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2025

Decarbonisation in Bulgaria:

Fifth in cuts, first in carbon intensity

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Table of contents

Introduction

Why care?

While concerns over climate change have often been dismissed as moral posturing or hand-waved as a mere distant threat, the scientific consensus legitimised them, highlighting the need for timely action. According to the European Commission (EC), the anthropogenic component of climate change is undeniable, as the combustion of fossil fuels, deforestation and intensive agriculture are contributing to the greenhouse effect, accelerating global warming. The planet has already warmed by roughly 1.2°C above pre-industrial levels, according to the European Environment Agency (EEA). To mitigate this, member states of the United Nations Framework Convention on Climate Change (UNFCCC) have committed to a temperature increase limit well below 2°C above pre-industrial levels, aiming to limit it to 1.5°C. In the absence of drastic cuts in global greenhouse gas (GHG) emissions, warming is expected to surpass the 2°C limit before 2050. Consequently, Europe could face more extreme weather events such as heatwaves, droughts, floods and wildfires. Sea levels could rise up to 80 cm by the turn of the century, threatening coastal areas and reducing the amount of available fresh water, which in turn could further affect agricultural output, threatening food security and driving unpredictable migration patterns. To this end, the EU is targeting climate neutrality by 2050, with the interim goal of achieving 55% cuts by 2030 relative to 1990 levels. In November 2025, an interim target for 2040 was reinforced by the Council of the EU, which set the bloc's sights on a 90% cut.

Conflicting incentives

Despite undeniable progress and political will, the tension between collective ambitions and short-term national incentives has left some dovish on decarbonisation. As a result, the 2040 target is more flexible than initially proposed, allowing for the use of international carbon credits for up to 5% by member states, effectively contracting EU-based emission cuts to 85%. The Draghi report, published in 2024 by the eponymous former president of the European Central Bank (ECB) and former Italian Prime Minister at the request of the EC, stressed that decarbonisation and competitiveness must advance in lockstep, warning of deindustrialisation risks in the absence of cost-effectiveness and supply-side security. These competing incentives have also been echoed beyond Europe. The United States and China have both tempered their climate commitments in favour of economic security and growth. The former eased regulatory pressure on fossil fuel industries, notified its withdrawal from international commitments, including the Paris Agreement and curbed its involvement in international climate financing. China, a major contributor to global emissions, continued to expand coal-fired capacity while also investing in renewables.

The tension between individual or local risk and collective global responsibility is also present at the level of policy. While no single household, production facility or country is solely responsible for climate change posing an existential threat, the aggregate impact of all carbon-intensive choices is what drives it. Much like herd immunity in public health, effective decarbonisation requires near-universal action.
Translating EU-level commitments into domestic reality is especially difficult in markets reliant on fossil fuels for competitiveness. In Bulgaria, hard-to-abate sectors such as cement, metals, chemicals or refining, are faced with high electricity costs and limited grid and storage capacity to mitigate renewable intermittency. While subsidies can accelerate progress, they are often unpredictable due to shifting political circumstances, risking stagnation in progress once funding ends. Carbon pricing and reporting obligations also put pressure on industries reliant on global exports that rarely reward green production at higher costs. Instead of stifling competitiveness, global coordination must calibrate policies that act as market-makers for low-carbon technologies. Such initiatives are what enabled scale and efficiency in the solar power industry, making it highly cost-competitive. In Bulgaria, 36% of companies consider stricter climate standards and regulations as a risk over the next five years, on par with EU firms (34%), according to the European Investment Bank's (EIB) Investment Survey 2024. However, only 8% of Bulgarian companies view it as an opportunity, compared to 27% across the EU.

Security concerns are often viewed as being at odds with climate objectives, but climate instability itself is an emerging security challenge. While the risk of climate change may not appear globally existential, its local and regional impact through extreme weather events can generate secondary pressures that extend beyond directly affected areas. Population displacement, resource scarcity, disrupted trade routes and geopolitical instability can send ripple effects into countries otherwise spared of immediate consequences.

Bulgaria's place in the global decarbonisation landscape

While Buglaria only accounted for 1.5% of the EU's gross GHG emissions in 2023, roughly matching its 1.4% share in the bloc's population, its decarbonisation results rank among the bloc's better performers in absolute terms. Between 1990 and 2023, Bulgaria achieved a 55% reduction in total emissions, ranking fifth in overall progress across the EU. However, on a per capita basis, the country achieved a 39% reduction, placing it 15th and highlighting the impact of its demographic decline. At the company level, 79% of Bulgarian firms reported having taken measures to reduce GHG emissions, compared to 91% across the EU, according to the EIB's latest investment survey.

The energy sector accounts for most of the country's emissions, although significant progress has been made due to a recent boom in solar capacity additions, which translated to a surge in low-carbon production. As a result, GHG emissions from fuel combustion in energy industries shrank by 56.8% in 2023 compared to 1990 levels. The most significant long-term GHG emission reduction occurred in fuel combustion in manufacturing and construction, where emissions fell by 78.4%, reflecting both energy restructuring and industrial contraction.

Despite undeniable progress, Bulgaria remains one of the EU's most carbon-intensive economies, at 967.6 g of CO2-equivalent (gCO2-eq) per EUR of gross value added (GVA) in 2023, over four times the EU average of 224.1 g CO2-eq per EUR.

Bulgaria's carbon footprint rendered it a net exporter of emissions between 2010 and 2023, as evidenced by a 4 MtCO2-eq net balance between production and consumption inventories. Roughly 51% of its GHG footprint originated domestically, while the remaining 49% resulted from imports.

Bulgaria's historical decarbonisation gains resulted from the combined effects of its transition to a market economy, demographic decline and efficiency gains. Meeting future global climate targets will require accelerating technological innovation, further investment in reliable low-carbon power and a deeper integration into the EU's clean energy value chains.

Key findings

55% Overall **39%** Per capita

Reduction in net GHG emissions (1990-2023)

5th Overall **15th** Per capita

Intra-EU rank in net emissions reductions (1990-2023)

34.8% Fuel combustion in energy industries

Technical process with largest share of emissions (2023)

78.4% Fuel combustion in manufacturing industries and construction

Largest share of emissions reduction by tech source (1990-2023)

29.9% Electricity, gas, steam and air conditioning supply

Economic activity with largest share of emissions (2023)

56.3% Electricity, gas, steam and air conditioning supply

Largest share of emissions reduction by sector/econ activity (%)

967.6 gCO2-eq/EUR vs **224.1** CO2-eq/EUR

Emissions intensity for all economic activities (2023)

4 MtCO2 net balance of GHG emissions from a production vs consumption/footprint perspective

Bulgaria was a net exporter of emissions in 2023

51% vs **49%**

Origin of GHG emission footprint

Policy and regulations

Wolf Theiss

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Bulgaria's legal path to decarbonisation: investor outlook

Katerina Novakova
Counsel, Wolf Theiss

Executive summary

Bulgaria's path to climate neutrality is increasingly guided by a strong legal framework aligned with EU climate obligations, particularly the "Fit for 55" package. For investors, this provides clearer regulatory signals, an expanding carbon market and growing opportunities in green infrastructure supported by EU funding.This article provides an overview of Bulgaria's decarbonisation framework, focusing on market-shaping laws and the challenges ahead in implementing reforms.

Legal backbone for carbon pricing

Bulgaria's climate legal framework is built on the Climate Change Mitigation Act (CCMA)[1] which underwent significant amendments in September 2025 in response to the European Union's "Fit for 55" legislative package[2] and the European Climate Law[3].

Notably, the scope of emissions regulation under the EU Emissions Trading System (ETS) has been expanded to include new sectors, such as transport, buildings, maritime and aviation. The introduction of a second emissions trading system (ETS2), specifically targeting fuel suppliers in road transport and heating, marks a transformative shift in how carbon is priced and managed. This system is set to launch in 2027, with a transitional phase starting in 2025.

The CCMA mandates that all allowances under ETS2 be auctioned. Free allocation of allowances is revised, linking them to investments in energy efficiency, with a phase-out planned by 2034. Auction revenues are prioritised for climate, energy and social objectives, with detailed provisions for their use in national programmes. Additional allowances may be granted to district heating operators under specific conditions.

The CCMA also implements the requirements under Directive (EU) 2023/958[4] , which revises the EU ETS for aviation. It phases out free allowances by 2026 and reserves 20 million allowances to support the uptake of sustainable aviation fuels (SAF). It also integrates the international CORSIA scheme. Additional amendments include extending the EU ETS to maritime transport, with mandatory monitoring and reporting of methane and nitrous oxide emissions from 2024 and expanding ship coverage from 2025[5]. Shipping companies are obligated to monitor and report emissions and gradually surrender allowances – 40% in 2024, 70% in 2025 and 100% in 2026.

The CCMA also introduces a suite of institutional reforms, including the establishment of the Climate Change National Expert Council – a consultative body encompassing ministries, the Bulgarian Academy of Sciences, the National Association of Municipalities in the Republic of Bulgaria and NGOs – to assist the Minister of Environment and Water regarding climate change policy implementation, monitoring progress and ensuring alignment with EU obligations.

The Modernisation Fund[6] is expanded to support a broader range of projects, including renewable energy heating or cooling systems, energy efficiency measures in industry, transport, buildings, agriculture and waste, as well as just transition measures in affected regions. Furthermore, social aspects of emissions trading are to be addressed through the Social Climate Plan. The CCMA places emphasis on the Just Transition principle as particularly relevant for sectors and regions dependent on carbon-intensive industries (East Maritsa region). As a recall, in December

1 Climate Change Mitigation Act, published in State Gazette No. 22 as of 11.04.2014, as amended from time to time, last amendments State Gazette No. 81 as of 03.10.2025 (In Bulgarian: Закон за ограничаване изменението на климата).
2 The "Fit for 55" package is a set of EU laws aimed at cutting greenhouse gas emissions by at least 55% by 2030, paving the way toward climate neutrality by 2050. It translates the Paris Agreement and European Green Deal goals into binding legislation, primarily by strengthening the EU Emissions Trading System (ETS) and expanding its scope to include maritime transport, buildings, road transport, fuels and aviation.
3 Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (European Climate Law).
4 Directive (EU) 2023/958 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC as regards aviation's contribution to the Union's economy-wide emission reduction target and the appropriate implementation of a global market-based measure.
5 Implementing the requirements under Regulations (EU) 2023/957, 2023/839 and 2023/857.
6 The Modernisation Fund (MF), established under Art.10d of Directive 2003/87/EC, enables Bulgaria, as a beneficiary Member State, to use allocated resources. In 2024, four Bulgarian projects – (i) to modernise electricity distribution networks and (ii) to enhance Bulgaria's grid capacity and support the integration of renewable energy (Greenabler project) – were funded from the MF in a total amount of approximately EUR 200 million. The Ministry of Energy proposes that during the period 2025–2026, investments supported by the MF focus on: renewable energy-based heating and cooling; zero-emission mobility infrastructure; non-priority waste-to-energy projects; pilot energy projects and industrial innovations; low-carbon hydrogen and exploration and exploitation activities for geothermal drilling: Министерството на енергетиката публикува проект на Индикативна работна програма за подкрепа на проекти със средства от Модернизационния фонд в периода 2025 -2026 г.

2023, Bulgaria received an allocation of EUR 1.2 billion from the Just Transition Fund to facilitate the transition from coal and support reskilling and upskilling, creating new job opportunities for over 15,000 people in the three most coal-intensive regions.

From a legal advisory standpoint, the implications are multifaceted. First, the compliance obligations for regulated entities have expanded. More specifically, fuel suppliers must obtain greenhouse gas emission permits, monitor and report verified emissions and surrender allowances accordingly.

Second, the risk of non-compliance is no longer theoretical. Bulgaria is currently subject to infringement proceedings initiated by the European Commission for delayed transposition of Directives 2023/958 and 2023/959. These proceedings, now at the reasoned opinion stage, expose the country to potential sanctions and reputational damage within the EU climate governance framework.

Not only do these changes reframe carbon from an environmental issue into a direct operating cost for businesses across logistics, manufacturing and energy-intensive industries, but they also require companies to factor carbon costs into their operational and financial planning.

Strategic targets and gaps: funding flows and political signals

Beyond these headline instruments, Bulgaria's legal framework includes the National Integrated Energy and Climate Plan (NECP)[7], Climate Neutrality Roadmap and the National Recovery and Resilience Plan (NRRP)[8] . The January 2025 NECP sets emissions reduction targets, including a 34.96% RES share in final energy consumption[9] and a 10 % reduction in non-ETS greenhouse gas emissions by 2030 compared to 2005 levels, in line with the Effort Sharing Regulation[10]. However, the NECP lacks enforceability and sector-specific legislative instruments or binding mechanisms. The Bulgarian government claims that the latest amendments to the CCMA address this gap.

The NRRP, meanwhile, reflects the political sensitivities surrounding Bulgaria's energy transition. Initially, the plan included a 40% CO_2 reduction target by 2025, which was repealed by the Bulgarian Parliament in 2023. The revised NRRP is now a EUR 6.17 billion strategy that aligns with a 2038 coal phase-out date[11]. This remains a strategic commitment rather than a statutory obligation. Further, the NRRP aims to operationalise 3,500 MW of new renewable capacity by 2026, supported by the RESTORE programme – an EU-funded initiative to develop 3,000 MWh of energy storage (a target already exceeded with the first round)[12].
In addition to the Climate Neutrality Roadmap[13] , Bulgaria's climate policy framework includes the Climate Change Adaptation Strategy and Action Plan until 2030[14] (2019) and the Long-Term Climate Strategy 2050[15] (2022). The Climate Neutrality Roadmap, last updated in July 2024, sets a phased path to net-zero greenhouse gas emissions by 2050. By 2026, Bulgaria plans to fully liberalise its electricity market and introduce long-term contracts for renewable energy, aligning with the EU Electricity Market Design Reform (Regulation (EU) 2024/1747[16]). The roadmap targets 5,200 MW of renewable energy and 1,000 MW of battery storage by 2026, while promoting energy communities and decentralised generation. By 2030, the country aims for 7,500 MW of renewables – including offshore wind – and 1,600 MW of storage, alongside energy efficiency measures and mine reclamation. Looking ahead to 2035, Bulgaria envisions over 10,000 MW of renewable capacity, with offshore wind reaching 1,500 MW.

Permitting reform: unlocking deployment

The recently adopted amendments to Bulgaria's Renewable Energy Act (**RES Act**)[17] aim to accelerate the permitting process for solar and geothermal installations by setting strict deadlines, such as issuing permits for PV equipment and co-located storage systems within 3 months and rooftop solar installations up to 20 kW within one month. These legislative changes are intended to streamline the deployment of renewable technologies and reduce administrative delays. However, concerns remain within the business community about the practical implementation of these shortened timelines and whether institutions have the capacity to efficiently manage the potentially higher volume of permit applications.

In September 2025, the Ministry of Energy proposed brand new amendments to the RES Act[18]. The draft law sets higher

7 See https://commission.europa.eu/publications/bulgaria-final-updated-necp-2021-2030-submitted-2025_en. Key objectives include energy efficiency improvements, decarbonisation, energy security through diversification, improved grid interconnectivity and plans for new nuclear capacity.
8 See https://nextgeneration.bg/14.
9 The most recent proposal for amendment to the Renewable Energy Act (RES Act) sets national indicative targets aligned with the EU's updated goal of 42.5% renewable energy share by 2030 as per Directive (EU) /2023/24113 and introduces sector-specific measures for electricity, heating and cooling, buildings, transport and industry.
10 Regulation (EU) 2023/857 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030, contributing to climate action to meet commitments under the Paris Agreement and Regulation (EU) 2018/1999
The Effort Sharing Regulation (ESR) sets binding national targets for emissions reductions in non-ETS sectors such as transport, buildings, agriculture and waste. Bulgaria's target is now a 10% reduction by 2030 compared to 2005 levels. The first compliance review for 2021–2025 is envisaged to occur in 2027–2028.
11 As a recall, in its Climate Neutrality Roadmap – revised twice in 2023 and 2024 – Bulgaria allowed for coal-fired power plants to operate without restrictions until 2038.
12 The National Infrastructure for Storage of Electricity from Renewable Sources (RESTORE) is a key initiative under Bulgaria's National Recovery and Resilience Plan (NRRP), aimed at supporting the country's energy transition. A total of 82 projects have been approved for funding, with total funding amounting to approx. EUR 587 million. However, the programme has faced delays due to permitting challenges, lack of transparency in connecting new renewable and storage capacities and an unpredictable regulatory environment. Recent amendments to the RES Act are expected to address these issues.
13 See gov.bg/files/common/pk.pdf, According to the Bulgarian Council of Ministers, the main role of this roadmap is to outline sector-specific key milestones and policy measures across energy, transport, buildings, industry and land use. It aims to support Bulgaria's compliance with the "Fit for 55" package, the European Climate Law and the REPowerEU initiative.
14 Strategy and Action Plan - Full Report - ENd3b215dfec16a8be016bfa529bcb6936.pdf - a strategic document that outlines nine (9) sectors with highest vulnerability and need for adaptation actions. The document also includes an analysis of the macroeconomic effects of climate change and a disaster risk management assessment.
15 See https://ec.europa.eu/clima/sites/lts/lts_bg_en.pdf/ The purpose of Bulgaria's Long-Term Climate Change Mitigation Strategy by 2050 is to guide the country's transition to climate neutrality in line with EU and international commitments, including the European Climate Law and the Paris Agreement. It outlines national priorities and decarbonisation pathways across all sectors, focusing on energy efficiency, renewable energy expansion and the adoption of low-carbon technologies such as hydrogen and nuclear. The strategy builds on the National Energy and Climate Plan (NECP). However, it is often criticised for lack of binding national targets.
16 Regulation (EU) 2024/1747 of the European Parliament and of the Council of 13 June 2024 amending Regulations (EU) 2019/942 and (EU) 2019/943 as regards improving the Union's electricity market design
17 Renewable Energy Act, published in State Gazette No. 35 as of 03.05.2011, as amended from time to time, last amendment State Gazette No. 67 as of 15.08.2025 (In Bulgarian: Закон за енергията от възобновяеми източници).
18 The draft bill was open to public consultations until 18 October 2025 at the public portal – Портал за обществени консултации.

national renewable energy targets, supports long-term power purchase agreements, introduces sustainability criteria for biomass and creates accelerated permitting zones for renewables. It also strengthens the role of the energy regulator and improves transparency in guarantees of origin.

Key changes introduce rules for joint renewable projects between EU member states. The law supports priority zones for renewable deployment, integrates renewables into building design and renovation and updates definitions and procedures to align with EU requirements. It emphasises energy efficiency in permitting, mandates public participation in planning and strengthens coordination between district heating operators and renewable energy providers.

