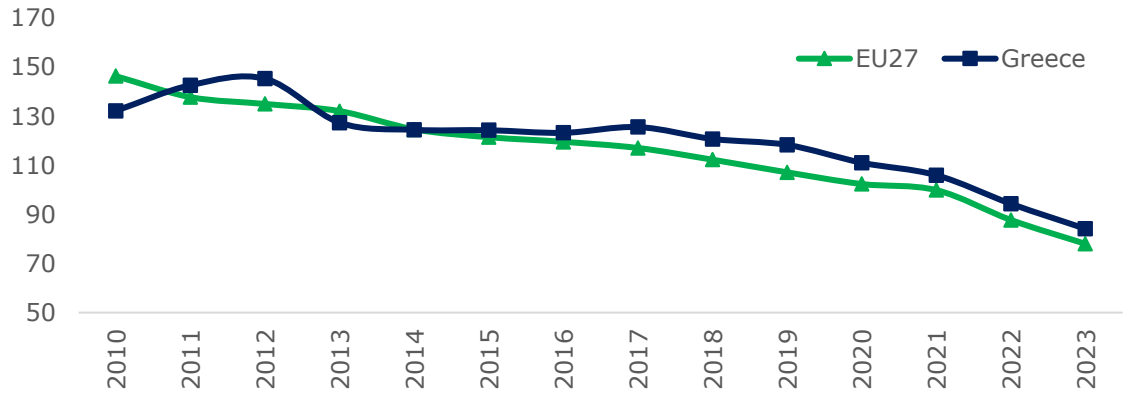
- EU27's primary energy consumption shows a 3.7% drop by 2030, signaling ongoing, steady decarbonization strategies.
- Final energy use within EU27 declines 4.9%, reflecting enhanced efficiency measures and reduced fossil dependency.
- Greece's primary energy consumption experiences a 4.8% decrease, highlighting progressive policy interventions and diversification efforts.
- Greek final energy consumption drops 2.5%, underscoring improvements despite challenges in transitioning to greener sources.
- Both graphs reveal downward trends, suggesting long-term commitments to efficiency and emissions reduction across Europe.

As energy intensity continues to drop, the effort towards energy efficiency must also continue in its current path

Energy Intensity (kgoe/1,000 € PPS) across Europe, [2023]



Evolution of Energy Intensity (kgoe/1000€ PPS) for EU27 and Greece, [2010 - 2023]