This legislative update responds to the EU's latest infringement procedure against Bulgaria. However, its effectiveness will depend on administrative capacity, active stakeholder engagement and the ability to balance regulatory stability with market flexibility.

The European legal backbone of climate change mitigation

In addition to the "Fit for 55" package – a key part of which has already been transposed into national legislation – the Carbon Border Adjustment Mechanism (CBAM) introduces another layer of climate legislation through its direct applicability in Bulgaria. CBAM complements ETS. According to the CBAM Omnibus Regulation in 2026, Bulgarian importers of carbon-intensive goods must prepare to report embedded emissions. The obligation to purchase and surrender CBAM certificates, however, has been postponed to 2027 as per the 2025 October key updates. These also included an exemption of threshold of 50 tons per year - importers below this threshold are exempt from CBAM obligations.From a strategic perspective, while the ETS directly limits emissions within EU, CBAM extends carbon pricing to global trade, mainly preventing businesses from relocating production to regions with weaker climate policies.

The combined effect of ETS, ETS2 and CBAM presents significant implications for Bulgarian industry. Energy-intensive sectors may face competitive disadvantages compared to firms in jurisdictions with less stringent climate policies. However, compliance may drive innovation, as the adoption of low-carbon technologies could enhance export competitiveness within the EU, where demand for climate-friendly products is expected to increase under evolving regulatory frameworks.

Investor takeaways

From a comparative legal perspective, Bulgaria's climate framework is increasingly aligned with EU law but still trails leaders like Germany, France and Denmark. These countries have adopted sector-specific legislation, clear coal exit strategies and robust enforcement mechanisms. Germany's Climate Change Act (Klimaschutzgesetz) sets binding targets for climate neutrality by 2045, while Denmark's Climate Act (Klimaloven) mandates 70% emissions cut by 2030 and a coal phase-out by 2028. Bulgaria's delay in legislating a coal exit risks the loss of EU funding and may undermine investor confidence. Public engagement remains low – fewer than 25% of Bulgarians view climate change as a top concern, compared to 46% EU-wide. While the 2025 CCMA and RES Act amendments represent progress, successful decarbonisation will require legal alignment, institutional capacity and active involvement from businesses, civil society and legal advisers to ensure an equitable, resilient and sustainable transition.

List of "Fit for 55" legislation:

- Regulation (EU) 2023/955 of the European Parliament and of the Council of 10 May 2023 establishing a Social Climate Fund and amending Regulation (EU) 2021/1060.
- Regulation (EU) 2023/956 of the European Parliament and of the Council of 10 May 2023 establishing a carbon border adjustment mechanism (Text with EEA relevance) (CBAM).
- Regulation (EU) 2023/957 of the European Parliament and of the Council of 10 May 2023 amending Regulation (EU) 2015/757 in order to provide for the inclusion of maritime transport activities in the EU Emissions Trading System and for the monitoring, reporting and verification of emissions of additional greenhouse gases and emissions from additional ship types (Text with EEA relevance).
- Directive (EU) 2023/958 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC as regards aviation's contribution to the Union's economy-wide emission reduction target and the appropriate implementation of a global market-based measure (Text with EEA relevance)
- Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system (Text with EEA relevance).
- Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU (Text with EEA relevance) (AFIR).
- Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation) (Text with EEA relevance) (ReFuelEU Aviation).
- Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC (Text with EEA relevance) (FuelEU Maritime).
- Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU (Text with EEA relevance) (LULUCF).
- Regulation (EU) 2023/857 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement, and Regulation (EU) 2018/1999 (Text with EEA relevance) (Effort Sharing Regulation).
- Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast) (Text with EEA relevance).
- Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652.
- Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast) (Text with EEA relevance).
- Directive (EU) 2024/1788 of the European Parliament and of the Council of 13 June 2024 on common rules for the internal markets for renewable gas, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/EC (recast) (Text with EEA relevance).
- Regulation (EU) 2024/1787 of the European Parliament and of the Council of 13 June 2024 on the reduction of methane emissions in the energy sector and amending Regulation (EU) 2019/942 (Text with EEA relevance).
- Regulation (EU) 2024/1789 of the European Parliament and of the Council of 13 June 2024 on the internal markets for renewable gas, natural gas and hydrogen, amending Regulations (EU) No 1227/2011, (EU) 2017/1938, (EU) 2019/942 and (EU) 2022/869 and Decision (EU) 2017/684 and repealing Regulation (EC) No 715/2009 (recast) (Text with EEA relevance).
- Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast) – COM(2021) 563 final.

ENERGY EFFICIENCY AND RENEWABLE SOURCES FUND

Bulgaria's National Decarbonisation Fund: Scaling up two decades of sustainable finance success

Luba Nikiforova
Executive Director at EERSF

"The energy saved is the cleanest, most affordable and most reliable source of energy!"

The Energy Efficiency and Renewable Sources Fund (EERSF) was established in 2004 to facilitate energy efficiency investments, reduce greenhouse gas emissions, and promote a functioning energy efficiency market in Bulgaria. Operating as a revolving fund governed by a public–private partnership, throughout the last 20 years the EERSF advanced Bulgaria's national energy efficiency goals, combining the functions of a lending institution, credit guarantee facility, and technical consultancy. EERSF's next phase is transitioning into the National Decarbonisation Fund (NDF), positioned to accelerate the country's green and inclusive transformation.

Luba Nikiforova holds a degree in Economics with a specialisation in Finance from Karl-Ruprecht University in Heidelberg and an MSc in European Politics and Governance from the London School of Economics (LSE). With over 15 years of corporate and public-sector experience in decarbonisation, she currently serves as Executive Director of the EERSF, soon to become the National Decarbonisation Fund (NDF).

How is Bulgaria managing the balance between industrial competitiveness and the EU's decarbonisation objectives?

Bulgaria faces the intricate challenge of advancing ambitious EU decarbonisation targets whilst protecting its economic backbone - energy-intensive industry. The latest European electrification strategy recognises that electrification and market integration form the bedrock of a successful green transition for sectors such as industry and transport. For Bulgaria, with its strategic network role and still partially tapped renewable potential (especially regarding wind and geothermal energy), the coordinated expansion of the electricity grid and investment in renewables are vital.

However, both European assessments and national experts highlight a continuing deficit in grid investment and the need for more predictable, long-term policy frameworks. Bridging regulatory gaps and accelerating cross-border electricity connectivity will enable Bulgaria to capitalise on its role in the unified European energy market, support domestic jobs and deliver on decarbonisation without undermining competitiveness. With stable European and national strategies and proven public–private project models, industry gains clear ground rules and access to finance for innovation, digitalisation and sustainable energy solutions. Such predictability not only safeguards existing industrial capacity but also positions Bulgaria as an attractive destination for foreign direct investment in green technologies, renewable energy infrastructure and advanced manufacturing - sectors where long-term policy clarity is the primary prerequisite for capital commitment.

How does the EERSF contribute to Bulgaria's decarbonisation, and what financing tools/mechanisms does it use?

EERSF's unique value lies in its hybrid approach - combining revolving loans, credit guarantees and technical advisory support. Since its launch in 2004, the Fund has provided energy efficiency loans to over 200 projects, with total project investment exceeding BGN 98 million. Additionally, EERSF has extended partial credit guarantees and portfolio guarantees to 33 projects, mobilising a further BGN 24 million in investments. These interventions have achieved around 130,000 MWh in annual energy savings and avoided around 94,000 tonnes of CO_2 equivalent emissions annually.

Beyond financing renovations and upgrades for municipalities and businesses, EERSF offers technical assistance, especially in project development and grant absorption. The Fund's public–private partnership model has been recognised as an efficient tool to unlock projects that would otherwise struggle to attract commercial financing - especially smaller municipalities, SMEs and vulnerable groups. Its flexibility allows it to adapt financial products to emerging needs, aligning with themes from the new European housing and renovation initiatives, which advocate for flexible models mixing grants, loans and technical support for greatest impact. EERSF carries the potential to bridge EU and national funding with private capital, delivering both financial leverage and risk-sharing.

Why was EERSF set up as a public–private partnership, and what lessons does this model offer?

The public–private partnership model behind EERSF was chosen to mobilise the strengths of both sectors: structured transparency and public responsibility combined with the agility, innovation and risk management of the private sphere. Initially capitalised entirely through grant funds - USD 10 million from the Global Environment Facility through the World Bank, EUR 1.5 million each from the governments of Austria and Bulgaria, and contributions from several private Bulgarian companies - the Fund was designed from the outset to operate as a self-sustainable commercial entity. In the last 20 years, the capital of EERSF has already successfully revolved almost three times.

This approach mirrors best practices highlighted in recent EU and international forums, where private finance is seen as essential for scaling up green and social infrastructure. The EU's new housing strategy, to give an example, also reinforces this: public–private partnerships help regulate costs, deliver quality and mobilise broader investments whilst keeping social aims at the forefront. Bulgaria's adaptation of this model through EERSF provides a blueprint for combining central strategic targets with highly localised,

ENERGY EFFICIENCY AND RENEWABLE SOURCES FUND

needs-driven execution. For already two decades, the Fund has been managed by the Consortium "Econoler-EnEffect-Elana" (EEE), composed of the Canadian energy efficiency consultancy Econoler International, the Foundation "Centre for Energy Efficiency EnEffect" and the non-banking financial institution Elana Holding, ensuring professional management and market discipline. At the same time, its public Management Board ensures strict housekeeping and efficient spending of public funds according to EU and national strategic goals and evolving green policies.

What is the status and implication of creating the new National Decarbonisation Fund (NDF)?

Bulgaria is preparing to transition EERSF into the National Decarbonisation Fund (NDF), which aims to leverage a broader capital base - including EU, EIB and climate finance - and extend its focus across energy, housing, industry, transport and vulnerable communities. As part of Bulgaria's long-term renovation strategy and its National Recovery and Resilience Plan, the establishment of the NDF has been identified as a key milestone to accelerate the decarbonisation of buildings whilst improving the use of public funds by leveraging additional private financing.

The structuring process, supported by the European Investment Bank and the Technical Support Instrument, has advanced through several phases. The first phase involved assessing barriers to energy efficiency and building decarbonisation in Bulgaria, whilst the second phase - preparation of an investment strategy for the NDF - was completed and presented in 2023. The process involved aligning with evolving EU frameworks for affordable housing, sustainable renovation, industrial competitiveness, and carbon-neutral transport, as well as integrating best practices from other countries.

The NDF's creation is a necessary step towards addressing systemic challenges and mobilising the scale of investment outlined in EU strategies, ensuring coordination across public, private and local actors. EERSF's accumulated knowledge, risk assessment protocols, proven track record of over 20 years and collaborative network are a strong launchpad for the NDF's wider reach and impact. The transition represents not an ending but an evolution - expanding EERSF's successful model to meet the ambitious decarbonisation targets facing Bulgaria.

What governance would best suit the NDF and how should it mobilise capital?

A multi-level, inclusive governance structure - engaging state, municipal, business, financial sector and civil society representatives - is essential for the NDF to remain transparent, credible and effective. Drawing on EERSF's experience, the separation between governance oversight and professional fund management has proven crucial. The NDF should maintain this independence whilst strengthening stakeholder engagement mechanisms.

The new European housing and electrification strategies emphasise the need for a "single-window" approach to finance, so the NDF should facilitate blended models combining grants, concessional loans and guarantees, making funding accessible and reducing administrative burden for project promoters. This approach has already demonstrated success through EERSF's combined financing structures under programmes such as the Financial Mechanism of the European Economic Area, the National Trust EcoFund and the "Beautiful Bulgaria" Project.

Proper monitoring, transparent reporting and regular stakeholder consultation will maintain investor and public trust. The governance structure must balance the need for swift decision-making with robust accountability, allowing the NDF to respond rapidly to emerging opportunities whilst ensuring prudent use of public and private capital. Building on EERSF's foundation, the NDF governance should institutionalise lessons learnt whilst adapting to the broader scope and scale of operations required for national decarbonisation.

Which areas should Bulgaria prioritise - energy, industry, SMEs, buildings, transport - to best accelerate decarbonisation?

Current strategies and EU guidance suggest prioritising energy system digitalisation, energy efficiency in buildings - especially the renovation wave - and industrial electrification. Upgraded, flexible grid infrastructure is the foundation for all these sectors, as reliable transmission links enable both domestic and cross-border decarbonisation. Bulgaria's strategic position in the European electricity network presents opportunities that cannot be realised without substantial grid investment.

However, housing policy must take centre stage. With the announced pan-European investment platform and focus on affordable, efficient and inclusive housing, Bulgaria is presented with a historic opportunity to address energy poverty and demographic renewal through integrated action. Over 65% of Bulgaria's existing buildings were constructed before 1990, resulting in poor energy performance and high heating costs that disproportionately affect vulnerable households. The renovation wave can simultaneously address energy efficiency, climate targets and social inclusion.

Empowerment of local governance structures, regulatory modernisation and open access to renovation finance are critical success factors. EERSF's experience in financing municipal facilities such as street lighting and public buildings demonstrates the potential for scaled-up intervention. Industry and SME decarbonisation must proceed in parallel, with targeted support for electrification, renewable energy integration and process efficiency. The transport sector's decarbonisation depends heavily on progress in grid expansion and renewable energy deployment, making it inseparable from energy system priorities.

How can financing become more accessible for smaller municipalities, vulnerable groups, and energy communities?

The strongest lesson from European experience is to simplify access and match support tools to recipients' capacities. Micro-credits, guarantees, direct technical assistance and capacity building must accompany financial instruments. EERSF has successfully deployed these combined approaches, offering free technical assistance alongside financing to help project initiators navigate complex application processes and technical requirements. It has played a vital role in promoting the concept of energy efficiency from the very beginning of its initial introduction in Bulgaria.

The EU's new platform for affordable housing and social inclusion, as well as targeted renovation programmes, provide blueprints for combined approaches - public land grants, simplified planning procedures, subsidised loans and fiscal incentives for local promoters. EERSF has supported numerous ESCO projects and developed specific financial products such as portfolio guarantees for the renovation of multi-family residential buildings, demonstrating how tailored instruments can unlock investment in challenging segments.

Public–private partnerships, cooperative models and dedicated technical support will open the renovation wave and green transition to those left behind by traditional market tools. For energy communities - another emerging priority under EU directives - dedicated support programmes combining legal advice, technical assistance and seed capital are essential. The NDF must build on EERSF's foundation by establishing streamlined application processes, regional support centres and standardised financing products that reduce transaction costs for smaller beneficiaries whilst maintaining proper due diligence and risk management.

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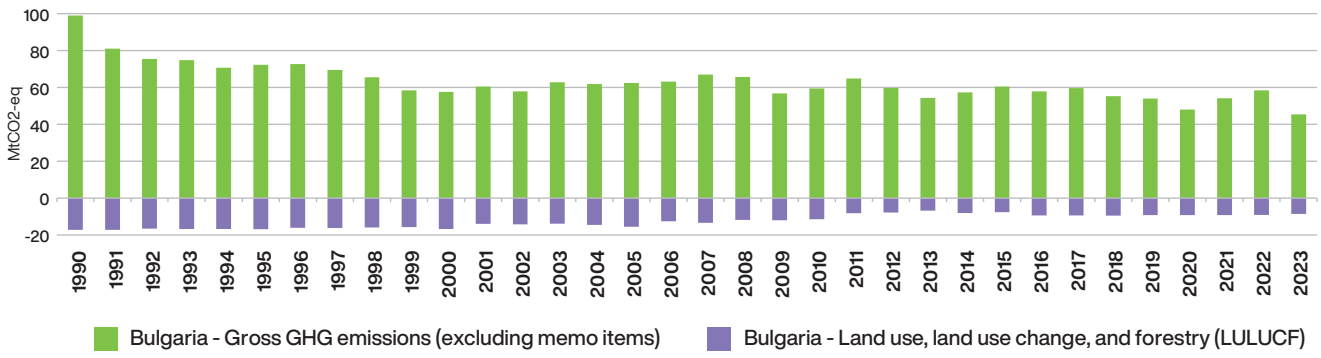
Emission trends

Overview of total emissions

Bulgaria's decarbonisation path has followed an overall decline in greenhouse gas (GHG) emissions from 1990 levels, which serve as the benchmark for the EU's climate ambitions. However, global disruptions have caused occasional setbacks. **In 2023, the country's gross GHG emissions were gauged at 45.4 MtCO2-eq, based on inventories compiled by the European Environment Agency (EEA) and published by Eurostat. This marks a 54.2% reduction from 1990 levels, placing Bulgaria fifth among EU member states for gross emission cuts, behind Estonia, Lithuania, Latvia, and Romania, which achieved reductions between 73% and 59.5%.**

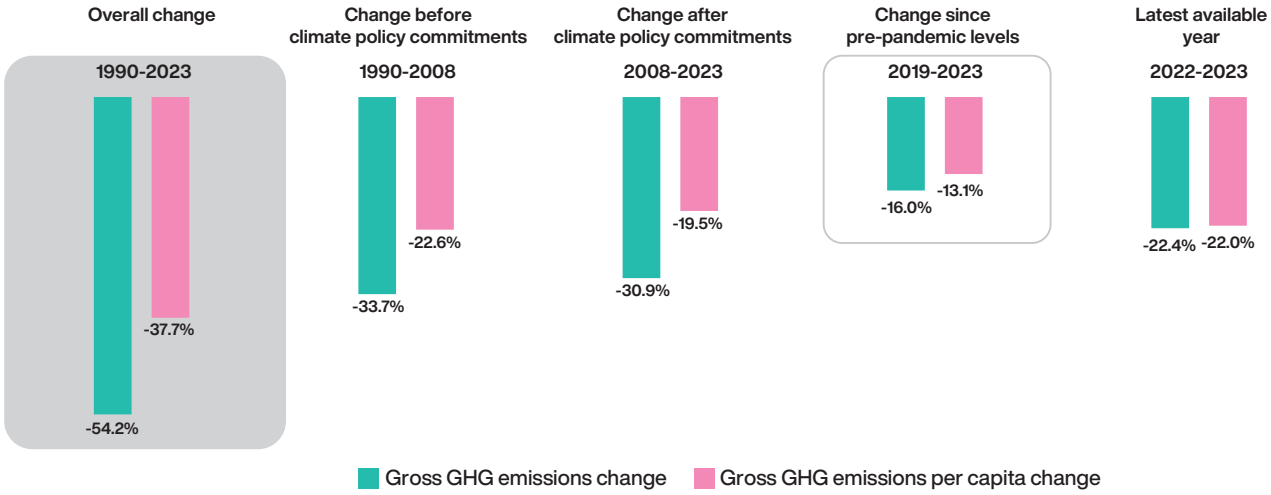
Net emissions, which also factor in land use, land use change and forestry (LULUCF), have followed a similar pattern. The LULUCF sector has consistently acted as a carbon sink throughout the period under review, though its capacity to absorb emissions has weakened somewhat in the past decade. **By 2023, Bulgaria's aggregate net emissions were estimated at 36.8 MtCO2-eq, marking a 55% reduction from 1990 levels and mirroring its fifth-place EU ranking in gross emission cuts.** While gross emissions declined by 54.2% over the same period, reductions achieved through LULUCF sequestration also fell by 50.1%, reaching 8.6 MtCO2-eq in 2023 compared to 1990 levels. This indicates that Bulgaria's emission cuts were primarily driven by direct reductions rather than by offsetting mechanisms. In 2023, 19% of Bulgaria's gross emissions were absorbed through LULUCF, marking the seventh largest offset in the EU.

Fig 1. GHG emissions in Bulgaria



According to Bulgaria's Ministry of Environment and Water, as outlined in its First Biennial Transparency Report under the Paris Agreement published in December 2024, the overall decline in GHG emissions stems largely from the country's radical shift from a centrally planned to a market economy. Reduced power generation from thermal plants, coupled with expanding renewable and nuclear energy also curbed emissions, while industry underwent structural change, with energy-intensive production falling and efficiency improving. In the residential sector, energy use became more efficient, and consumption shifted from solid and liquid fuels to natural gas. Agriculture also contributed to the decline, as smaller cattle and sheep populations and lower fertiliser use cut emissions further.

Fig 2. Changes in GHG emissions



Source: Eurostat, EEA

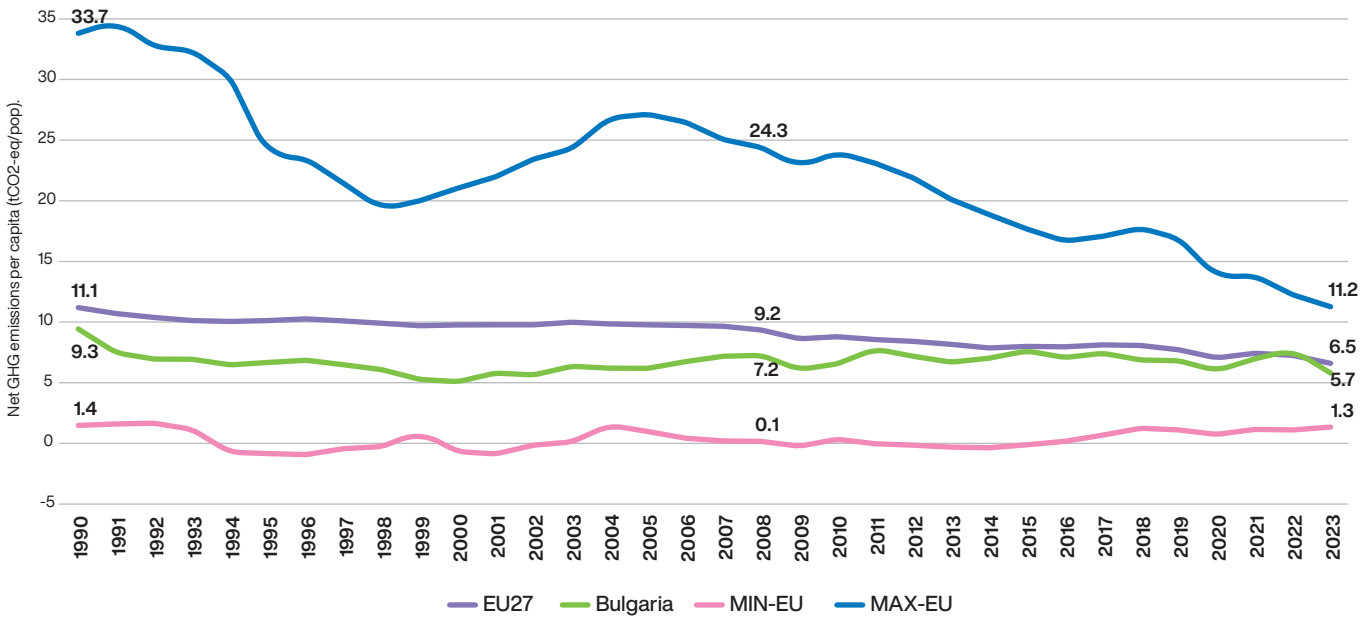
In 2023, Bulgaria's GHG emissions plummeted by 22.4% on the year, marking the steepest annual drop across the entire 34-year period. The sharp decline was partly influenced by the previous year's spike, as the economy rebounded following the pandemic-induced slowdown of 2020. The economic recovery drove total emissions up by 8.1% in 2022 compared to 2021, which itself had already marked the country's largest annual increase in the same timeframe, at 12.7%.

The statistical effect of the slump induced by the pandemic in 2020 cannot be overstated. However, energy production, which dominates Bulgaria's emissions landscape both as a technical process and as an economic activity, underwent a notable shift in 2023. Renewables accounted for 54% of the country's installed capacity, up from 42.4% a year earlier, and for 20.5% of gross electricity generation, up from 15.1%. **At the same time, Russia's illegal invasion of Ukraine in early 2022 disrupted regional energy markets, reducing gas flows and likely shifting dependence on domestic coal.** Gas shortages across the region sent ripple effects through electricity demand, amplifying demand for Bulgarian power and pushing the country's exports to 13.7 TWh in 2022, nearly double the 2020 level. At that point, renewables accounted for only 15.1% of gross generation, down from 17.5% in 2021 but well below the sharp rise to 20.5% in 2023, which helps explain the subsequent drop in emissions.

The combined effects of the pandemic and the war in Ukraine reveal how external shocks continue to shape Bulgaria's emissions. COVID-19 briefly suppressed activity, while the rebound and energy turmoil that followed reignited emissions before hastening a shift toward renewables.

The year 2008 marked the start of the Kyoto Protocol's first commitment period, when binding emission reduction targets for developed countries took effect. As the first international agreement to establish such obligations, the Kyoto Protocol laid the foundation for today's global climate policy, shaping mechanisms that continue to guide the EU's approach to decarbonisation**. By the start of Kyoto's first commitment period in 2008, Bulgaria had already reduced its gross GHG emissions by 33.3 MtCO2-eq, or 33.87%, relative to 1990. However, despite the expansion of climate policies since then, the pace of reduction slowed between 2008 and 2023, with emissions falling by a further 20.3 MtCO2-eq, or 30.9%.**

Fig 3. Net GHG emissions per capita



While Bulgaria's high ranking within the EU with regard to its absolute decarbonisation record is undeniable, demographic decline drove part of that reduction. By 2023, Bulgaria's headcount shrank by 26.5% since 1990, according to Eurostat data. Consequently, net GHG emissions per capita plummeted from 9.3 tCO2-eq in 1990 to 5.7 tCO2-eq in 2023, marking a 38.9% decline, well below the pace of absolute net emissions, which had decreased by 55%. These dynamics reshuffle the EU ranking in per-capita terms, placing Bulgaria in 15th place and marking a more modest achievement than its fifth-place standing in absolute emission reductions. The gap points to fewer efficiency gains than most of its European peers, suggesting future reductions hinge on the energy transition, further technological change, as well as behavioural shifts. From a gross emissions per capita perspective, excluding the sequestration effect of LULUCF, Bulgaria ranks 17th in the EU, with a 37.7% reduction bringing emissions to 7 tCO2-eq per person in 2023 compared to 1990 levels.

KINSTELLAR

Scaling up of EU-made green technologies – new opportunities for manufactures in Bulgaria

Mladen Minev
Counsel at Kinstellar

Mihaela Dimitrova
Senior Associate at Kinstellar

Kinstellar is a leading independent law firm in Central and Eastern Europe (CEE), Southeast Europe (SEE) and Central Asia, with offices in Austria, Bulgaria, Croatia, Czech Republic, Hungary, Kazakhstan, Romania, Serbia, Slovakia, Turkey, Ukraine and Uzbekistan.

Mladen Minev, Counsel, Co-Head of Energy & Natural Resources sector at Kinstellar Sofia, and Mihaela Dimitrova, Senior Associate, are recognised for their extensive experience on major energy and infrastructure projects.

The Net-Zero Industry Act ("**NZIA**") establishes a general legal framework to support the development and expansion of the capacity of the European Union ("EU") to manufacture net-zero technologies, including final products, specific components, and specific machinery essential for their production. The NZIA applies to 19 categories of net-zero technologies that make a substantial contribution to the EU's decarbonisation objectives, including solar, battery and energy storage, electricity grid, and nuclear fission technologies. These categories, including the relevant sub-categories, the final products, and essential components, are defined in more detail under the secondary legislation to the NZIA. The Member States are not obliged to ensure the development of all technologies and should uphold their right to choose between different energy sources, the structure of their energy mix, and their industrial policy.

In addition, the NZIA may also apply, subject to certain exceptions, to energy-intensive industry decarbonisation projects (in the steel, aluminium, non-ferrous metals, chemicals, cement, lime, glass, ceramics, fertilisers, as well as pulp and paper sectors), provided that the respective manufacturers produce components used in the supply chain(s) of a net-zero technology and invest in the decarbonisation of industrial processes at their commercial facilities.

The NZIA aims to ensure the reduction of strategic import and supply chain dependencies on third countries by reaching an overall domestic EU manufacturing capacity of at least 40% of the EU's annual deployment capacity needs by 2030 and 15% of the global production (in value) of said technologies by 2040.

To achieve its objective, the NZIA lays down various measures, among the most important of which is the mechanism for the designation of net-zero strategic projects.

Net-zero strategic projects

A net-zero strategic project is (i) a planned commercial facility, including the repurposing of an existing facility, to manufacture a net-zero technology; or (ii) an energy-intensive industry decarbonisation project; or (iii) a carbon capture, carbon storage, or carbon transport infrastructure project located within the EU and recognised by a Member State based on its contribution to the NZIA's objectives and that the project meets specific criteria set out in the NZIA.

Benefits

The benefits of net-zero strategic project status include: (i) treatment "in the most rapid way possible" of the permit-granting process (which covers all permits for realisation and operation of the project, including the building, chemical, and grid connection permits and environmental authorisation), facilitated by a single point of contact (a role fulfilled in Bulgaria by the Ministry of Economy and Industry); (ii) pre-set short time limits for the permit-granting process (e.g., a nine-month cap on the permit-granting process related to the construction and expansion of a project with a yearly capacity of less than 1 GW); (iii) financing advice provided through the Net-Zero Europe Platform; (iv) the potential to benefit from a simplified assessment for certain environmental rules; and (v) potential urgent treatment in dispute resolution procedures, litigation, appeals, and judicial remedies. Additionally, a recognised strategic project under the NZIA can potentially benefit from financial support via the Strategic Technologies for Europe Platform (STEP).

Procedure

The standard procedure for applying for "net-zero strategic project" status involves submitting a standardised application form with evidence related to the fulfilment of the NZIA's criteria, a business plan (evaluating the financial viability of the project), and a first-draft timetable for realisation of the project. The assessment outcome (i.e., recognition or rejection of the application) should be communicated by the respective Member State within 30 days of confirming the application's completeness. More detailed information about the procedure is available in the Guide for Applicants published on the website of the European Commission.

Practical considerations

An undertaking or a consortium of undertakings seeking to qualify under the NZIA should consider (i) whether the relevant technologies or components fall within the scope of the NZIA (as amended in 2025); and (ii) whether they would meet the selection criteria under the Commission's new implementing decision.

Status of the NZIA framework implementation

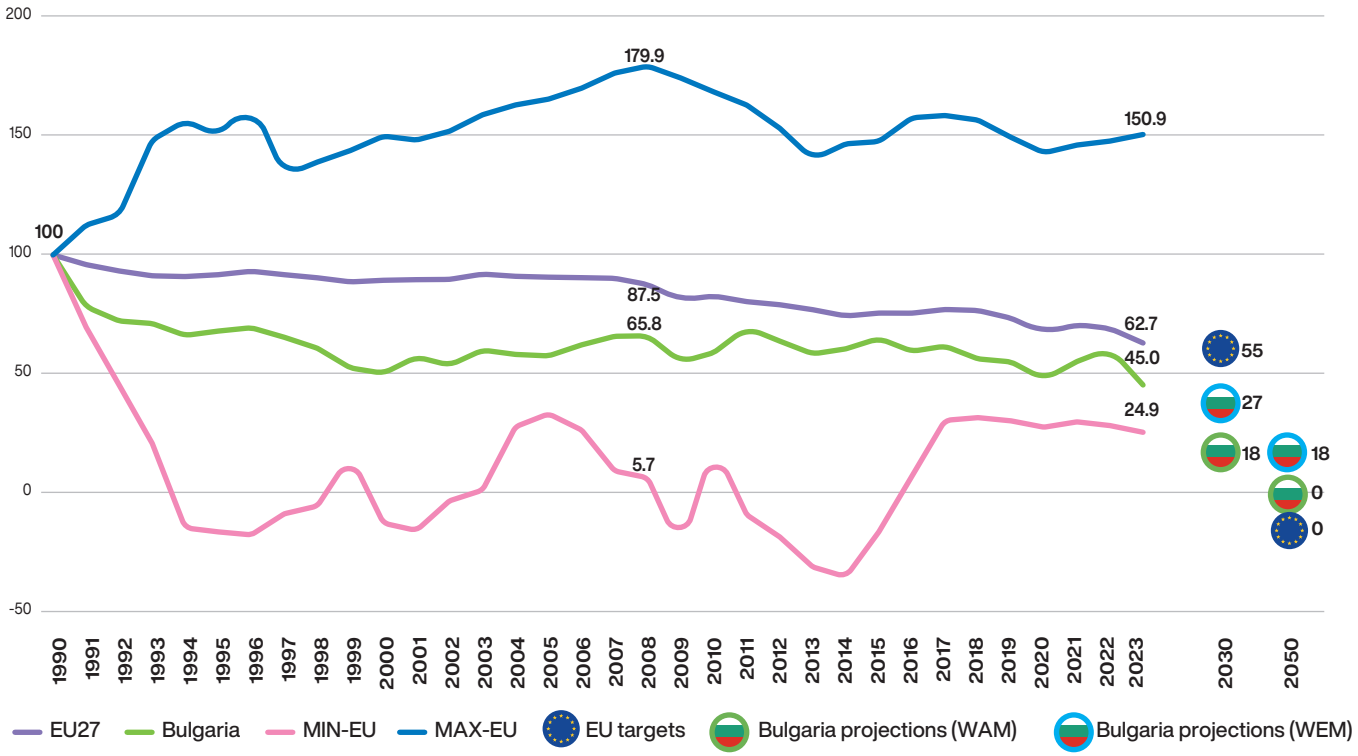
The NZIA entered into force on 29 June 2024 and is directly applicable in all 27 Member States, including Bulgaria. A secondary legislative package was adopted by the European Commission in May 2025.

Some changes remain necessary at the national level in Bulgaria to ensure compliance with certain aspects of the NZIA, e.g., that the permit-granting process related to such projects does not exceed pre-set time limits.

Currently, eight projects in the EU have been designated as net-zero strategic projects: four are energy-intensive industry decarbonisation projects (in the steel, non-ferrous metals, cement, and chemical production sectors), and four are net-zero technology projects, including a battery energy storage project in Bulgaria.

Progress towards reduction targets

Fig 4. Net GHG emissions index and targets (1990=100)



The Kyoto Protocol, adopted in 1997, was the first international treaty to impose legally binding emission reduction targets on developed countries. Despite entering into force in 2005 following a complex ratification process, its first commitment period covered 2008-2012, using 1990 as the reference year. Under this framework, the EU and its member states accepted a collective target to cut emissions by 8% below 1990 levels. By 2012, Bulgaria had already cut its net emissions by 36.5% and its gross emissions by 39.7%. By comparison, the current EU member states collectively slashed their net emissions by 21.1% and their gross emissions by 16.5%. Average gross emission cuts over the 2008-2012 period amounted to 38.1% for Bulgaria and 14.8% for the current 27 EU member states. Since the EU only numbered 15 members at the time the legislation was adopted, the so-called EU-15 achieved an overall gross cut of 11.7%. While the protocol envisaged an 8% collective reduction for the 15 member states, this target was later tailored to the relative wealth of each member state under a burden-sharing agreement. Bulgaria, which joined the EU in 2017, was subsequently designated an 8% reduction target relative to 1988 levels, overshooting it by a large margin.

The Kyoto framework shaped the architecture of today's climate policy, spurring broader climate action, including the launch of the EU Emissions Trading System (ETS) in 2005, inspired by Kyoto's market mechanisms and paving the way for the Paris Agreement in 2015, which expanded climate ambitions globally.

The EU's 20-20-20 package, adopted in 2008, was largely driven by the momentum of the Kyoto Protocol and the push to define its updated framework, referred to as Kyoto II. **The EU set more ambitious goals for 2020, which included cutting emissions by 20%, boosting renewables in energy consumption to 20%, and improving energy efficiency by 20%.** This framework ensured continuity beyond Kyoto and embedded climate action in EU law through mechanisms like the ETS. **Bulgaria, as an EU member, adopted these collective commitments, exceeding its national targets with emissions reductions well above the levels required under both Kyoto and the 20-20-20 framework. The current 27 member states collectively achieved a 32.7% drop in gross GHG emissions compared to 1990 levels by 2020, with Bulgaria managing to slash 51.5%. Net emission reductions were even more pronounced, with the EU cutting 33.1% and Bulgaria 52.6%.** However, this progress was not solely driven by climate policy, as the COVID-19 pandemic significantly slowed economic activity across Europe. In Bulgaria, where energy production accounted for the majority of total emissions and remained heavily dependent on fossil fuels at the time, the reduced demand for power during the downturn also contributed meaningfully to the decline.

Building on the foundations of the Kyoto Protocol, the Paris Agreement of 2015 marked a shift toward a global, cooperative approach to climate action. Unlike Kyoto, which initially applied only to developed nations, the Paris Agreement required all signatories to submit Nationally Determined Contributions (NDCs). **Acting as a single bloc, the EU, including Bulgaria, pledged to collectively cut emissions by at least 40% by 2030 compared with 1990 levels.**

In 2019, the European Green Deal raised these ambitions further, setting the goal of climate neutrality by 2050, encoded in the European Climate Law. This made climate policy a core element of EU strategy, linking emission cuts with innovation, competitiveness, and social transition. **To deliver**

on these goals, the Fit for 55 package was introduced in 2021, raising the 2030 target to a net 55% reduction from 1990 levels. By 2023, Bulgaria had already met this goal, reducing its net emissions by 55%. Gross emissions fell nearly as much, by 54.2%, underscoring the contribution of land use as a carbon sink. The EU as a whole lags behind this pace, having achieved a 37.3% net reduction and a 36.3% decrease in gross emissions by 2023. **Looking ahead, according to Bulgaria's latest update to its National Energy and Climate Plan (NECP) submitted in 2025, under the WEM (With Existing Measures) scenario, Bulgaria's net GHG emissions are projected to decline by 46% by 2030 compared to 2022, or 73% compared to 1988, reaching 26.19 MtCO2-eq. By 2050, emissions are projected to fall further to 17.73 MtCO2-eq, representing an 82% reduction from 1988 levels. Under the WAM (With Additional Measures) scenario, net GHG emissions are projected to decrease by 82% by 2030 compared to 1988, achieving net zero by 2050.** This outlook marks a notable increase in optimism. The European Commission's Climate Action Progress Report on Bulgaria, published in January 2025, cited earlier projections showing net GHG reductions of 51% by 2030 and 72% by 2050 compared with 1990 levels under the WEM scenario. Under the WAM scenario, the projected reductions were slightly higher, at 53% by 2030 and 74% by 2050.