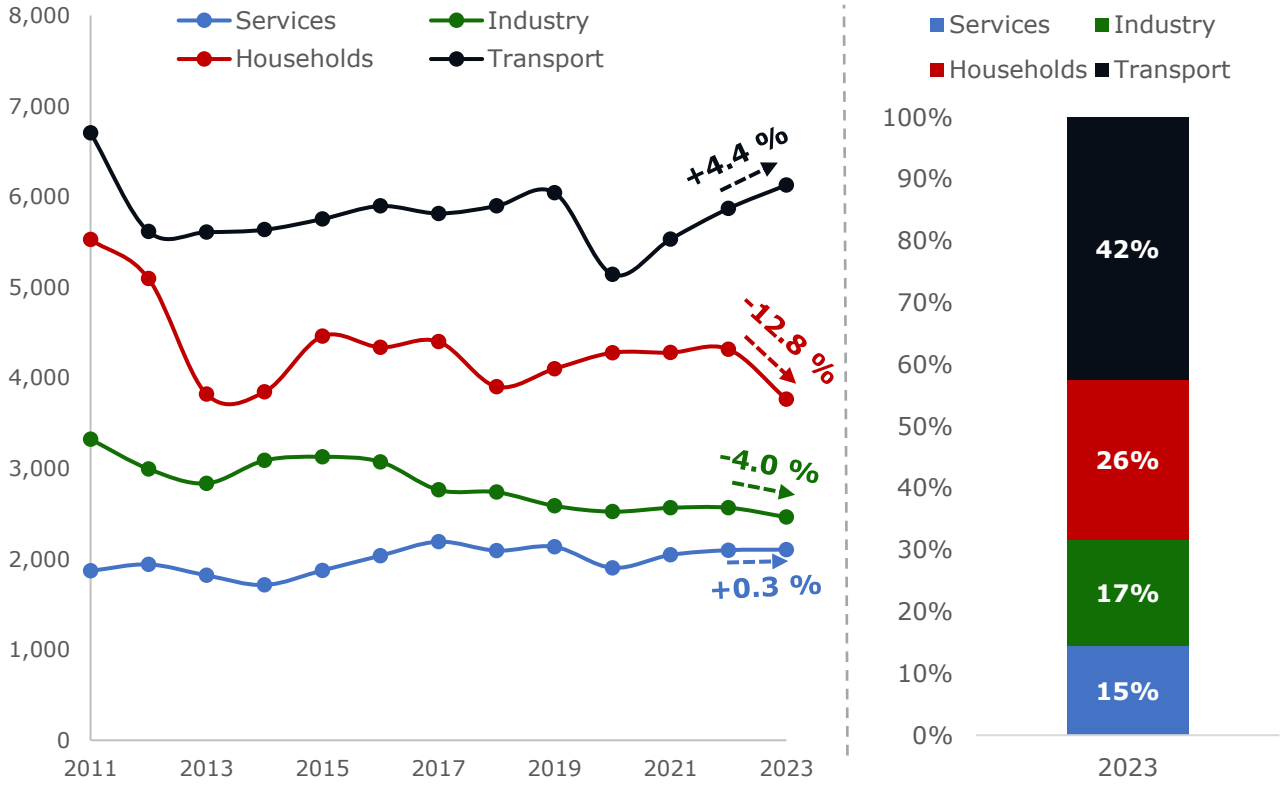
Source: Eurostat, HAEE analysis

Highlights

- Greece's energy intensity remains high yet shows a consistent decrease paralleling wider European efficiency improvements.
- EU27 exhibits a downward energy intensity trend, indicating technological advances plus streamlined sectoral energy usage.
- Ireland achieves Europe's lowest energy intensity, notably reflecting highly efficient consumption relative to economic output.
- Finland's notable peak value indicates continued challenges in decoupling heavy industries from excessive energy use.
- SE European countries display moderate-to-high levels, highlighting the need for further modernization and policy support.

Transport remains dominant in Greek final energy use, balanced by drops in households, services, and industry

Final Energy Consumption in Greece (ktoe) by Sector, [2011-2023]



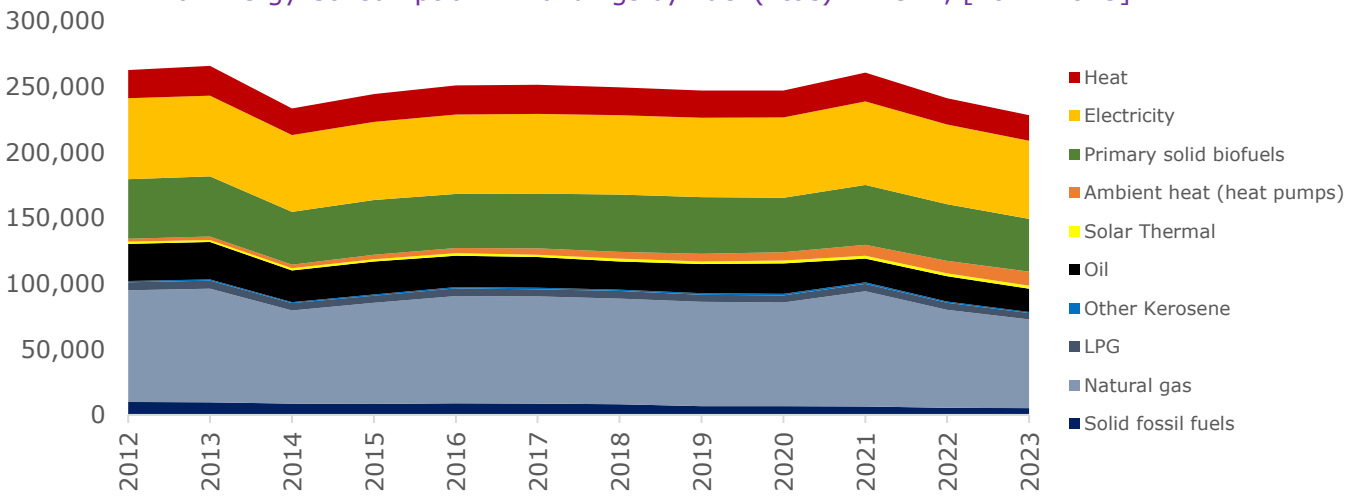
Source: Eurostat, HAEE analysis

Highlights

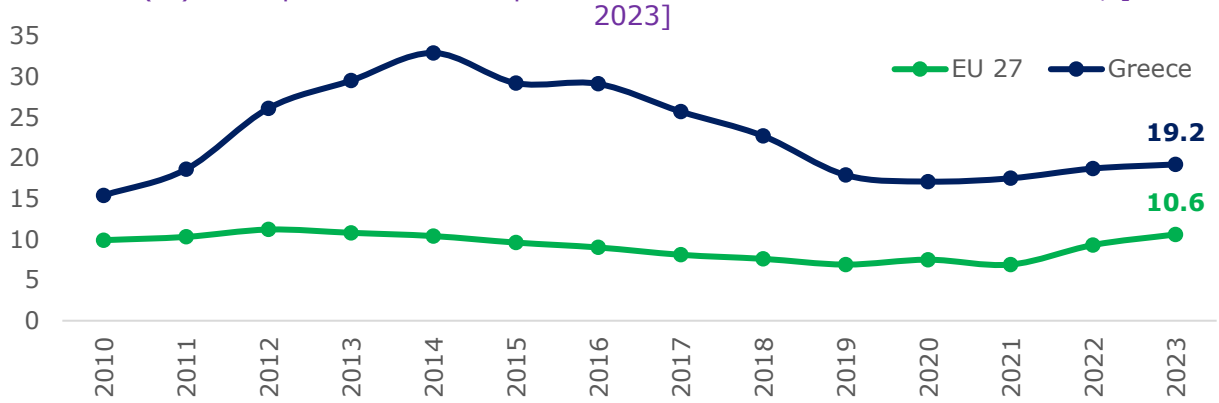
- Transport holds the largest share (42%) of Greece's final energy consumption, reflecting strong mobility demand.
- Household consumption dropped by 12.8% yet still represents significant domestic demand within Greek energy usage.
- Services usage rose minimally (+0.3%), indicating relatively stable consumption patterns across Greece's tertiary economic sector.
- Industry declined slightly (-4.0%), reflecting efficiency improvements or limited growth across manufacturing and production activities.
- Overall, Greece's consumption mix emphasizes transport, suggesting future decarbonization policies should prioritize cleaner mobility solutions.