The latest development in EU climate ambitions came on November 5, 2025, when the Council of the EU agreed on a common position to amend the European climate law, setting a binding target to cut net GHG emissions by 90% by 2040 compared with 1990 levels. The agreement introduces flexibility measures, including the use of international carbon credits of up to 5% of 1990 EU emissions from 2036. If this framework is adopted into law by the European Parliament, the inclusion of foreign carbon credits would effectively reduce the real emission cut requirement to about 85%. The agreement aims to balance climate ambition with competitiveness, fairness, innovation, and energy security, introducing a biennial progress review. In addition, the launch of the new emissions trading system for buildings and road transport (ETS 2) has been postponed by one year, from 2027 to 2028.

BFIEC
BULGARIAN FEDERATION OF INDUSTRIAL ENERGY CONSUMERS

Industry decarbonises and needs partner: the state

Dr. Ivaylo Naydenov
Executive Director of BFIEC

Established in 2006, the Bulgarian Federation of Industrial Energy Consumers (BFIEC) represents Bulgaria's largest industrial users of electricity and natural gas. As a key voice for the country's energy-intensive industries and a member of KRIB and IFIEC Europe, BFIEC engages with government institutions, regulators and energy producers to promote transparent, competitive and sustainable energy markets. Guided by international best practices, BFIEC advocates for policies balancing industrial competitiveness with the goals of the energy transition. Dr. Ivaylo Naydenov, Executive Director of BFIEC, holds a PhD in Nuclear Power Systems from the Technical University of Sofia and specialises in energy security, electricity trading and critical raw materials.

What are the main challenges in Bulgaria's industrial decarbonisation path across different subsectors?

The Bulgarian industry currently contributes around 5% of the GHG emissions in the country and has decreased them by 44% compared to 1990. The industry forms over 20% of the country's GDP and about a quarter of the exports. The main challenge is that there is no silver bullet solution. Cement and chemicals have a considerable share of hard-to-abate emissions that cannot be eliminated by electrification. For metallurgy the main solution is decarbonised electricity, for glassmaking, fertilisers and oil refining – hydrogen usage, etc. We need to keep in mind that most of these technologies need further development and require massive investment. The next challenges are leveraging finance and overcoming the red tape that accompanies such big investment projects. On a national level we need a 'one-stop shop' for administrative services related to decarbonisation as numerous local and central administrations are involved in implementing the decarbonisation policies and carrying out the permitting processes for the large-scale decarbonisation projects.

How can Bulgaria's energy-intensive industries stay competitive while mobilising the investments required for decarbonisation and is there a balance between current regulatory ambitions and productivity?

The key to maintaining competitiveness is to have competitive energy prices. That will allow staying on the market and being able to mobilise investment. Moreover, introducing carbon capture and storage (CCS), hydrogen and electrification will increase power consumption, so long-term stability and affordability of energy prices are crucial both for staying competitive and for being able to decarbonise. On the regulatory side, introducing new regulations on EU level should be halted – the requirements for decarbonisation become stricter and stricter while it is recognised that EU's industry remains uncompetitive compared to its American and Chinese counterparts.

The industry needs stability and predictability in order to invest. Decarbonisation is a huge long-term endeavour; for example, a CCS installation in the cement industry is larger than the cement plant itself. Also, we insist that free allowances should not be retracted in an accelerated manner, CBAM should be reformed in order to be air-tight and physical electricity interconnection within the single EU market should be markedly improved to lower prices. There also should be standards that encourage usage of low-carbon products, e.g. cement, concrete, steel and other metals, fertilisers. That will create a market demand for low carbon products and will ensure market presence not only for Bulgarian industry but for EU manufacturing overall. Otherwise, the decarbonisation goals will be met not by investment but by deindustrialisation.

Among technologies such as carbon capture, utilisation and storage (CCUS), renewable energy integration, and small modular reactors (SMRs), which do you see as most viable for large-scale deployment in Bulgaria over the next decade?

All of the abovementioned technologies will be needed to ensure decarbonisation, especially for decarbonising hard-to-abate emissions and high-temperature heat. Renewable energy sources are already well developed both in the power system and at the end-user, especially PV, and we see BESS rapidly developing. CCS will be crucial for cement manufacturing and will require regulatory and investment support as it is a capital intensive and complicated technology.

SMRs could play a key role for decarbonising high-temperature heat and support hydrogen production but we need to build an institutional capacity in order to guarantee smooth licencing and safe deployment. Also they cannot be deployed and operated by a single enterprise because of the CAPEX needed (in the billions) and the strict operational standards applied to nuclear power. SMR development will also require a political consensus and commitment on a national level.

Can technological progress and economies of scale alone drive decarbonisation, or are deeper policy reforms and market mechanisms also needed? If so, which policy measures are most urgent?

The most urgent measures are to stop introducing new regulations, stop moving the decarbonisation target closer, improve electricity market integration and provide instruments to mobilise funding and support investment, as decarbonisation is capital and time intensive. State aid alone won't cut it and while technological progress and economies of scale will drive costs down, the needed investment is staggering as it measures in the tens of billions of euros for the Bulgarian industry.

Emissions by technical process

Energy-related technical processes consistently made up the largest share of GHG emissions in Bulgaria, with fuel combustion (including fugitive emissions) representing about two-thirds of total emissions from 1990 to 2023. Within this category, fuel combustion in energy industries dominated, accounting for an annual average of 43.8% of total gross GHG emissions, peaking at 55.7% in 2011 and reaching its lowest level in 2023 at 34.8% or 15.8 MtCO2-eq. Electricity and heat production generated over 90% of the emissions from fuel combustion in energy industries, while petroleum refining contributed around 6%.

Fig 5. GHG emissions by technical source

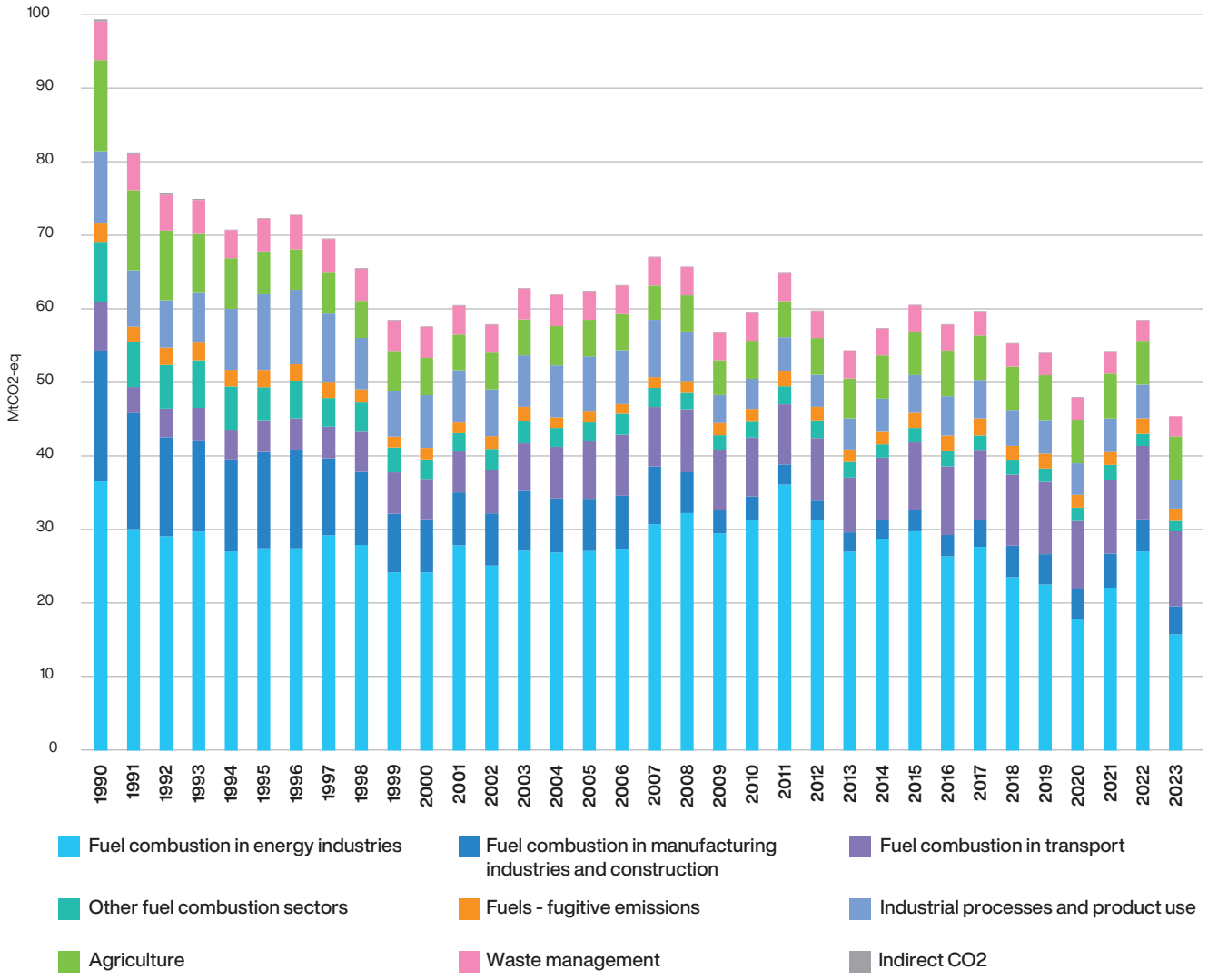
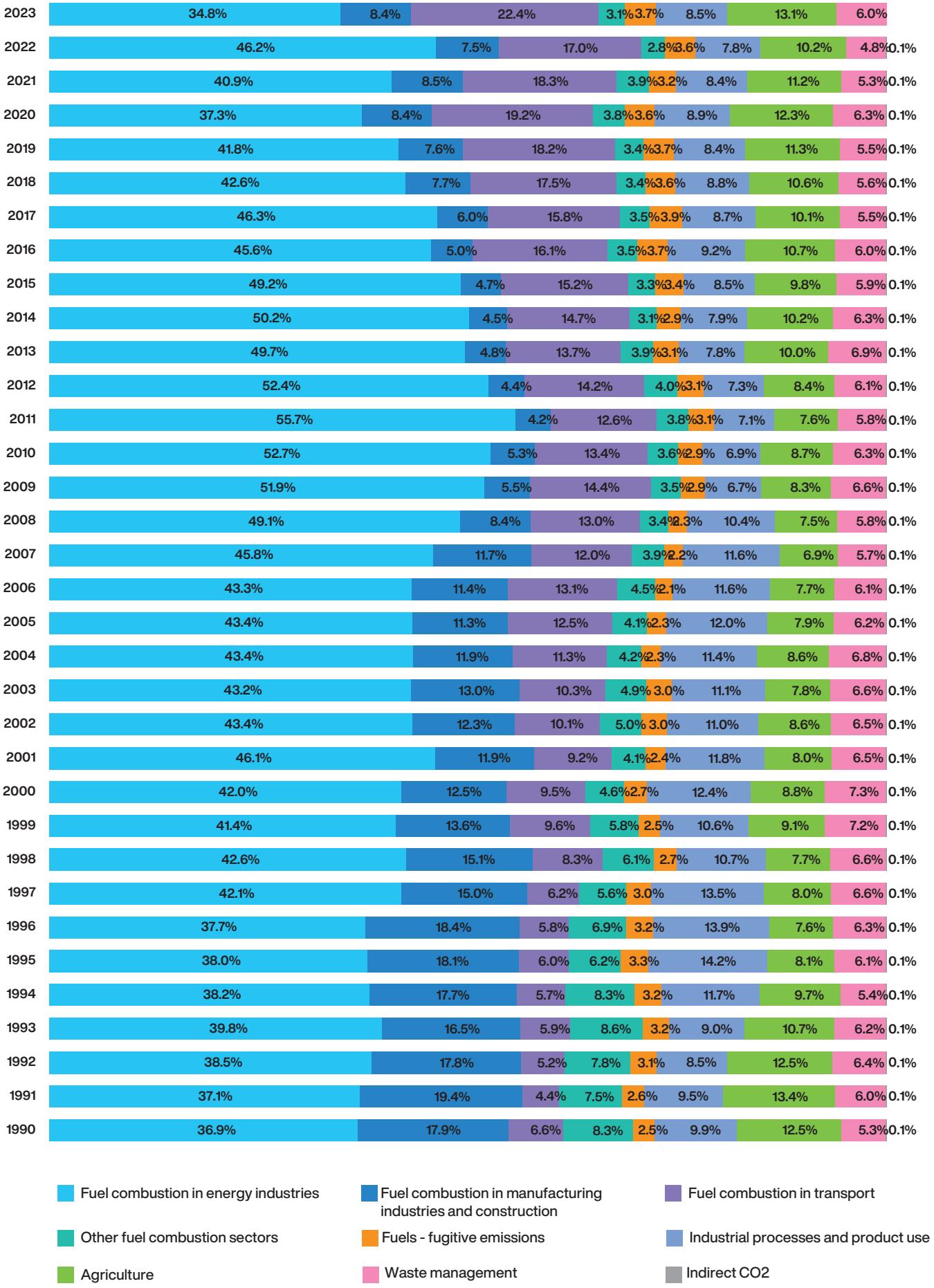


Fig 6. Shares of gross GHG emissions by technical process



Dividing the 34-year period into "before and after Kyoto" timeframes, taking 2008 or the start of the first commitment period, as the point when climate policy began to accelerate, reveals that fuel combustion in energy industries benefited most from these changes. By 2023, emissions from this sector had declined by 51.1%, compared with an 11.7% reduction in 2008 relative to 1990 levels. Emissions fell by 56.8% between 1990 and 2023, surpassed by larger cuts in fuel combustion within manufacturing and construction, where emissions dropped by 78.4%. In 2023 alone, emissions from energy industries fell by 41.7% year-on-year, reflecting the sharp increase in renewable electricity output driven by a surge in solar generation, which grew by 64.9% alongside a 79.1% rise in installed capacity.

Fuel combustion from transport accounted for the second largest share of emissions, averaging 12% of the total over the 34-year period, with the lowest share of 4.4% or 3.6 MtCO2-eq in 1991 and the highest of 22.4% or 3.8 MtCO2-eq in 2023. Despite a declining population, the expansion of road, water, and air transport fleets offset some of the reductions resulting from demographic change, underscoring the need for transport electrification and wider use of low-carbon fuels. Of the 22.4% share from transport-related fuel combustion in 2023, road transport alone contributed 21.8 percentage points (pp).

The rise in transport's share of emissions mirrors trends in absolute terms, as fuel combustion in this sector was the only major source to record an overall increase between 1990 and 2023, gauged at 55.9%. Market-based incentives and the development of the e-mobility sector helped slow this growth, with emissions rising by only 18.8% between 2008 and 2023, compared with a 31.3% increase in 2008 relative to 1990. The COVID-19 pandemic triggered the only annual decline in transport emissions in the past decade, equating to a 6% drop in 2020. As mobility rebounded in 2021, emissions jumped by 7.6%, followed by more moderate increases of 0.2% in 2022 and 2.2% in 2023.

The shares of emissions from energy use in manufacturing industries and construction have effectively traded places with those from transport. In 1990, the former accounted for 17.9% of total emissions or 17.8 MtCO2-eq, falling to 8.4% or 2.8 MtCO2-eq by 2023. This reflects efficiency gains in heavy industry driven by fuel switching and greater use of renewables. In contrast, the shift toward fleet electrification and low-carbon transport began much later, explaining why transport's share has overtaken that of manufacturing and construction.

The declining share of fuel combustion in manufacturing and construction in overall emissions was accompanied by the largest absolute drop among major sectors, with emissions falling by 78.4% in 2023 compared with 1990. Notably, most of this reduction occurred before 2008, with emissions falling by 68.9% between 1990 and 2008, followed by a smaller 30.8% decrease from 2008 to 2023. As noted in Bulgaria's First Biennial Transparency Report under the Paris Agreement, the sharper pre-2008 decline was mainly driven by structural changes in energy-intensive industries during the transition to a market economy, which led to major cuts in fuel combustion for industrial processes. After 2008, the pace of reduction slowed, as most emission-intensive adjustments had already taken place, leaving further progress dependent on technological innovation and policy incentives.

Outside of fuel combustion, industrial processes and product use contributed an average of 9.9% of total emissions between 1990 and 2023. Their share rose to double digits from the mid-1990s to 2008 before declining again to single digits, likely reflecting the impact of emerging climate policies. By 2023, these processes accounted for 8.5% of total emissions or 3.9 MtCO2-eq, with the mineral industry responsible for 4.3 percentage points, of which cement production alone accounted for 2.3 pp. The chemical industry also cumulatively contributed 2.3 pp during the same year, about half of which came from ammonia production.

Industrial processes and product use recorded a 60.7% reduction in GHG emissions between 1990 and 2023, with post-2008 cuts of 43.7% outpacing the 30.1% reduction achieved between 1990 and 2008. While the early structural downsizing of heavy industry and the transition to a market economy drove most pre-2008 cuts in manufacturing combustion, later policy-driven efficiency gains and technology upgrades led to the sharper post-2008 reductions in industrial process emissions. **The largest annual decline in industrial process emissions occurred in 2009, reflecting the effects of the global financial crisis, which also led to the steepest drop in Bulgaria's industrial output since 2001, according to Eurostat data.**

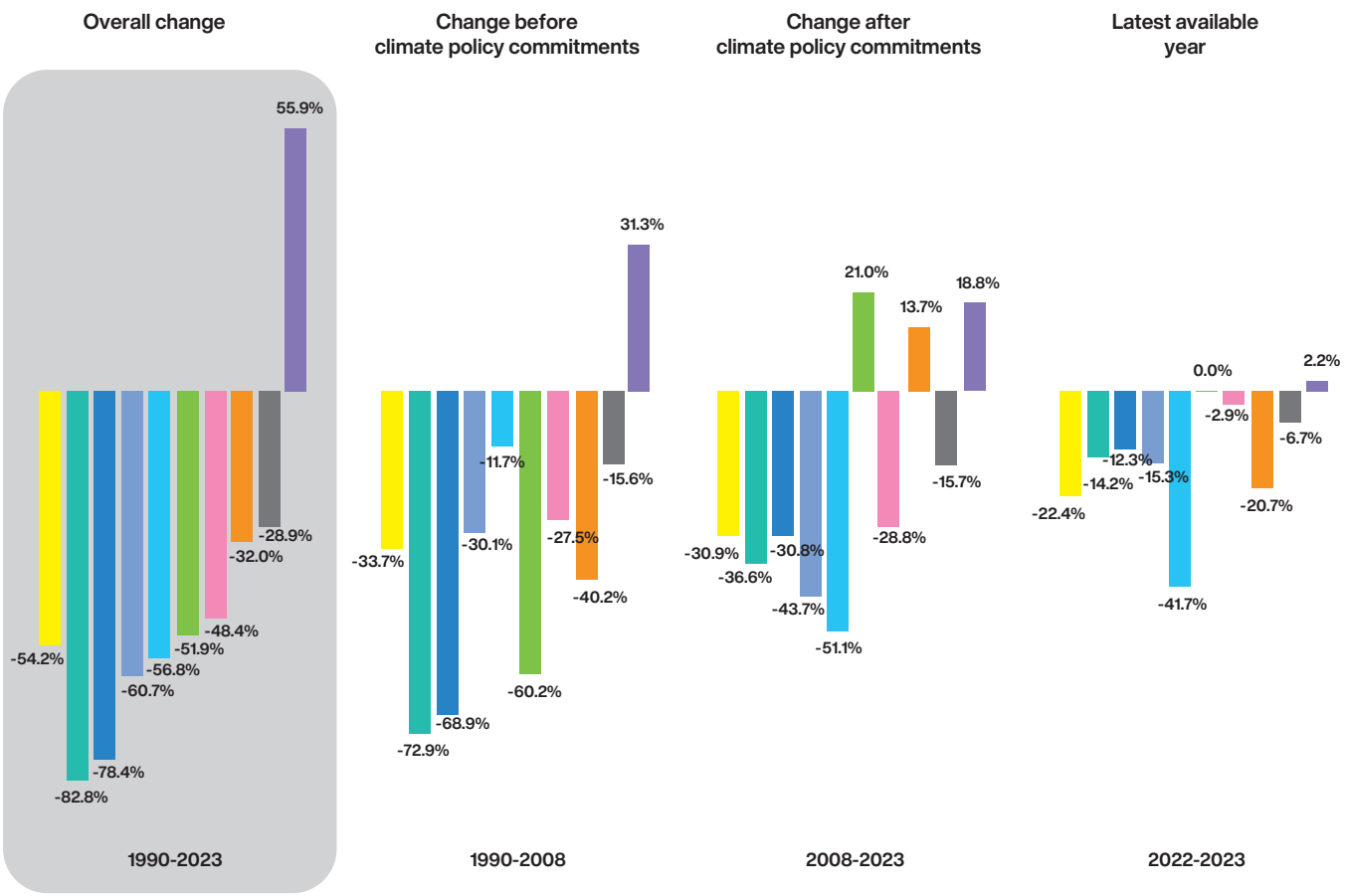
Beyond energy, industry and construction, agriculture processes accounted for an average of 9.5% of emissions over the period, with double-digit shares in the early 1990s and after the mid-2010s. In 2023, agriculture processes accounted for 13.1% or 5.9 MtCO2-eq of total GHG emissions, driven mainly by nitrous oxide emissions from soil management, which constituted 7.6 pp.

Agricultural emissions in Bulgaria fell by 51.9% between 1990 and 2023, driven mainly by the post-1990 restructuring of the sector. By 2008, emissions had declined by 30.1%, in contrast to a 21% increase between 2008 and 2023. The sharp early decline reflected widespread land abandonment, reduced fertiliser use, and a steep drop in livestock numbers following the transition to a market economy, as noted in Bulgaria's latest update to the NECP. In recent years, emissions have fluctuated before stabilising in 2023, with increases linked to land-use changes and the expansion of agricultural and infrastructure activity after EU accession.

Waste management remained the most stable sector in terms of emission contributions. With an annual average share of 6.1% in total emissions over the 34 years, these fluctuated between 4.8% in 2022 and 7.2% in 2000. By 2023, waste management processes accounted for 6% or 2.7 MtCO2-eq of total emissions, with waste disposal sites responsible for over two-thirds and wastewater treatment for most of the remainder.

Waste management emissions fell by 48.4% between 1990 and 2023 in Bulgaria, reflecting sustained progress in modernising the sector. The rate of decline was relatively steady, with a 27.5% drop before 2008 and a 28.8% decrease between 2008 and 2023. According to Bulgaria's latest update to the NECP, waste-sector emission reductions have been driven primarily by improved waste management since 2000, particularly through landfill methane mitigation, increased recycling and reuse, and programmes to limit biodegradable waste and capture or incinerate landfill gas. EU accession also supported emission cuts through adherence to policies such as the EU Waste Framework, as well as landfill and circular economy directives, which mandated improved waste collection, recycling, and disposal standards.

Fig 7. Changes in GHG emissions by technical process



Note: 2023 data unavailable for Indirect CO2 emissions; 2022 used as baseline.
Source: Eurostat, EEA

Balancing climate goals and industrial competitiveness

Boyan Rashev
Founder, MindYourFuture

Boyan Rashev holds both a bachelor's and a master's degree in Environmental and Resource Management from Germany. In 2007, together with his wife, he founded denkstatt, which they turned into the most successful sustainability consulting firm in Bulgaria. Over the years, he has gained extensive experience in finding the intersection between economy, society, and environmental protection while working with industries and institutions of all kinds. He has long shared his views publicly and is today among the most influential voices on these topics in Bulgaria. During the COVID crisis, he successfully ventured into the vast world of investments. Thanks to this, he can now afford to work on his personal cause – the analytical platform MindYourFuture.org. Through it, Boyan seeks to bring common sense and rational optimism into the public dialogue, with the ambition to change the environment, the mentality, and the governance of Bulgaria.

Mr. Rashev, with industry accounting for around a fifth of Bulgaria's economy, how well is the country balancing its climate goals with economic priorities, and which sectors are most difficult to decarbonise?

Bulgaria isn't "balancing" climate goals with industrial priorities—it is absorbing targets written in Brussels without a delivery mechanism at home. Decarbonisation has been framed as a compliance exercise: meet deadlines, file plans, wait for grants. In reality, cement, metals, chemicals and refining are structurally hard-to-abate, and expecting them to decarbonise on short political timelines with old equipment and expensive energy is physically and economically impossible. European climate policy has created a model where industry must survive through subsidies—if the grants stop, projects stop. The long-term cost is loss of competitiveness, relocation of production, and shrinking exports. A credible strategy must finance modernisation, not paperwork.

In the metallurgical and mining sectors, decarbonisation hinges on a clean power supply. How prepared is Bulgaria's renewable energy system to meet this demand, and what other key challenges do these industries face?

Renewables are expanding, but Bulgaria's system is nowhere near ready to supply firm, low-cost, 24/7 power for expanding mining and metallurgy in Europe and Bulgaria in particular. Grid capacity lags behind ambitions, storage is minimal, and baseload renewables (like huge hydropower on the Danube) do not exist in Bulgaria. These industries cannot operate on "theoretical megawatts"—they need real electrons every hour, at stable prices. Companies are making efforts to build their own power plants, mostly photovoltaics and batteries. They help but cannot satisfy their needs in full. Without massive investment in nuclear repowering, additional reactors, and accelerated grid reinforcement, electrification of heavy industry will remain a political slogan. And if policy continues to insist that competitive baseload is unnecessary, the outcome is simple: industry won't decarbonise in Bulgaria, it will simply close.

High-temperature processes are indispensable to chemical industrial processes. What realistic pathways do you see for replacing fossil-based heat in Bulgaria?

Electrification above ~400°C is technically possible but economically absurd under current power prices. Hydrogen sounds visionary but doesn't exist at scale, and imported green hydrogen will be too expensive for most Bulgarian factories. Biomass could support part of the transition, but the country uses it mostly to heat homes. There is no guaranteed sustainable feedstock supply, and very limited logistics. Waste-to-energy is another missed opportunity: instead of burying municipal waste and methane emissions in landfills, Bulgaria could generate stable, dispatchable heat and power, as most developed European economies do. Combined with sustainable biomass residues from forestry and agriculture, Bulgaria could unlock several hundred

megawatts. Instead, ideology and bureaucracy keep the country dependent on imported fuels and expensive electricity.

The realistic short-term path is: immediate efficiency upgrades, partial substitution with low-carbon fuels including biomass and waste-to-energy, and planning for carbon capture, utilisation, and storage (CCUS) where chemistry creates unavoidable CO_2. But none of this works without cheap, firm electricity, and that ultimately points back to nuclear.

In addition to renewable electricity, gas supply is also crucial to decarbonisation. Is securing affordable gas and greener alternatives a challenge in this context?

Gas is the only practical balancing fuel and pretending otherwise is politics, not economics. Securing long-term gas at stable pricing is essential, but the country also needs biomethane and low-carbon hydrogen in niche uses. The real risk is political: government policy is torn between promising a rapid gas exit and secretly relying on gas to keep industry alive. If politicians restrict gas faster than substitutes arrive, heavy industry faces price spikes, shutdowns, or relocation. No investor will commit billions into factories that don't know if they will have an affordable molecule tomorrow.

Instead of pretending gas must disappear instantly, Bulgaria could reduce dependency, stabilise prices and increase energy security by developing its own resources. The Han Asparuh block in the Black Sea, operated by OMV Petrom, has enormous potential but remains stuck in political hesitation and regulatory uncertainty. Meanwhile, Bulgaria sits on shale gas resources that have never been seriously evaluated, let alone drilled. Other countries used shale to cut emissions, lower prices and bring industry back. Bulgaria banned it without a scientific assessment.

If the country wants affordable gas, high employment in industry, and energy independence, it needs geological exploration, not political taboos. Europe lectures about security of supply while refusing to produce its own molecules. That is not a transition plan—it is dependency with better PR.

While some sectors have made strides with alternative fuels, process emissions remain an issue. How far along is Bulgaria in developing carbon capture solutions, and which industries need them most urgently?

CCUS is not a luxury – it is the only route for cement and lime, and a key safeguard for chemicals within the current political framework in Europe. Bulgaria is at the pilot stage, far behind where it needs to be relative to 2030 targets. Without full-chain CCUS – capture, transport, storage – industry will have to either pay punitive carbon prices or shut down. And CCUS requires state support, regulatory clarity, and cross-border storage agreements. Instead, policymakers expect industry to decarbonise with "aspirations." Aspirations don't neutralise CO_2. Infrastructure does.

Keep in mind that CCUS would make economic sense only in case of very high carbon prices and available market demand for very expensive "blue" cement, metals, fertiliser and/or chemicals. I have to admit, I do not see any signs of willingness to pay among European consumers or anywhere else on the planet. People talk and promise but when they have to spend, reality strikes.

Do ammonia levies make it harder for Bulgaria to stay competitive in exporting agricultural inputs?

Yes, carbon-linked levies make Bulgarian fertiliser and potential food exports less competitive. Policy assumes that "green and/or blue fertiliser" will bring premium prices, but the global market rewards low cost, not ideology. Under current EU policies, producers that cannot document lower carbon intensity will lose contracts. Those that depend on subsidies instead of restructuring will survive only as long as taxpayers finance them. That is not industrial policy – it is hospice care. Selling "green" but expensive fertilisers or food abroad is not a viable strategy.

Is the regulatory environment, including reporting, efficient and balanced?

Reporting obligations have grown faster than actual decarbonisation capacity. Many companies spend more time and effort preparing disclosures than building projects. Regulation has become a system where industry must "prove virtue" instead of producing competitively. And because investments depend on grants, the state has quietly turned industry into a client, not a partner. If the goal was resilience, competitiveness and energy security, the policy would be different: predictable carbon pricing, fast permitting, cheap baseload power and tax incentives. Instead, we have a compliance industry – and shrinking production.

You mentioned nuclear several times. There is an ongoing nuclear renaissance, especially in America. What is the role of nuclear in decarbonisation?

If Bulgaria wants cheap electricity for AI workloads, electrified transport, hydrogen production and reindustrialisation, the answer is not more promises – it is nuclear capacity. Renewables cannot carry the full system load without massive storage that doesn't exist. Industry won't run on hope. Data centres and AI workloads are already migrating to jurisdictions with firm baseload – mostly nuclear, coal, hydro and gas. If Bulgaria wants to be in that game, new reactors are a prerequisite, not an optional debate. Every year of delay pushes industry, investment and innovation elsewhere.

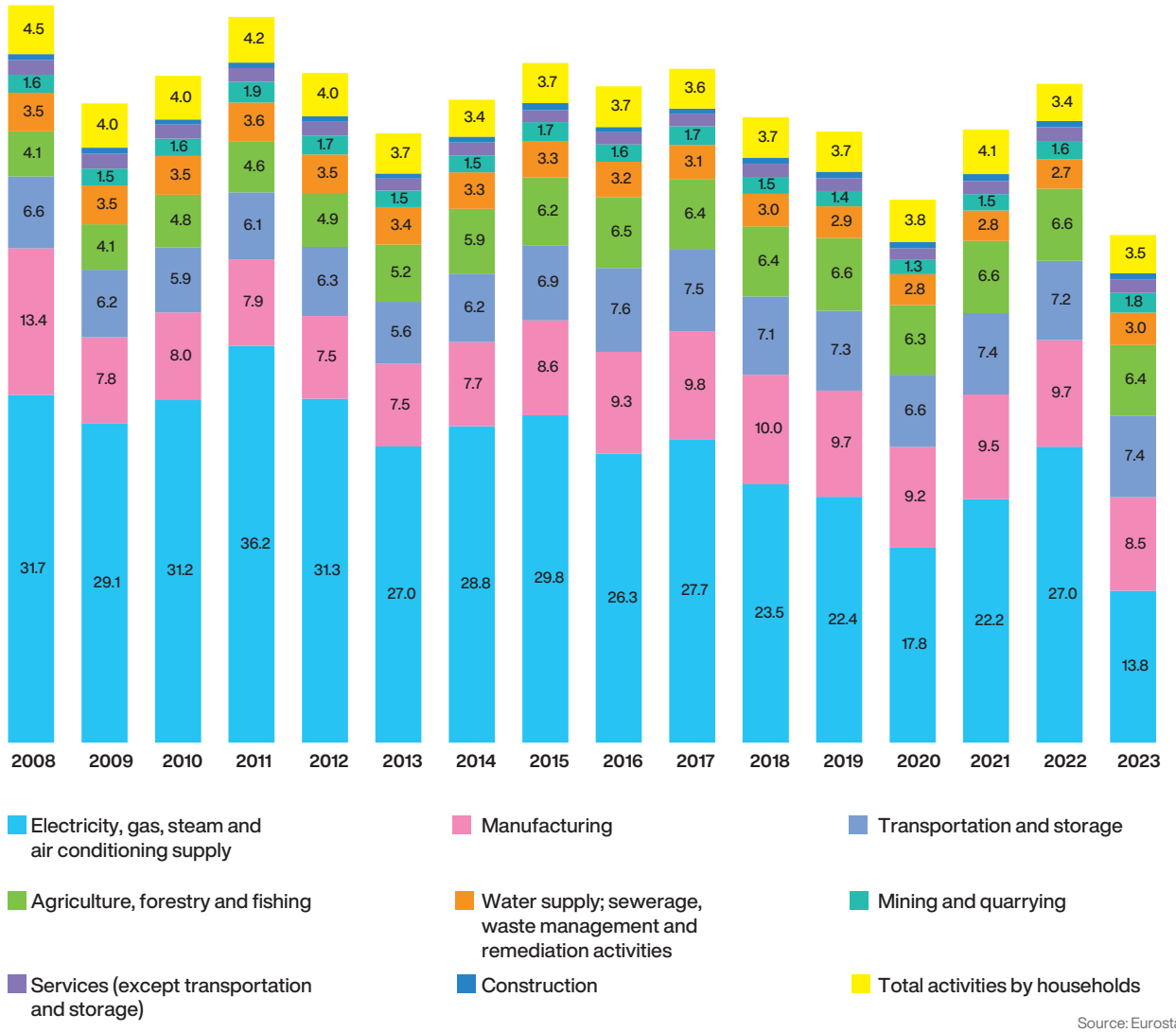
President Trump has been quite clear in changing the course on decarbonisation, even Bill Gates has recently admitted that decarbonization cannot be the ultimate goal to achieve at any price. What do you think about the US route?

While Europe tightens targets, the USA is now signalling a completely different doctrine: abundant, reliable and cheap energy first, competitiveness first, no climate policy that destroys industry. The message is simple: if decarbonisation lowers costs, do it; if it raises costs and kills jobs, drop it. Europe insists there is no alternative to decarbonisation. The USA is already demonstrating one and it attracts investment even from European energy-intensive industries that are looking for survival outside of Europe. Is this what we really want?

Emissions by economic activity

GHG emissions by economic activity are derived from air emissions accounts based on the System of Environmental-Economic Accounting (SEEA) and differ from those in national GHG inventories due to their alignment with national accounts rather than technical emission processes. While inventories classify emissions by technical processes based on the territory principle, air emissions accounts follow the residence principle, assigning emissions to the economic activities and enterprises responsible, according to the EU's statistical classification (NACE). Therefore, total emissions may differ between the two accounting systems, which also vary in how emissions are classified by responsible sectors. For example, those classified as transport in GHG inventories are partly reallocated in air emissions accounts to households and businesses that operate their own vehicle fleets.

Fig 8. GHG emissions by economic activity



Source: Eurostat, EEA

DPM METALS

Strategic commitments and decarbonisation alignment at Dundee Precious Metals

DPM Metals is a Canadian-based international gold mining company with key operations in Bulgaria, Ecuador, and Serbia. Driven by a commitment to unlocking resources and creating shared value, the company focuses on responsible mining, innovation, and sustainability. DPM Metals aims to achieve net-zero emissions by 2050, with an interim target of reducing emissions by 37.5% by 2035. The company has been reporting annual sustainable performance since 2011, with a GRI-aligned maturity assessment undertaken in 2020 and a CSRD-aligned double materiality assessment performed in 2024. In Bulgaria, where it operates the Chelopech underground gold-copper mine and the Ada Tepe open-pit gold mine near Krumovgrad, the company supports environmental protection, community development and long-term regional growth.