In recent years, the percentage of people unable to keep their homes warm has been increasing across Europe

Final Energy Consumption in Buildings by Fuel (ktoe) in EU27, [2012-2023]



Share (%) of People Unable to Keep their Household Warm in EU27 and Greece, [2010-2023]



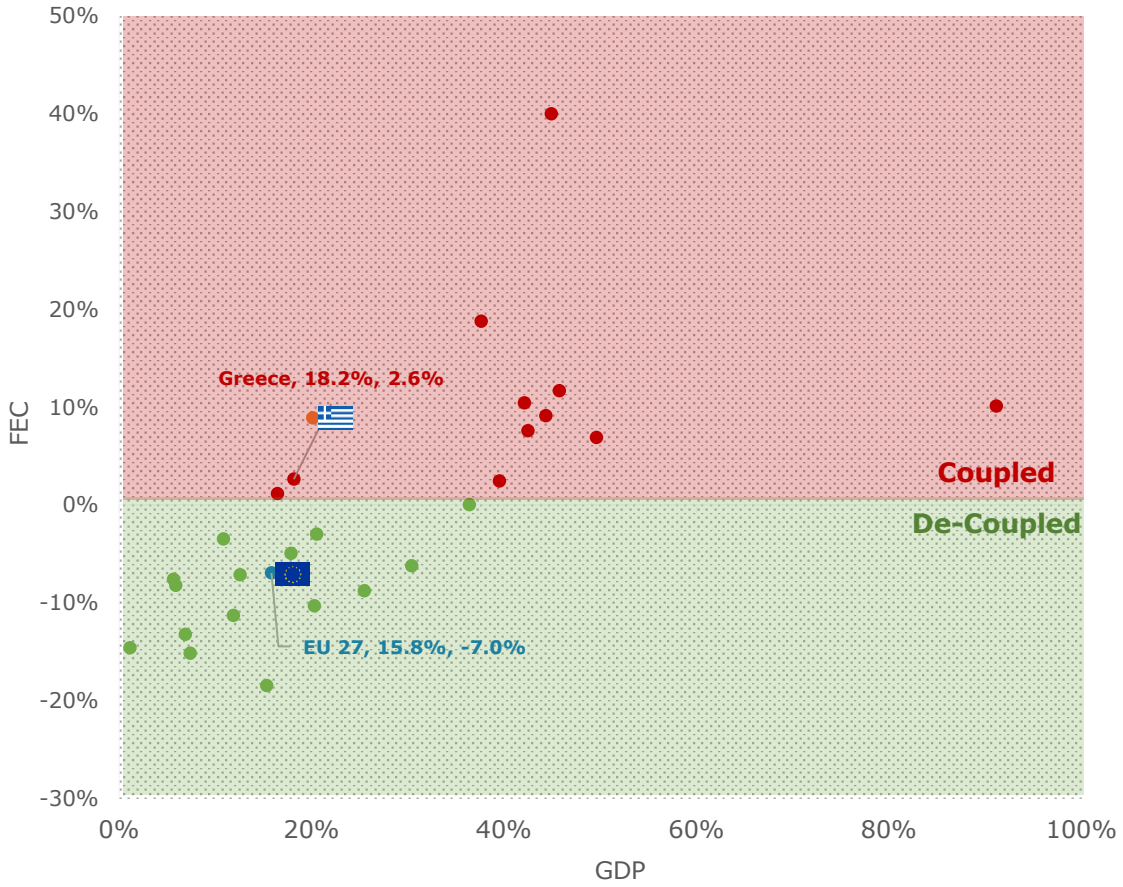
Source: IEA, Eurostat, HAEE analysis

Highlights

- Natural gas dominates building energy consumption, although overall final demand declines slightly after 2021's peak.
- Electricity usage remains substantial, with increased uptake of heat pumps highlighting Europe's decarbonized heating ambitions.
- Greece's energy poverty rates stand at 19.2%, almost double the EU27 average, emphasizing persistent affordability challenges.
- EU-level building consumption remains on a downward trend, due to efficiency measures and tighter standards.
- The gap between Greek and EU warming access underscores uneven socio-economic conditions across member states.

The GDP/FEC correlation across Europe varies greatly, with Greece still having "coupled" its energy use and economic growth

Change (%) in FEC and GDP in EU, [2013/2023]