DPM Metals has made significant strides in aligning its operations with the global sustainability and decarbonisation goals. By the end of 2024, the company made notable progress in the areas of environmental and social performance, advancing key initiatives focused on achieving its purpose of unlocking resources and generating value to thrive and grow together. An acknowledgement of these efforts was reflected in DPM Metals' ranking in the 91st percentile in the 2024 S&P Global Corporate Sustainability Assessment for the Metals and Mining industry.

As part of its strategic objective to generate a net positive impact, DPM has embedded environmental, social, and governance (ESG) principles into its core business practices. Over the past 20 years, the company has achieved significant improvement in performance and now, special attention is drawn to its decarbonisation journey, focusing on Scope 1, 2, and 3 emissions, collaborations with suppliers and a sustainable future outlook.

Strategic Commitments to Decarbonisation

DPM Metals has committed to reducing absolute Scope 1 and 2 greenhouse gas (GHG) emissions by 37.5% by 2035, using 2020 as the baseline year. The company's ultimate goal is to achieve net zero emissions by 2050. These targets are supported by a range of initiatives, including energy efficiency measures, renewable energy procurement and integration of climate considerations into key business processes such as production efficiency, capital allocation, mergers and acquisitions and budgeting.

Progress on Scope 1 and 2 Emissions

Compared to the 2020 baseline, DPM Metals has already reduced its absolute Scope 1 and 2 emissions by over 25%. This achievement places the company ahead of its linear trajectory towards the 2035 target. Energy consumption at the mining operations has remained stable, with a slight

decrease since 2020, and energy intensity per tonne of ore processed decreased by 3% in 2024 compared to the previous year.

Key energy efficiency measures include the installation of Variable Speed Drive (VSD) technology to optimise machinery performance and reduce energy consumption. Additionally, DPM Metals is exploring ventilation-on-demand technologies to further enhance energy efficiency. Since 2022, DPM Metals has been sourcing renewable energy through green energy certificates. In 2024, the company purchased EU guarantees of origin for 30,000 MWh for both Chelopech and Ada Tepe mines, totalling 60,000 MWh or 216,000 gigajoules of renewable electricity.

Scope 3 Emissions and Supplier Collaboration

Recognising the importance of Scope 3 emissions, DPM Metals has engaged with its top 100 suppliers to identify emissions hotspots and improve data quality. Although the announcement of a formal Scope 3 target has been deferred due to data availability challenges, the company continues to make progress in this area.

One notable example of supplier collaboration is the partnership with Titan Zlatna Panega Cement. Cement is a critical component in the backfilling process at the Chelopech mine, where tailings are mixed with cement to fill mined-out stopes, ensuring rock stability and contributing to the circular economy. Given the large volumes of cement used, it significantly impacts operating costs and carbon emissions.

In 2022, DPM Chelopech tested various products from different suppliers. Titan Zlatna Panega introduced a sustainable cement product that met DPM's performance, cost efficiency, and environmental criteria. The CEM IV/A(P-V) 42.5N cement provided excellent curing time and strength with 1.2% less cement, resulting in an estimated reduction of 5,904 tonnes of cement in 2023 alone. This translated to substantial cost savings of nearly BGN 1.8 million annually and a 42% reduction in Scope 3 carbon emissions, or about 10,000 tonnes compared to the 2020 baseline.

Role of Chelopech and Ada Tepe Mines

The Chelopech and Ada Tepe mines are central to DPM Metals' decarbonisation strategy. Chelopech focuses on energy efficiency and tailings management, reusing over 100% of its waste rock as backfill. This practice mitigates acid rock drainage and ensures a safer working environment.

Ada Tepe employs an Integrated Mine Waste Facility (IMWF) for tailings management, allowing for continuous land restoration during mining operations.

Both mines have benefited from renewable energy purchases and energy efficiency measures. In 2024, they reduced their purchases of goods, services, and capital goods, contributing to a decrease in Scope 3 emissions. Additionally, both sites achieved zero industrial wastewater discharge, with Chelopech maintaining this record for five consecutive years and Ada Tepe for three.

Scenario Analysis and Climate Risk Management

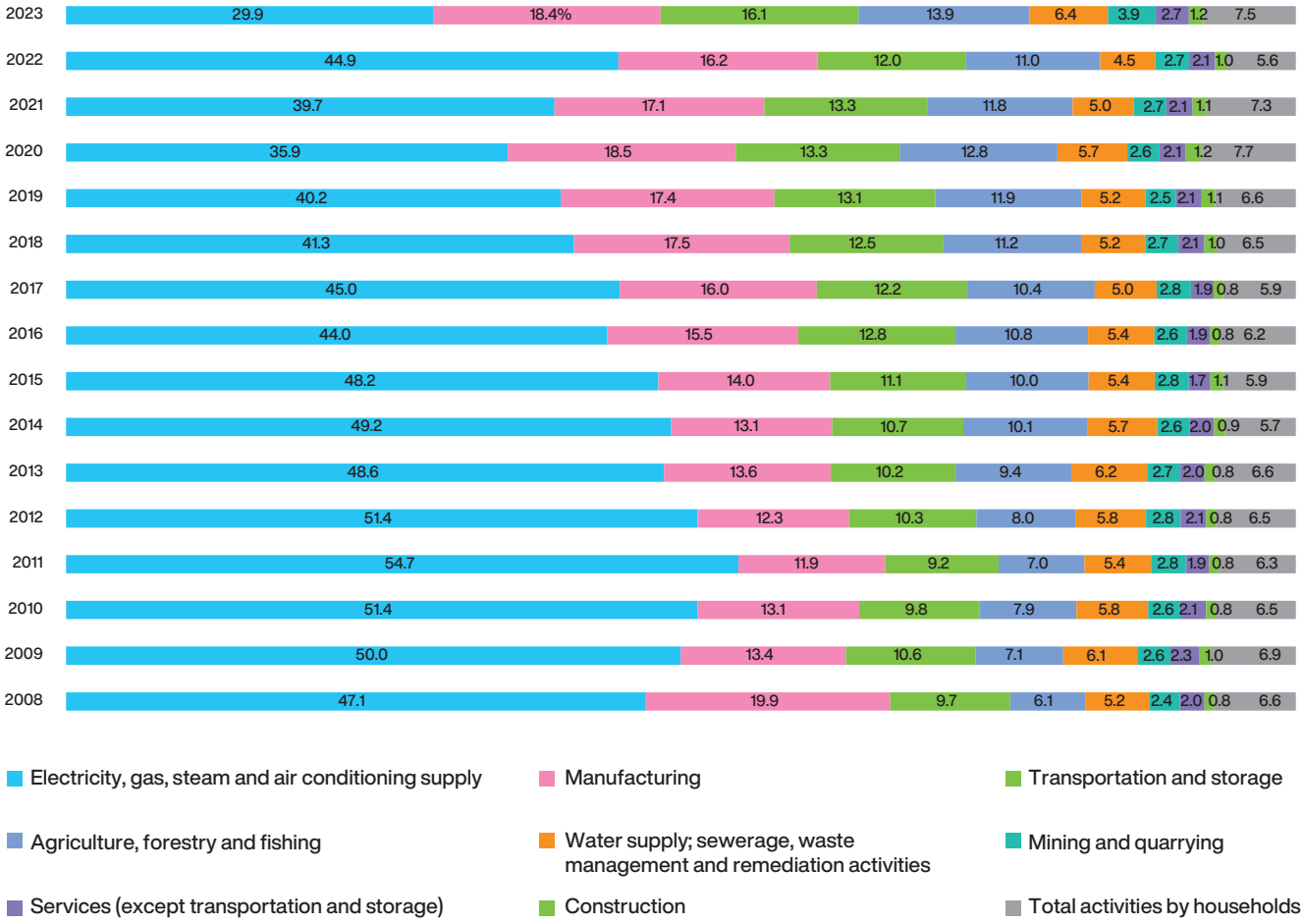
DPM Metals employs the Task Force on Climate-Related Financial Disclosures (TCFD) framework to assess climate-related risks and opportunities across different scenarios. This approach enables the company to make informed decisions and adapt its operations to future climate conditions.

Future Outlook

Looking ahead, DPM Metals remains committed to its decarbonisation goals and continuous improvement in ESG performance. The company plans to further optimise future development sites for carbon efficiency, expand renewable energy procurement, and enhance supplier engagement to address Scope 3 emissions. With a strong foundation and proven results, DPM is well-positioned to lead the mining industry towards a more sustainable and resilient future.

dpmmetals.com

Fig 9. Share of GHG emissions by economic activity (%)



In the breakdown by economic activity, the energy sector, represented by electricity, gas, steam and air conditioning supply, accounted for the largest share of GHG emissions, averaging 47.8% between 2008 and 2023. However, its share declined from 47.1% in 2008 to 29.9% or 13.8 MtCO2-eq in 2023. **Emissions from energy supply plummeted by 56.3% over this period, marking the steepest reduction among all sectors. The largest annual drop of 48.7% occurred in 2023, following a solar boom that saw photovoltaic production rise by 64.9% and installed capacity surge by 79.1%.**

The manufacturing sector claimed the second largest share over the period, averaging at 16.2% in the 2008-2023 period and decreasing from 24% in 2008 to 15.3% or 8.5 MtCO2-eq by 2023. Manufacturing sector emissions fell by 36.1% over this period, accounting for the second-largest drop after the energy sector. Most of the reduction occurred between 2008 and 2015, when emissions dropped by 42.5%. This steep decline likely reflected the post-financial crisis industrial slowdown, compliance with EU environmental standards, and early efficiency gains after EU accession. The largest annual drop over the period was recorded in 2009, at 41.4%. This emerged on the heels of the global financial crisis, which drove a record-high drop of 22.3% in the output of the manufacturing sector. Emissions then rose by 12.4% between 2015 and 2022 as industrial activity recovered, before falling again in 2023 amid weaker growth and cleaner production.

Transportation and storage activities were the third-largest source of GHG emissions, averaging 11.7% of total emissions between 2008 and 2023, up from 9.7% in 2008 to 16.1% in 2023. Notably, the share of transport emissions viewed as a technical process was larger, averaging 16% during the same period and maxing out at 22.4% in 2023. This underlines the difference between the two accounting methods, as the breakdown by economic activities reassigns transport processes to businesses in other sectors using their own fleets. In absolute terms, emissions from transportation and storage rose by 13.7% to 7.5 MtCO2-eq in 2023 compared to 2008, driven by expanding vehicle fleets and a slower uptake of e-mobility compared to other EU peers. In 2023, land transport accounted for 93.8% of these emissions, followed by air transport at 2.9%, water transport at 1.7%, warehousing and support activities for transportation at 1%, and postal and courier services at 0.6%.

The agriculture, forestry and fishing sector accounted for an average of 10% of total emissions between 2008 and 2023, increasing from 6.1% in 2008 to 13.9% in 2023. In absolute terms, emissions from the sector rose by 55.9% over this period, reaching 6.4 MtCO2-eq in 2023 and marking the largest increase across major sectors. Most of this growth occurred between 2008 and 2015, when emissions surged by 43%, followed by a slower 6.7% rise through 2023. This contrasts sharply with the pre-2008 period, when widespread land abandonment, lower fertiliser use, and declining livestock numbers during the transition to a market economy drove a significant reduction in agricultural emissions, as reflected in GHG inventories by technical process. In 2023, crop and animal production made up 99% of all emissions from the sector.

Water supply, sewerage, waste management and remediation activities accounted for an average of 5.7% of total emissions during the period. Emissions from this sector declined by 16% between 2008 and 2023, reaching just under 3 MtCO2-eq. The first half of the period saw a modest 5.1% reduction from 2008 to 2015, followed by a sharper 19.1% drop between 2015 and 2022. This decline reflects the impact of major modernisation achievements in sewerage, waste management and remediation, which together made up 83.2% of emissions in this sector in 2023.

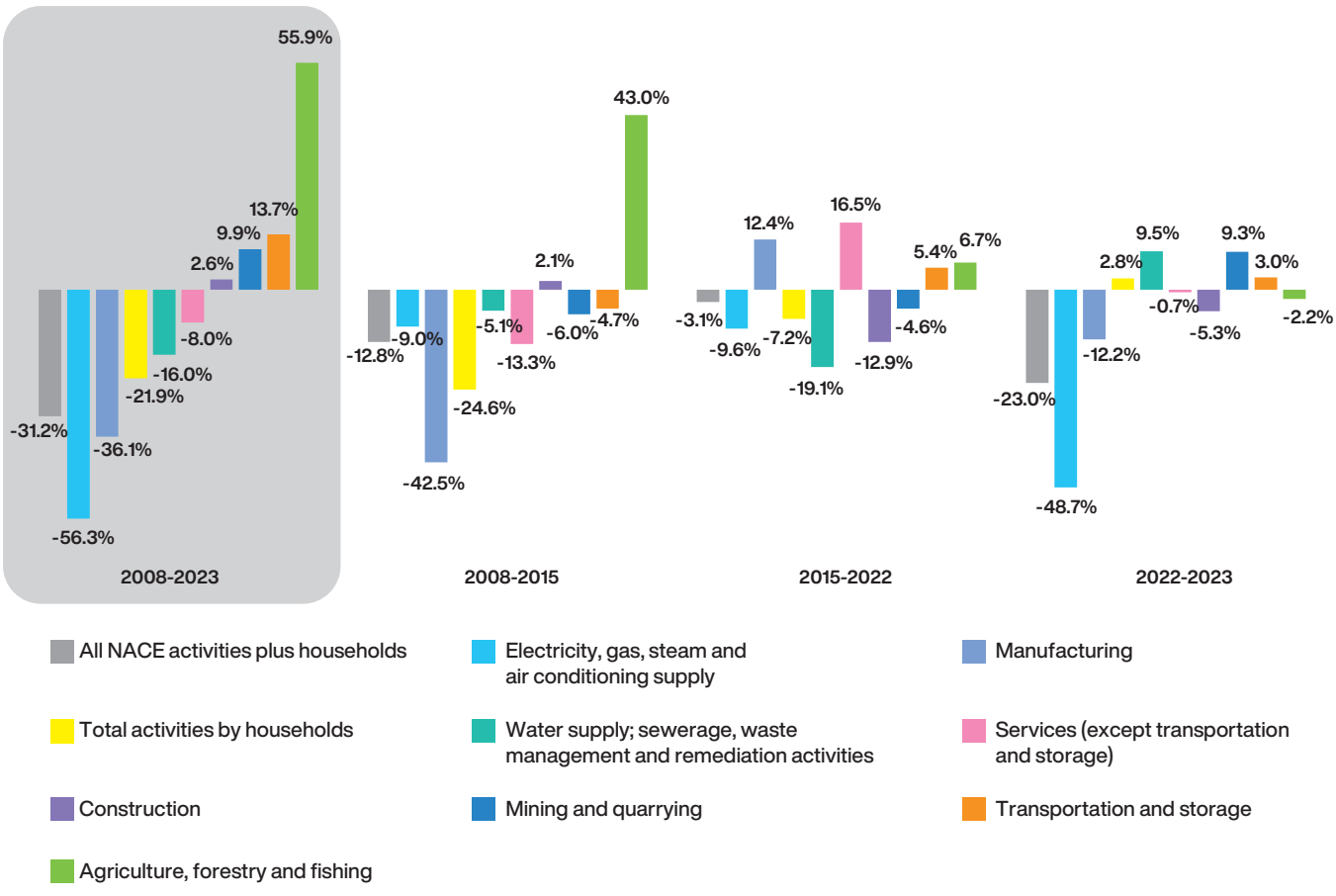
Unlike the manufacturing sector, mining and quarrying were a smaller source of industrial emissions, accounting for an average of 2.7% of all Bulgarian GHG emissions between 2008 and 2023 and rising from 2.4% at the beginning of the period to 3.9% in 2023. In absolute terms, the sector's emissions grew by 9.9% since 2008, reaching 1.8 MtCO2-eq in 2023 and reflecting its hard-to-abate nature. Emissions declined moderately by 6% between 2008 and 2015 and by 4.6% between 2015 and 2022, due to efficiency improvements, lower extraction volumes, and compliance with EU environmental standards. However, these spiked up by 9.3% between 2022 and 2023 and by 38.6% between 2020 and 2023, likely driven by intensified coal extraction during the post-pandemic recovery and the energy security crisis following Russia's invasion of Ukraine. According to Bulgaria's latest update to the NECP, coal is to be phased out by 2038 at the latest, in line with the Recovery and Resilience Plan (RRP) and the Territorial Just Transition Plan (TJTP). This transition is expected to cut emissions in both the energy and mining sectors as coal extraction and coal-fired power generation are gradually replaced with cleaner energy sources.

The services sector, excluding transportation and storage, accounted for an average of 2.1% of total GHG emissions between 2008 and 2023, with emissions declining by 8% to 1.2 MtCO2-eq in 2023 compared to 2008. However, the share of total service-generated emissions marginally increased over the period to 2.7%, as aggregate emissions declined more rapidly. Within the sector, wholesale and retail trade generated the majority of emissions, representing 59.5% in 2023, while all other subsectors contributed single-digit shares or less.

The construction sector accounted for an average of just 0.9% of total emissions between 2008 and 2023. Over this period, its emissions increased by 2.6% to slightly over 0.5 MtCO2-eq, with its share of total emissions rising from 0.8% in 2008 to 1.2% in 2023. While the construction sector remains a small contributor to GHG emissions, buildings account for a significant portion of energy-related emissions, making efficiency measures in construction crucial for overall decarbonisation.

Household activities claimed an average share of 6.6% in total emissions over the period, falling by 21.9% to 3.5 MtCO2-eq in 2023 compared to 2008. Of the household emissions generated in 2023, 64.6% were related to transport activities and 27.7% to energy-related activities through heating and cooling.

Fig 10. Changes in GHG emissions by economic activity



REZOLV ENERGY

More and more small companies are looking at PPAs to manage their energy costs and meet their sustainability goals

Gergana Sazlaykova
Rezolv Energy's Country Manager in Bulgaria

Rezolv Energy is one of the largest independent renewable energy producers in Central and Eastern Europe, with a 2.3 gigawatt (GW) portfolio of onshore wind farms and solar parks in Romania and Bulgaria.

One of these projects is 'St. George' in Silistra, northeastern Bulgaria, where Rezolv is transforming a decommissioned airfield into a 225-megawatt (MW) solar plant.

Last year, Rezolv signed a long-term Virtual Power Purchase Agreement (VPPA) with Ardagh Glass Packaging-Europe for power from your St. George solar park. How significant a deal was that for Rezolv?

Rezolv has signed six VPPAs so far, and the Ardagh deal was the largest –110 gigawatt-hours per year for 12 years. To put that in context, St. George will be one of Bulgaria's largest solar parks once it comes onstream at the beginning of 2026, and Ardagh will take almost a third of the capacity. It is one of the biggest PPAs signed anywhere in Southeastern Europe.