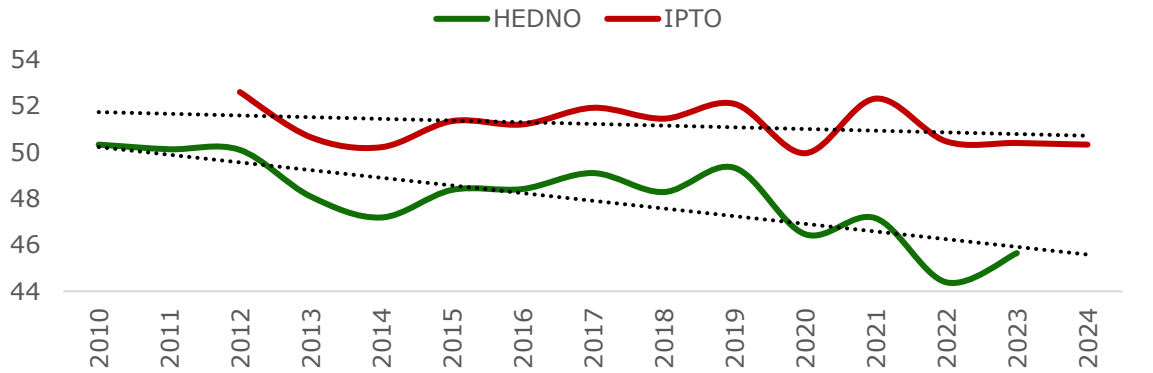
Source: Eurostat, HAEE analysis

Highlights

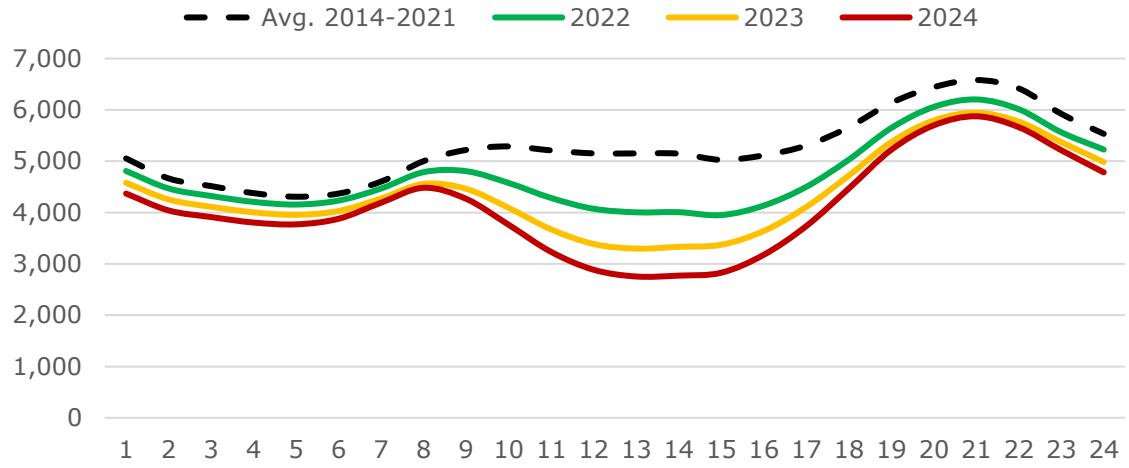
- Greece increased final energy consumption (FEC) by 18.2% despite only 2.6% GDP growth.
- The EU-27 achieved 15.8% GDP growth while reducing energy consumption by 7.0%, indicating decoupling.
- Countries in the green zone show economic growth with declining energy use—successful decoupling achieved.
- Red-zone countries, including Greece, exhibit coupled growth: energy consumption rising alongside modest GDP gains.
- Decoupling patterns vary across Europe, reflecting differing energy policies, efficiencies, and structural economic transitions.

The duck curve intensifies and reveals midday surplus and rapid evening ramping, stressing grid stability and flexibility

Total Electricity Demand (TWh) in the Greek interconnected system, [2010-2024]



Average Daily Net Load Profile in Greece (MWh), [2014 - 2024]