More importantly, it was also a very significant deal for Bulgaria.

First, it enabled us to move quickly into the construction phase at St. George, a project which has created 200 direct jobs and will have a major impact on Bulgaria's energy transition.

Second, it demonstrated that foreign investment into decarbonising Bulgaria's energy system can be secured even from companies that do not have operations here. It was a landmark deal in that sense.

Why did Ardagh choose to invest in Bulgaria?

Ardagh had already secured a supply of wind power in Sweden, so were looking for a major solar PPA to complement it. Bulgaria was a compelling proposition for the same reason it originally appealed to Rezolv – because it was an opportunity to make a real impact.

Bulgaria has made enormous progress on solar power over the last couple of years, to the point where the share of solar power in the energy mix is now above the EU average. That's great news, but there's still a long way to go, and St. George is the kind of large-scale project that will move things forward very substantially.

Many companies are looking for a balanced mix of wind and solar power. Can Rezolv offer PPAs that combine both?

Yes. We don't have a wind project in Bulgaria, but we have more than 1GW of wind power in Romania – and a hybrid PPA encompassing solar power from St. George and wind power from one of our Romanian wind farms is definitely an option.

Having both wind and solar in our portfolio is a big advantage. We are one of very few renewables developers in the region that can offer hybrid PPAs.

Are PPAs an option for smaller companies as well?

Absolutely. PPAs do not have to be big-volume deals – nor do they necessarily need to be 10+-year deals. More and more small companies are looking at PPAs as a way to manage their energy costs and meet their sustainability goals – just like the large corporates.

In due course, I also expect to see aggregated PPAs in Bulgaria, where several smaller companies join together to buy renewable electricity as a group. That's a pretty new model, particularly outside Western Europe and the U.S., but I'm sure we will see the first aggregated PPA in Bulgaria before too long.

Does the regulatory environment support the development of the PPA market?

PPAs are being signed in Bulgaria, so the regulatory environment is not a major barrier, but it was good to see the provisions aimed at facilitating PPAs in the draft amendment to the Renewable Energy Sources Act. The government should be applauded for prioritising this.

Another important step concerns the Association of Issuing Bodies (AIB), the European organisation set up to enable Guarantees of Origin (GOs) for electricity to be transferrable across Europe. GOs prove to a final customer that the energy they are buying was produced from renewable sources and they are a critical component of corporate PPAs. Bulgaria's Sustainable Energy Development Agency (SEDA) is a member of the AIB and is in the final stages of connecting to the AIB Hub. Once that happens, Bulgaria will be able to issue GOs and transfer them across borders within the EU. It will accelerate the PPA market here, so the sooner that happens, the better.

rezolv.energy

Sectoral analysis

EU ETS and ESR sectors

To understand Bulgaria's decarbonisation progress, the national emissions profile must be viewed through the two-pillar policy framework of the EU, consisting of the main emissions curbing market mechanisms - the Emissions Trading System (EU ETS) and the Effort Sharing Regulation (ESR).

Launched in 2005, the EU ETS is the world's first carbon market. Based on a cap-and-trade principle, it requires polluters to pay for their GHG emissions, featuring carbon dioxide, nitrous oxide and perfluorocarbons. To reduce overall EU emissions while generating revenues to finance the green transition, **the mechanism sets an EU-wide cap on emissions from electricity and heat generation, energy-intensive industries such as cement, steel, refineries, chemicals, glass and paper, intra-EU aviation and, since 2024, maritime transport**. Together, the activities under the **EU ETS scope account for 34% of the total GHG emissions in the EU**, according to the European Environment Agency. The cap is expressed in emission allowances, with one allowance giving the right to emit one tonne of CO2-eq. This cap on the total amount of GHG that can be emitted by installations and operators covered under the EU ETS scope is reduced annually in line with the EU climate target to keep emissions decreasing over time. As a result, EU **emissions from power and industry plants fell by 47% in 2023 compared to 2005 levels**. In order to achieve the **target of bringing emissions down by 62% in 2030 compared to 2005 levels**, the ETS Directive was updated in 2023 to step up the effort by doubling the 2.2% **reduction factor to 4.3% per year over 2024-2027 and to 4.4% from 2028**.

In contrast, the **ESR sets binding national reduction targets for each member state, expressed as percentage reductions in the remaining 66% non-ETS emissions by 2030 compared to 2005 for all other sectors**, including road transport, buildings, agriculture, waste and smaller, less energy-intensive industrial plants. In these sectors, decarbonisation relies almost entirely on the successful design and implementation of national policies. In force since 2018 and amended in 2023, the **ESR Regulation aims for an emission reduction of 40% compared to 2005 levels at the EU level**. Benefitting from the differentiated ESR targets, which reflect the different capacities of Member States to take action according to their GDP per capita, **Bulgaria has been the EU Member State with the lowest ESR target both before the 2023 amendment, when it was the only country with a zero-reduction target, and after it, with its new target of 10%**.

Fig 11. Share of ETS and ESR in total

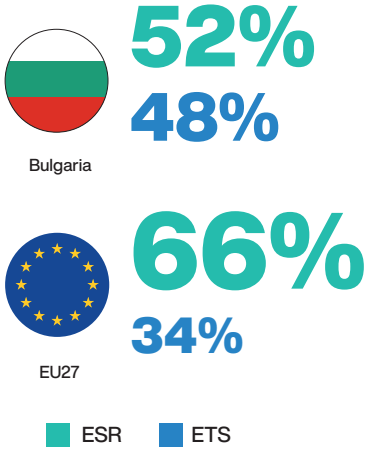
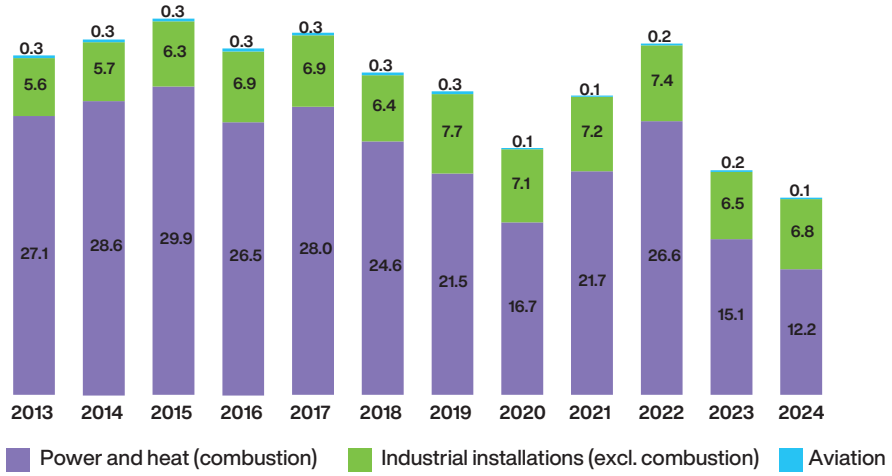


Fig 12. Bulgaria's Verified ETS emissions (MtCO2-eq)



Source: Eurostat, EEA

The structure of the Bulgarian economy differs significantly from the EU average from an EU ETS versus ESR perspective. Due to the legacy of its industrial and energy base, **48% of the country's entire GHG footprint falls under the EU ETS scope, with 52% covered by ESR**. This far **more ETS-heavy profile than the EU average** makes Bulgaria's economy exceptionally exposed to the ETS carbon price and the performance of its largest industrial assets.

The trajectory of Bulgaria's ETS-regulated emissions, tracked from 2013 to 2024, reveals a two-faced story. The dominant component - **Power and heat (combustion), accounted for the bulk of the country's ETS emissions throughout the analysed decade**. After peaking at 29.9 MtCO2eq in 2015, it remained highly volatile but consistently high ever since, until its slump in 2023. **Verified ETS emissions from power and heat generation collapsed by 42% y/y to 15.1 MtCO2-eq, a trend that continued into 2024 with a further drop to 12.2 MtCO2-eq.** The abrupt contraction of coal-fired power generation, driven by market forces and carbon pricing, not only affected ETS and sectoral emissions structure, but is the primary reason for the sharp decline in the overall GHG emissions of the Bulgarian economy since 2022.

Conversely, **the second largest ETS pillar, Industrial installations excluding combustion, has remained remarkably static over the years in terms of the amount of GHG emissions**. The sector, representing industries like cement and chemicals, characterised by a persistently high GHG footprint, saw its **emissions confined in the narrow range between 5.6 MtCO2eq in the beginning of the period under consideration and the 7.7 MtCO2eq peak in 2019**. Encouragingly, the two recent decreases of emissions - in 2020 and 2023 - also affected Industrial installations, although to a lesser extent than the energy sector, and brought the **sector's GHG output down to 6.8 MtCO2eq in 2024**.

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Energy

Renewables as an enabler of decarbonisation of Bulgaria's energy sector

Bulgaria's updated National Energy and Climate Plan (NECP), submitted to the European Commission in early 2025, outlines higher renewable energy ambitions in line with the EU's 2030 climate and energy goals. **The country now targets 34.96% renewables in gross final energy consumption by 2030, up from 27.09% in its 2019 plan, and aims for 49.34% renewables in gross final electricity consumption.**

In 2023, renewables made up 22.6% of Bulgaria's gross final energy consumption, up from 19.0% in 2022 but still below the 23.3% seen in 2020. Renewable electricity rose more sharply, reaching a share of 29.43% in 2023, up from 20.08% in 2022 and the previous high of 23.59% in 2020.

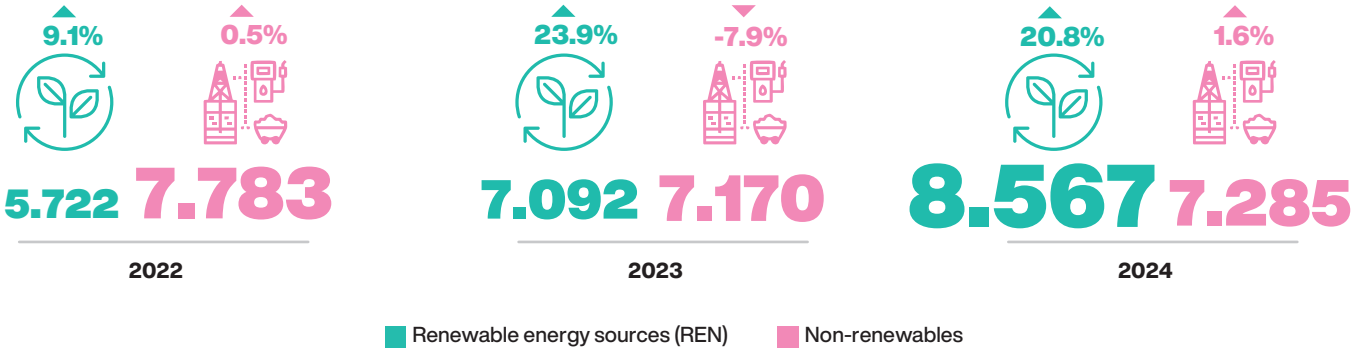
The NECP 2030 electricity target is expected to be achieved through the addition of up to 7.160 GW of renewable generation capacity after 2022, including 5.050 GW of photovoltaic capacity and 1.280 GW of onshore wind. The forecast in the document also includes 500 MW of installed offshore wind capacity in 2030, although this timeline appears optimistic given the lack of a regulatory framework. Solar, by contrast, is expanding faster than the plan's projections.

22.60%
Share of Renewables in gross final energy consumption (2023)

34.96%
Target share of renewables in gross final energy consumption (2030)

Source: NECP, Eurostat

Fig 13. Installed power generation capacity in Bulgaria (GW)



Source: Elektroenergien Sistemen Operator

Bulgaria's generation capacity is undergoing a structural transformation as renewables overtook non-renewable capacity in 2024, reaching 8.567 GW - about 54% of the total installed mix - after increasing by more than 20% in both 2023 and 2024, driven by a solar boom. Within the 2024 renewables mix, solar accounted for 4.568 GW, followed by hydro (3.211 GW), wind (711 MW) and biomass (77 MW).

Installed photovoltaic capacity grew at rapid annual rates of 38.5%, 79.1% and 47.7% over the past three years, surging from 1.246 GW in 2021 and becoming the main source of new power capacity. With a 28.8% share in the installed mix, it is now the leading technology, ahead of lignite (26.0%), hydro (20.3%) and nuclear (12.6%).
Wind energy, however, has made no gains in recent years, with installed capacity remaining just above 700 MW, constrained by administrative barriers and public opposition and misinformation.

While solar power production has also risen sharply in recent years, its share in total electricity generation remains relatively modest, at 8.3% in 2024, up from 3.1% in 2021. Electricity generation continues to be dominated by nuclear and thermal power, which together supplied close to 80% of Bulgaria's output in 2024 - 40.2% from nuclear and 39.2% from thermal sources.

Solar's rapid expansion and the gap between renewable capacity and its contribution to power output underscore the importance of complementary investments in flexibility and storage to ensure that capacity additions translate into efficient generation. According to electricity system operator ESO's data, battery energy storage entered the installed mix in 2024 with 86 MW. Significant expansion in this sector, however, is in the offing after in April 2025 a call under Bulgaria's National Recovery and Resilience Plan (NRRP) awarded 9.713 GWh across 82 energy storage projects, set for commissioning in 2026. An expansion of this RESTORE programme has been launched to back a further 1.9 GW of energy storage systems.

SUNGROW
Clean power for all

Sungrow: Storing the power of tomorrow

Founded more than 28 years ago, Sungrow is a global leader in renewable energy solutions with over 870 GW of power electronic converters installed worldwide. The company operates two R&D centres in Munich and Amsterdam, along with more than 520 service outlets globally. With a strong presence in Europe and a growing local team in Bulgaria, Sungrow continues to drive innovation in solar inverters, battery storage and EV charging systems, bringing the energy of tomorrow closer to reality.

The global race toward decarbonisation is redefining how energy systems are designed and managed. Flexibility, reliability and innovation have become key drivers of this transformation. Sungrow, a long-established provider of renewable energy technologies, supports this shift with advanced inverter and storage solutions that help Europe - and Southeast Europe in particular - develop a stable and efficient clean power infrastructure.

Turning intermittency into opportunity

Solar and wind power have transformed how energy is produced - but they also pose new challenges for grid operators as their intermittent nature makes generation less predictable, requiring smarter systems to maintain grid balance and reliability. In this context, battery energy storage systems (BESS) have evolved from a “nice-to-have” to a crucial enabler of the clean energy transition. By storing surplus electricity when renewable generation is high and releasing it during periods of peak demand, BESS ensure a more efficient balance between supply and consumption. They play a key role in strengthening grid stability, providing essential frequency and voltage regulation to prevent power outages and support the integration of variable renewable sources such as wind and solar. Moreover, battery storage reduces energy waste by limiting curtailment and ensuring that clean power is fully utilised rather than lost. Beyond their technical functions, BESS also deliver significant economic value - enabling price arbitrage, lowering peak electricity costs and opening new revenue streams through participation in grid services and flexibility markets. With European capacity set to quadruple by 2028, energy storage now stands as the backbone of a reliable, efficient and sustainable power system.

As renewable penetration rises, the need for smarter, safer and more flexible energy systems becomes critical. Sungrow tackles these challenges through technologies that make renewable generation more predictable and cost-effective. Its flagship PowerTitan 2.0, a liquid-cooled energy storage platform, allows utilities and developers to balance generation and consumption seamlessly, combining high performance with compact design and stringent safety standards. With high energy density, easy deployment and advanced safety features, PowerTitan 2.0 showcases Sungrow’s innovation in large-scale renewable integration and grid flexibility.

Commitment to safety, innovation and trust

As energy storage expands, safety and reliability remain paramount. Sungrow has been investing heavily in innovations – with advanced fire suppression, intelligent liquid-cooling technology and rigorous testing - setting new industry standards. This approach undoubtedly contributes to reduced failure incidents, which dropped by 97% globally as reported by EPRI for the period 2018-2023. At the same time Sungrow is the first BESS manufacturer that completed succesfully larger scale burn tests, proving the effectivnes of its designs.

Innovation is embedded in Sungrow’s DNA. With 19 years of experience in Energy Storage Systems, and 40% of its workforce in R&D, the company invested USD 444 million in innovation in 2024 to ensure continuous improvement. Recognised as the world’s most bankable company for PV Inverters, ESS and power conversion systems (PCS) by BloombergNEF (2024), Sungrow also achieved an AAA ESG rating from Morgan Stanley Capital International (MSCI) for 2025, the highest possible grade, reaffirming its position as a trusted global leader in safe and sustainable clean energy technologies.

A growing footprint in Bulgaria

In Southeast Europe, Sungrow is investing heavily in projects that strengthen national grids and accelerate the regional energy transition. In Bulgaria, several large-scale hybrid and storage installations are underway, representing more than 3.4 GWh of capacity—among the most significant in Europe. Partnering with leading renewable energy companies such as SUNOTEC and Sunterra RE, Sungrow’s technologies are being deployed to connect solar generation with advanced storage, stabilising costs and enhancing grid resilience.

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These projects are not just technical milestones - they are strategic steps toward energy independence and security for Bulgaria and the wider region.

Sungrow's presence extends beyond Bulgaria, reflecting its leadership in Europe's green energy transition. Sungrow delivers advanced renewable projects across the continent. In Southeast Europe, its teams in Greece and Bulgaria counts more than 40 experts, providing local expertise and full-service support for solar, storage and EV charging solutions, ensuring every project is innovative, efficient, and built for long-term reliability.

Interview

Dimitris Galanos
Regional Manager for Southeastern Europe at Sungrow

Dimitris Galanos is the Regional Manager for Southeastern Europe at Sungrow, a global leader in renewable energy solutions. With a Ph.D. in Environmental Design and Energy Efficiency and more than a decade of experience in B2B and EPC sales, he has played a pivotal role in expanding Sungrow' s presence across Greece, Cyprus and the wider SEE region.

What initiatives is Sungrow undertaking to advance the decarbonisation of its operations?

At Sungrow, we truly believe that meaningful decarbonisation starts from within. We've committed to using 100% renewable electricity across all operations by 2028 as part of the RE100 initiative — and we're already more than 70% there. Our factories are improving energy efficiency under the ISO 50001 and EP100 frameworks, while we're also integrating digital energy management and low-carbon materials into production. Ultimately, we want to lead by example and minimise our environmental footprint, proving that clean energy can power not only our products, but also the way we operate every day.

With Sungrow committed to carbon neutrality and targeting 100% renewable electricity in its production by 2028, how is it approaching Scope 3 emissions across its broader supply chain?