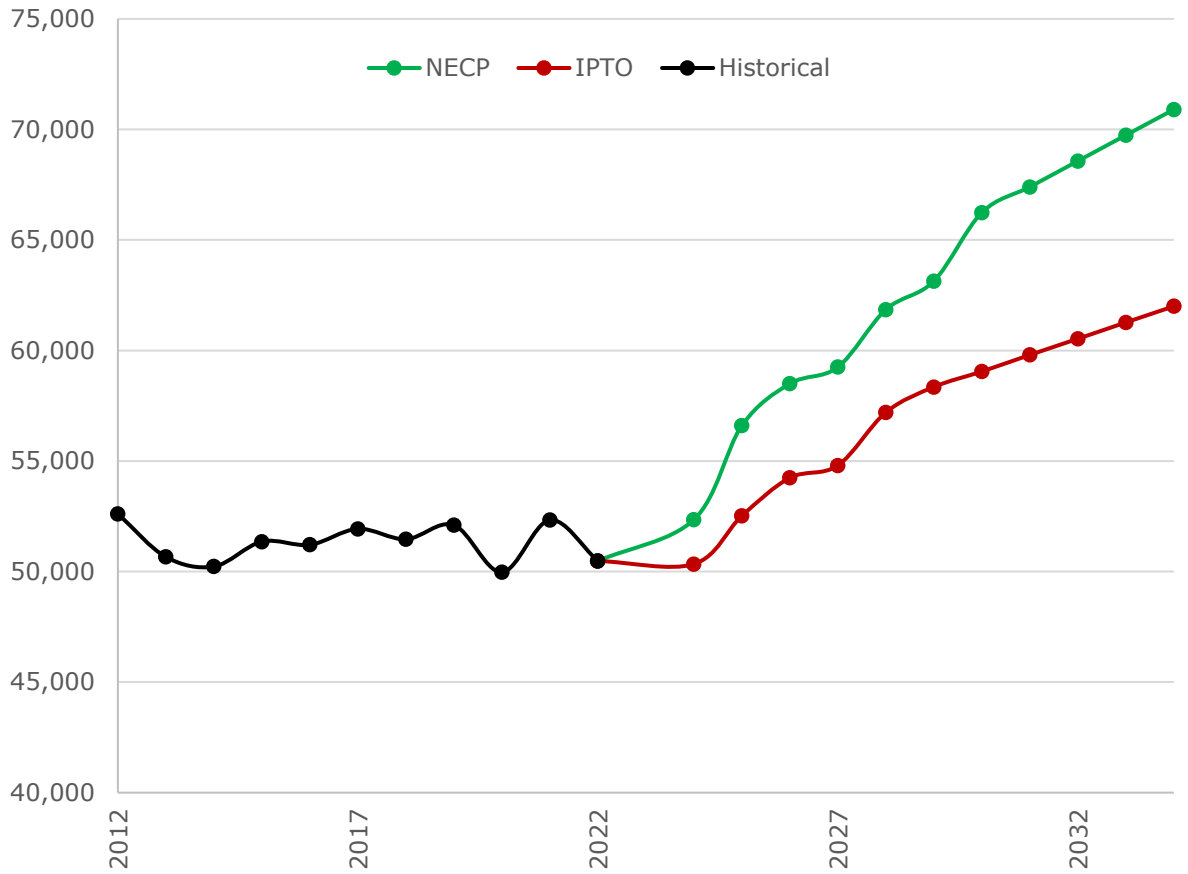
Source: IPTO, HEDNO, HAEE analysis

Highlights

- Greek electricity demand hovers around 50 TWh, exhibiting modest increases from 2010 through the 2024 timeframe.
- IPTO and HEDNO projections converge near 48 TWh, underscoring stable consumption trends across the analyzed horizon.
- Average daily net load peaks midday, reflecting solar generation offset, higher daytime industrial, commercial activities.
- Summer demands exceed winter levels, driven by widespread cooling needs and consistent seasonal tourism-based consumption.
- Post-2020 slight growth suggests industrial rebound, emphasizing continued electrification within Greece's evolving interconnected power system.

Projected electricity demand surges under NECP, outpacing IPTO's forecast, emphasizing policy-driven electrification in Greece's future

Electricity Demand Historical Data and Forecast under IPTO and NECP in Greece (GWh), [2012-2034]



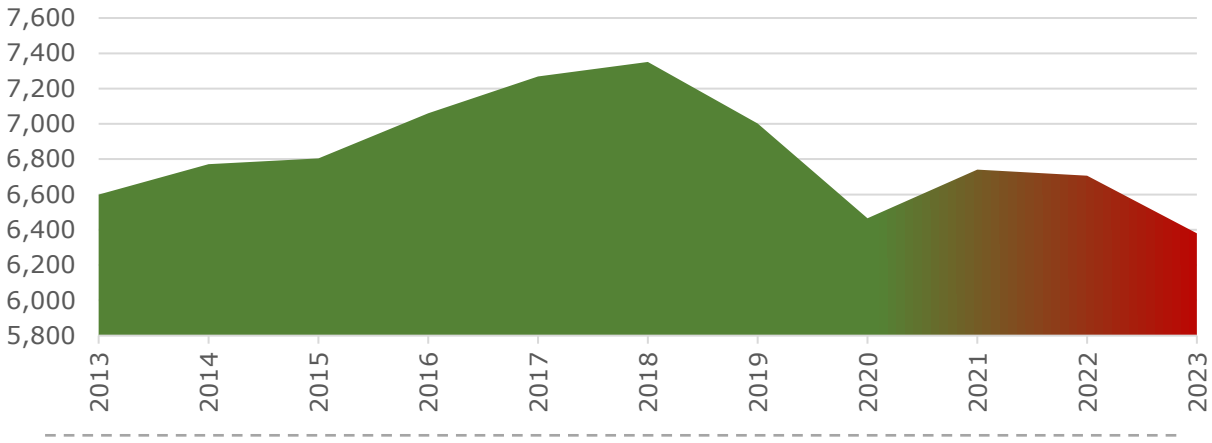
Source: IPTO, HEDNO, HAEE analysis

Highlights

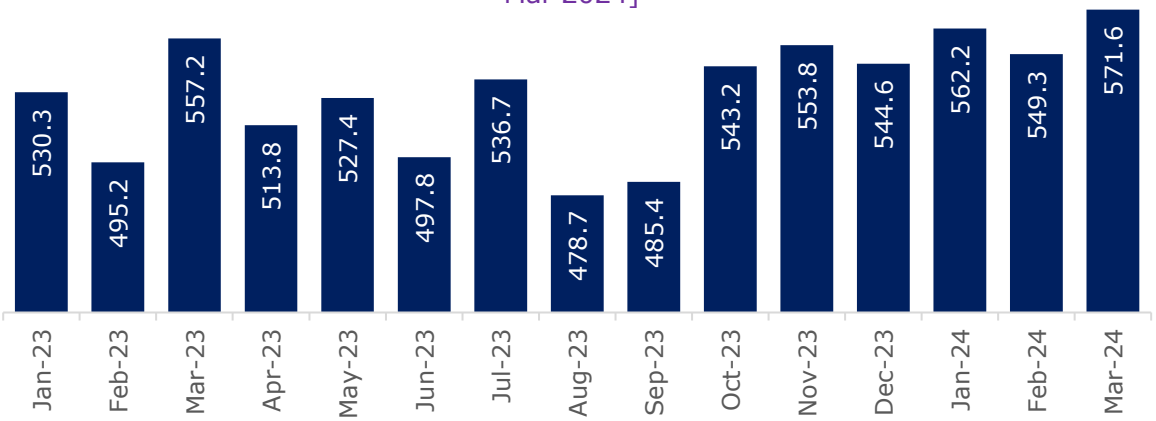
- Historical electricity demand begins near 50,000 GWh in 2012, reaching about 55,000 GWh before 2022's forecast split.
- NECP projections exceed 70,000 GWh by 2032, signifying a more robust, policy-driven electrification than IPTO anticipates.
- IPTO's outlook steadily climbs near 65,000 GWh, reflecting moderate growth driven by industrial expansion and electrification.
- Differences between NECP and IPTO highlight varying assumptions on Greece's trajectory and energy efficiency progress.
- Rising demand underscores the necessity for expanded power infrastructure, renewable integration, and sustained decarbonization measures.

Greek HV electricity consumption declines from 2018 peak, recovers monthly, reflecting dynamic industrial energy demand

Electricity Consumption of HV Customers (GWh) in Greece, [2013-2023]



Monthly Electricity Consumption (GWh) of HV Industry Customers in Greece, [Jan 2023-Mar 2024]



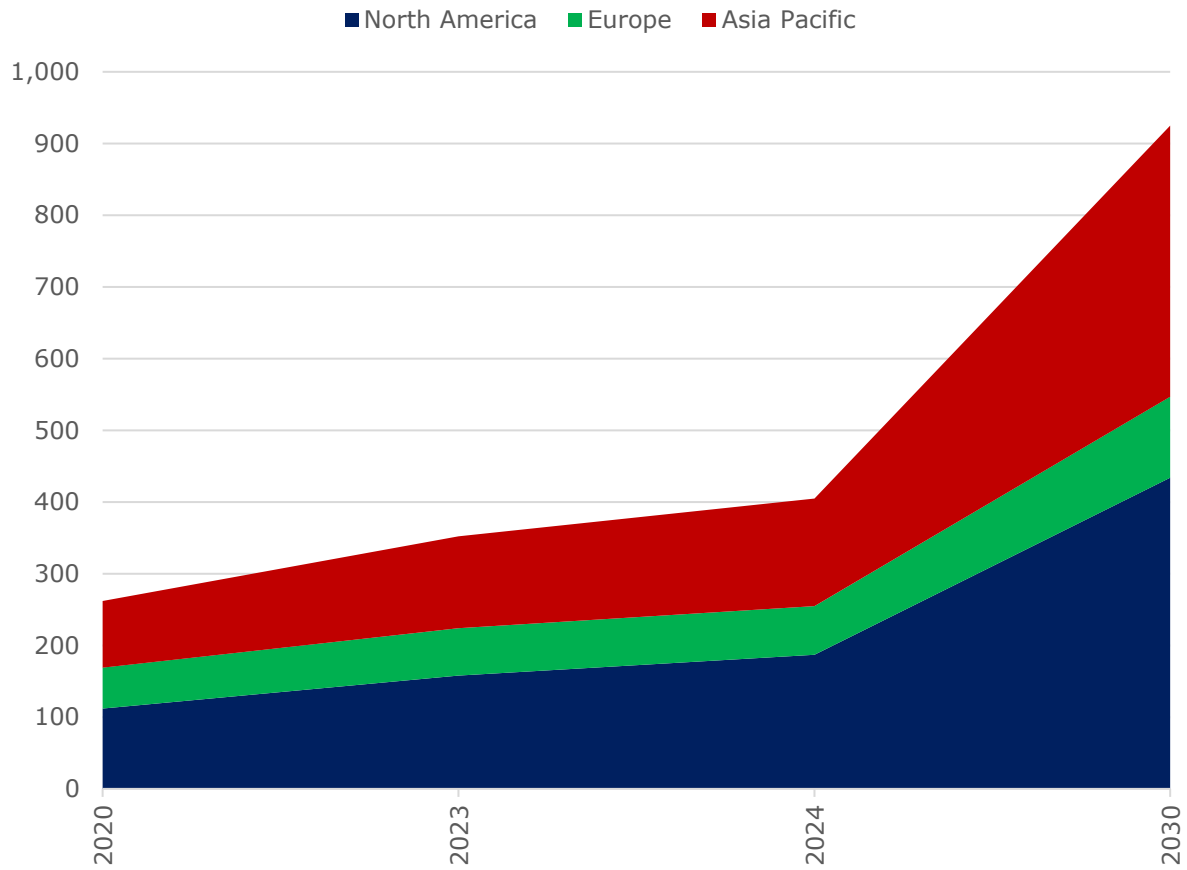
Source: IPTO, HAEE analysis

Highlights

- HV electricity consumption peaked around 2017 at 7,200 GWh, declining into 2020 before partial recovery.
- In 2021-2022, annual usage hovered near 6,200 GWh, ending 2023 lower at about 6,000 GWh.
- HV usage dips below 480 GWh in August 2023, tops 570 GWh by March 2024, signaling a need for boosting the industry customers of electricity.
- The highest monthly consumption in early 2023 reached 557 GWh, suggesting industrial or seasonal demand.
- Post-peak consumption around 2020 rebounded slightly, evidenced by stable monthly averages near 550 GWh into 2024.

Global data center electricity consumption escalates, especially in Asia-Pacific, prompting urgent solutions for sustainable infrastructure

Data Centers Electricity Consumption (TWh) by Region, [2020-2030]



Source: IEA, HAEE analysis

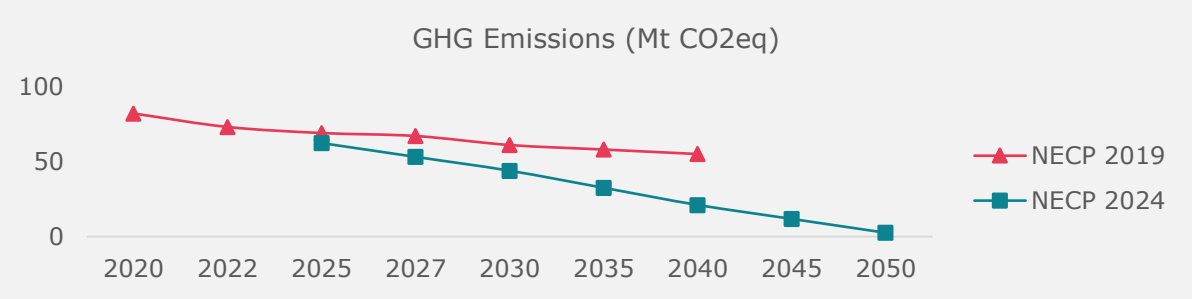
Highlights

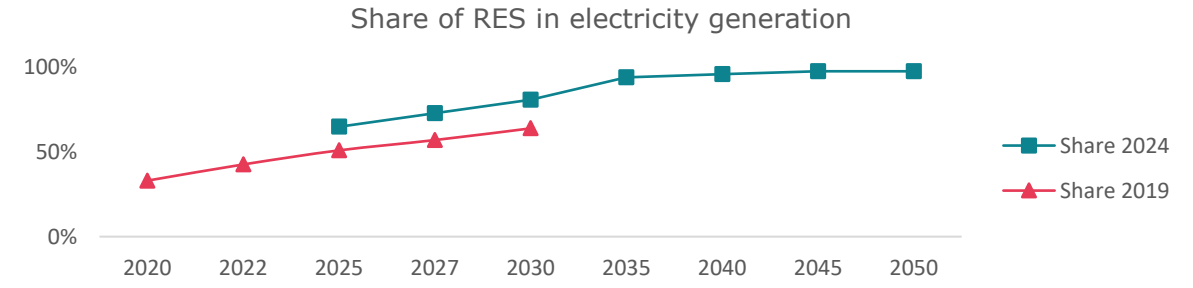
- Global data center electricity demand rises from 400 TWh to nearly 1,000 TWh between 2020–2030.
- Asia-Pacific leads significant growth, surpassing 400 TWh by 2030, reflecting accelerated cloud adoption and digitalization.
- North America maintains considerable share, climbing to exceed 250 TWh, supported by entrenched data ecosystems.
- Europe witnesses' robust yearly increases, approaching 200 TWh by 2030, underscoring cloud and IoT expansion.
- Mounting data center demands highlight crucial efficiency measures, greener energy strategies to reduce environmental impacts.

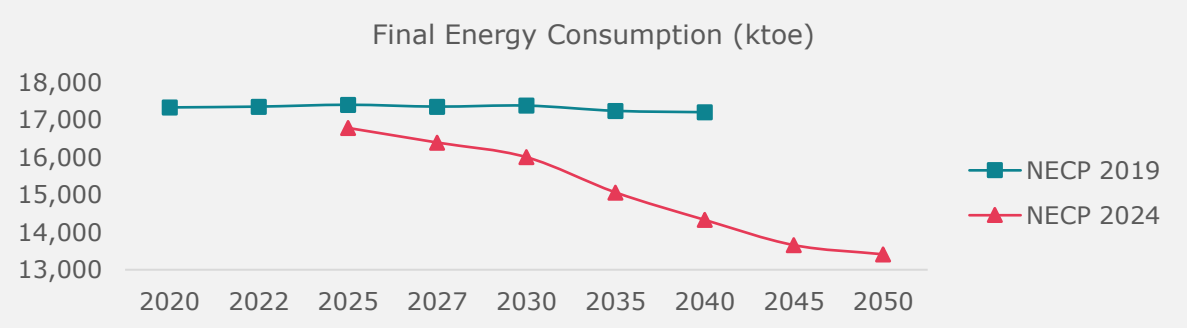
2030 Targets comparison

	NECP 2019			NECP 2024	
Solar PV installed capacity (GW)	7.7 GW	11.8 TWh	+75%	13.5 GW	+73% 20.4 TWh
Wind power (onshore & offshore) installed capacity (GW)	7 GW	17.2 TWh	+54%	10.8 GW	+24% 21.4 TWh
Natural Gas installed capacity (GW)	6.9 GW	18.3 TWh	+14%	7.9 GW	-40% 10.9 TWh
EVs (number) stock in the market	82.422 EVs		+31%	108.304 EVs	

% change compared to the 2019 NECP







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https://www.aade.gr

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CCPI Climate Change Performance Index

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COAL TO CLEAN ENERGY POLICY

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mb meteoblue

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Acronyms and abbreviations

AC	Alternative Current
BEV	Battery Electric Vehicle
CAGR	Compound Annual Growth Rate
CCS	Carbon Capture and Sequestration/Storage CRES
CCUS	Carbon Capture, Utilisation & Storage
CNG	Compressed natural gas
CfD	Contracts for differences
DAM	Day-Ahead Market
DC	Direct Current
ESG	Environmental, Social and Governance
EV	Electric Vehicle
EU	European Union
FEC	Final Energy Consumption
FSRU	Floating Storage and Regasification Unit
FSU	Floating Storage Unit
GDP	Gross Domestic Product
GHG	Greenhouse gases
ICE	Internal Combustion Engine
IDR	Issuer Default Rating
LCOE	Levelized Cost of Electricity
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MCP	Market Clearing Price
NECP	National and Climate Energy Plan
NG	Natural Gas
NII	Non-Interconnected Islands
NIR	National Inventory Report
NNGS	National Natural Gas System
NPEs	Non-Performing Exposures
OECD	Organisation for Economic Co-operation and Development
PEC	Primary Energy Consumption
PPA	Power Purchase Agreement
PV	Photovoltaic
RECAI	Renewable Energy Country Attractiveness Index
RES	Renewable Energy Sources
RRF	Recovery and Resilience Facility
RU	Russia
R&D	Research and Development
SE	Southeastern
SMP	System Marginal Price
SSLNG	Small Scale LNG
TAP	Trans Adriatic Pipeline
Y-o-Y	Year-over-Year

Units of measurement

bcm	billion cubic meters
bpd	barrels per day
bn	billion
CO2	carbon dioxide
EJ	exajoule
gr	grams
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
ktoe	thousand tonnes of oil equivalent
kW	kilowatt
kWh	kilowatt hour
m3	cubic meter
mcum	million cubic metres
Mt	million tonnes
MtCO2	million tonnes of carbon dioxide
MtCO2-eq	million tonnes of carbon dioxide equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
MWh	megawatt hour
m/s	meter pes second
pp	percentage points
sqm	square meter
tCO_2	tonne of carbon dioxide
toe	tonne of oil equivalent
tn	tonne
TWh	terawatt hour

Conversion of units

Natural and LNG	**To convert**						
	Billion cubic metres NG	Billion cubic feet NG	Petajoules NG	Million Tonnes oil equivalent	Million Tonnes LNG	Trillion British thermal units	Million barrels oil equivalent
From	Multiply by						
1 billion cubic metres NG	1.000	35.315	36.000	0.860	0.735	34.121	5.883
1 billion cubic feet NG	0.028	1.000	1.019	0.024	0.021	0.966	0.167
1 petajoue NG	0.028	0.981	1.000	0.024	0.021	0.952	0.164
1 million tonnes oil equivalent	1.163	41.071	41.868	1.000	0.855	39.683	6.842
1 million tonnes LNG	1.360	48.028	48.747	1.169	1.000	46.405	8.001
1 trillion British thermal units	0.029	1.035	1.050	0.025	0.022	1.000	0.017
1 million barrels oil equivalent	0.170	6.003	6.093	0.146	0.125	5.800	1.000
Units							
1 metric tonne	= 2204.62 lb		= 1.1023 short tons				
1 kilolitre	= 6.2898 barrels						
1 kilolitre	= 1 cubic meter						
1 kilocalorie (kcal)	= 4.1868 kJ		= 3.968 Btu				
1 kilojoule (kJ)	= 0.239 kcal		= 0.948 Btu				
1 petajoule (Pj)	= 1 quadrillion joules (1x10^15)						

Crude Oil	**To convert**					
	Tonnes (metric)	Kilolitres	Barrels	US gallons	Tonnes/year	
From	Multiply by					
Tonnes (metric)	1	1.165	7.33	307.86	-	
Kilolitres	0.8581	1	6.2898	264.17	-	
Barrels	0.1364	0.159	1	42	-	
US gallons	0.00325	0.0038	0.0238	1	-	
Barrels/day	-	-	-	-	49.8	
	To convert					
Products	Barrels to tonnes	Tonnes to barrels	Kilolitres to tonnes	Tonnes to Kilolitres	Tonnes to gigajoules	Tonnes to barrels of oil equivalent
From	Multiply by					
Ethane	0.059	16.850	0.373	2.679	49.400	8.073
LPG	0.086	11.600	0.541	1.849	46.150	7.542
Gasoline	0.120	8.350	0.753	1.328	44.750	7.313
Kerosene	0.127	7.880	0.798	1.252	43.920	7.177
Gas oil/diesel	0.134	7.460	0.843	1.286	43.380	7.089
Residual fuel oil	0.157	6.350	0.991	1.010	41.570	6.793
Product basket	0.124	8.058	0.781	1.281	43.076	7.039
Units						
1 exajoule (EJ)	= 1 quintillion joules (1x10^18)					
1 Briitish thermal unit (Btu)	= 0.252 kcal			= 1.055kJ		
1 tonne of oil equivalent (toe)	= 39.683 million Btu			= 41.868 million kJ		
1 barrel of oil equivalent (boe)	= 5.8 million Btu			= 6.119 million kJ		
1 kilowatt-hour (kWh)	= 860 kcal		= 3412 Btu		= 3600 kJ	

Source: BP Approximate conversion factors – Statistical Review of World Energy – updated July 2021

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