Addressing Scope 3 emissions is essential to Sungrow's carbon-neutrality journey for all regions. So, in the SEE region as well, we work closely with our suppliers through an ESG Code of Conduct that promotes renewable energy use, transparent reporting, and ISO 14001 certification. ESG audits and efforts to use low-carbon innovation in materials and logistics are ongoing, while by using product carbon footprint assessments and digital monitoring tools, upstream emissions can be identified and reduced. For Southeastern Europe as well, this means partnering with local suppliers to expand green sourcing, creating a truly low-carbon ecosystem across our entire value chain.

Sungrow's PowerTitan 2.0 and advanced PV inverters will be deployed in Bulgaria. What technological advantages do these solutions bring to local developers and grid operators – particularly in terms of efficiency, safety and reliability?

PowerTitan 2.0 represents the next generation of energy storage technology — combining liquid-cooled thermal management, modular architecture, and grid-forming capabilities. For developers in Bulgaria, this means higher system efficiency, reduced operating costs, and faster project delivery. For grid operators, PowerTitan 2.0 provides advanced frequency and voltage support, improving grid stability as renewable penetration rises. At the same time, our PV inverters reach up to 99% efficiency, rapid response, and enhanced safety protections, making them ideal for the region's evolving energy landscape. In Southeastern Europe, where reliability and flexibility are key, these solutions help integrate more renewables while maintaining safety, performance, and long-term project value.

Safety is a critical factor in large-scale energy storage, with ERPI research pointing to a 97% reduction in BESS failure incidents for 2018-2023. What are the main innovations and safety standards of Sungrow, and how do they ensure reliability in Bulgaria?

Safety is at the core of Sungrow's design philosophy and we are very proud to retain a zero fire incident in our ESS record. The reported 97% reduction in failure incidents is truly remarkable. Sungrow constantly invests in major innovations such as liquid-cooled battery technology, multi-layer protection systems, and real-time fault diagnostics, towards failure minimisation. Each module integrates cell-level temperature and voltage monitoring, redundant protection circuits, and intelligent shutdown protocols. All products comply with safety standards - IEC 62619 and UL 9540A, verified through rigorous testing and third-party certification. In Bulgaria's climate, these systems ensure stable operation across temperature extremes and grid conditions. For developers and operators, that translates into bankable reliability, minimised downtime, and safer large-scale storage assets that strengthen the national grid and accelerate the transition to clean power.

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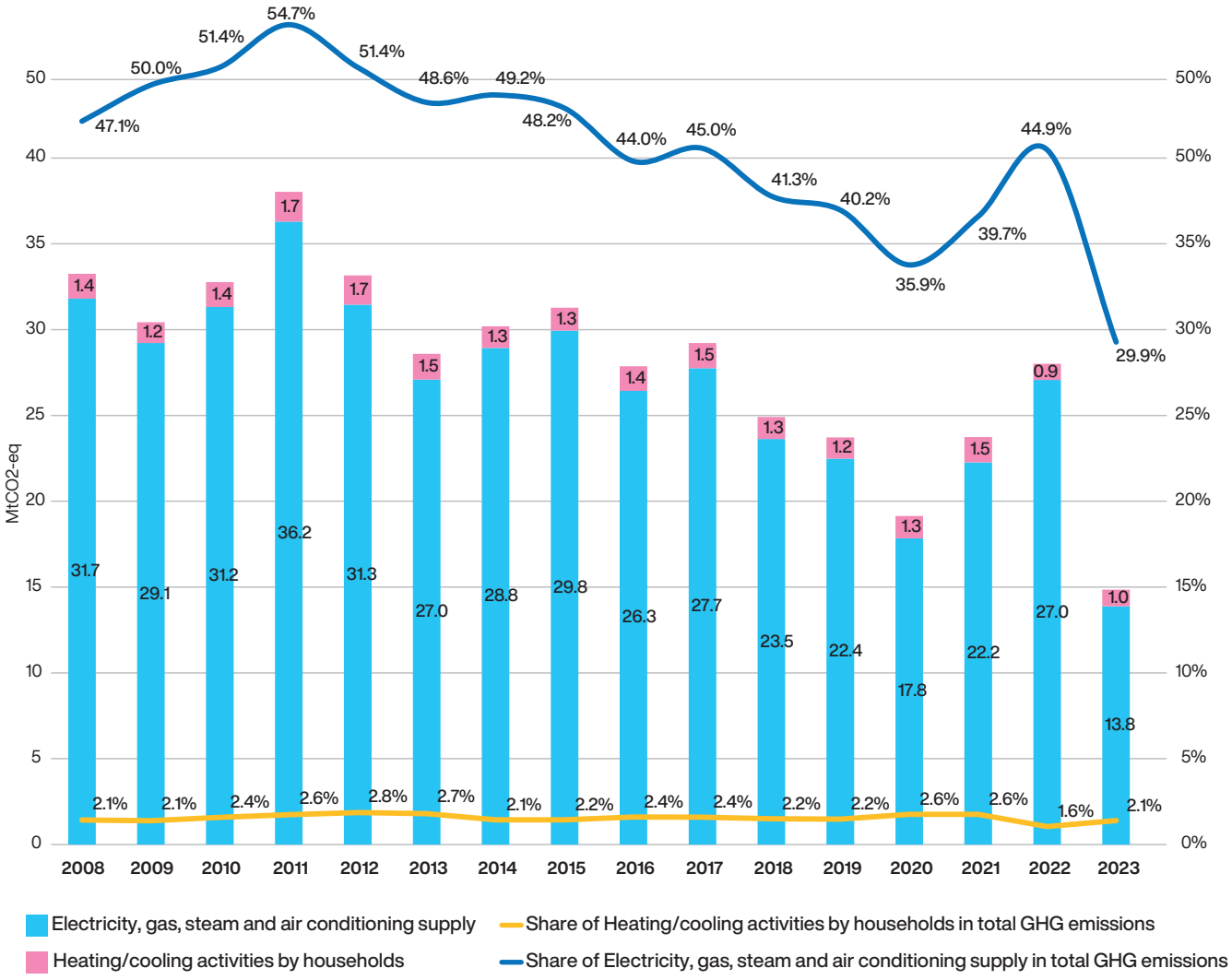
Greenhouse gas emissions of the energy sector

Fig 14 GHG emissions in the energy sector



Source: Eurostat, EEA

Bulgaria's energy sector, consisting of electricity, gas, steam and air conditioning supply, has historically been the dominant source of greenhouse gas emissions, shaping the pace of overall decarbonisation. Between 2008 and 2022, this single sector was consistently responsible for between 36% and 55% of the country's total GHG output. Emissions from power and heat generation have shown significant volatility throughout the period, reflecting economic shifts and energy demand. After peaking at 36.2 MtCO2-eq in 2011, GHG emissions fluctuated, especially immediately prior to and after the 2020 pandemic-related dip. Recovery in economic activity, coupled with the effects of the war in Ukraine, as Bulgaria ramped up lignite-fired power generation to offset the loss of Russian gas imports, resulted in a sharp rebound and a secondary peak of 27.0 MtCO2-eq in 2022.

However, come 2023 and the trend was shattered again. The energy sector's GHG emissions plummeted by nearly 50% year-on-year to a record low of 13.8 MtCO2-eq. This unprecedented drop fundamentally shifted Bulgaria's emissions profile, with the power sector's share of total national GHG emissions narrowing to just 29.9% from 44.9% in 2022. By contrast, heating and cooling activities in households contributed a relatively small and stable share of around 2% of the total emissions in the economy, but remain emblematic of Bulgaria's slow progress on energy efficiency retrofits and fuel-switching in residential heating. The reason behind the seemingly sudden cut of GHG emissions by the energy sector in 2023 lies in the notable shift towards renewable energy sources in the energy mix.

Energy efficiency of Bulgaria's economy

The energy efficiency of the Bulgarian economy is assessed from a macroeconomic perspective through the lens of the energy productivity metric. It is defined by the European Commission and Eurostat as the amount of economic output that is produced per unit of gross available energy and is part of the EU Sustainable Development Goals (SDG) indicator set used to monitor progress towards SDG 7 on affordable and clean energy and SDG 12 on ensuring sustainable consumption and production patterns.

Fig 15. Energy productivity (EUR/kgoe)

Source: Eurostat

Bulgaria's energy productivity indicator has consistently improved and increased by 52% over the 2008 – 2023 **period to reach EUR 2.94 per kilogramme of oil equivalent (kgoe). Despite the significant progress, Bulgaria still remains** at **rock bottom within the EU as of 2023**, with its energy productivity reaching only 65% of the level of the next least energy-productive EU Member State economy – Malta, and 30% of the EU average. Convergence with the rest of the EU has been extremely slow, with Bulgaria's energy productivity metric gaining only 2 pp on the EU level over a period of 15 years. Furthermore, the country even trails behind many non-EU SEE economies in terms of energy productivity, including Albania, Montenegro and North Macedonia.

The rising energy productivity of the Bulgarian economy is a testament to progress in the decoupling of economic growth from energy consumption. However, while the metric is useful for analysing energy efficiency in the macroeconomic sense, it is not a pure measure of energy efficiency as a technical concept. Hence, it should be taken into consideration that a large part of the increase in the energy productivity of the Bulgarian economy can be attributed to a reason that has nothing to do with technical efficiency - the structural shift from heavy, energy-intensive industry based on burning fossil fuels to cleaner energy sources and a more service-oriented economy. **Thus, while not necessarily due to true technical efficiency gains, but rather driven by a transition away from fossil fuels, Bulgaria's economy enjoys rising energy productivity at an accelerating rate, with half of the progress since 2008 having happened in the last five years.**

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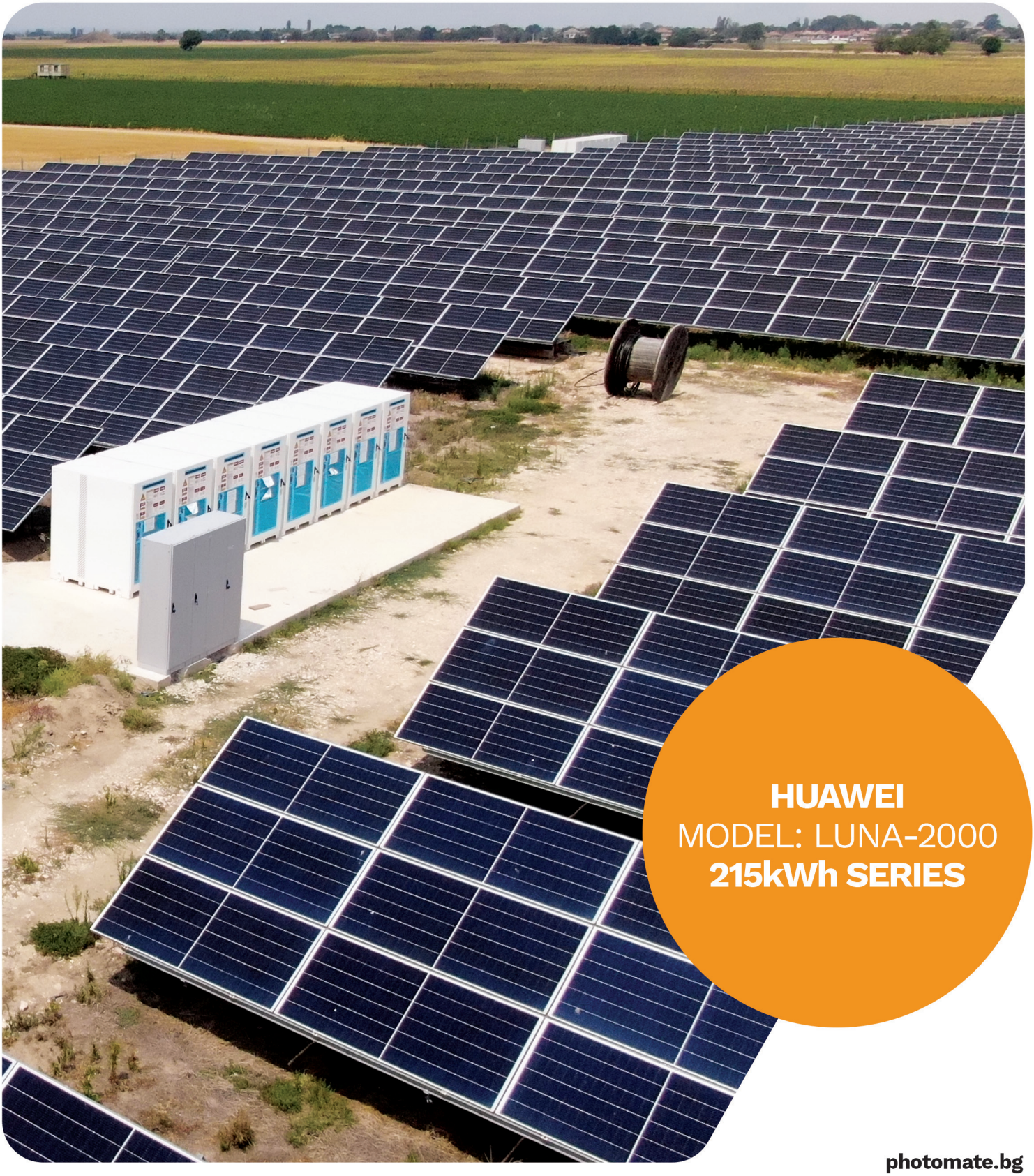

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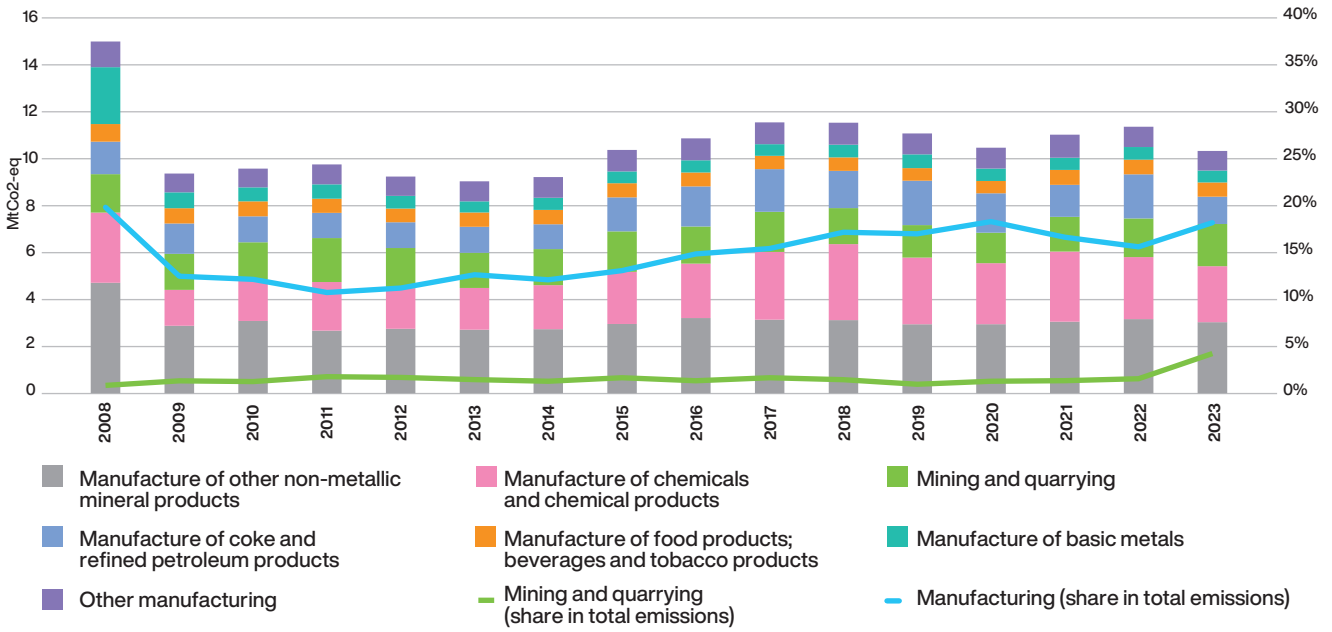
As a Huawei VAP (Value added partner), we offer an extensive portfolio that includes Huawei FusionSolar inverters and storage systems for residential, commercial and utility markets. This portfolio is further complemented by EV chargers, heat pumps, an energy management system (EMS) and services related to consumption analysis.

Industry

The industrial sector, encompassing all manufacturing and mining activities but excluding energy production, stands as the second-largest source of GHG emissions in Bulgaria. Its emissions trajectory between 2008 and 2023 reveals a sector vulnerable to economic shocks, structural decline in some legacy areas and persistent hard-to-abate emissions in others.

Fig 16. Industry emissions (MtCO2-eq) and share in total emissions (%)



Source: Eurostat, EEA

While in the base year 2008, the combined emissions from manufacturing and mining and quarrying stood at 15 MtCO2eq, by 2023 they shrank to 10.3 MtCO2-eq. However, the full story behind the impressive **31% decrease** is far from one of a sustainable and uniform reduction of emissions over the 15-year period. Mining and manufacturing emissions were reset permanently at the very beginning of the analysed period, which coincided with Bulgaria hitting the bottom of the global financial crisis in 2009 and the decommissioning of the Sofia steel plant, which alone generated almost 2.0 MtCO2-eq of emissions. To a lesser extent, Bulgaria's EU accession in 2007 and the country's eligibility to regulations like the allocation of emission allowances and the required integration of green energy sources into the national energy mix also played a role in the emission reduction during the period, especially in the long term, preventing GHG emissions from returning even close to pre-2008 levels. **Within a single year, total industrial emissions collapsed by over 37% to 9.4 MtCO2-eq. Since 2009, however, annual industrial GHG emissions remained within the 9 – 12 MtCO2-eq interval with slight upward movement.** The long-term trend was briefly interrupted by the demand shock caused by the Covid-19 pandemic in 2020, followed by another rise until **the 9.6% y/y contraction in 2023 brought the aggregate GHG emissions of the sector to their lowest level since 2014. The 2023 reduction was primarily driven by emissions in Manufacture of coke and refined petroleum products plummeting by more than a third to 1.2 MtCO2-eq from 1.9 MtCO2-eq.**

In absolute terms, the industrial sector's GHG emissions profile has been dominated by a few key heavy industries with often divergent paths. **The largest polluter is the Manufacture of other non-metallic mineral products, primarily cement and glass**, which was responsible for 4.7 MtCO2eq, or nearly a third of all industrial GHG emissions in Bulgaria in 2008. **It is also the sub-sector with the largest decarbonisation progress during the 2008-2023 period, reaching annual emission levels as low as 3.0 MtCO2-eq**, if we don't count Manufacture of basic metals, whose emissions decreased five times compared to the base year, due to the one-off event of closing the steel plant near the capital Sofia in 2009. **The second pillar of industrial GHG emissions in Bulgaria is Manufacture of chemicals and chemical products**, a sector defined by intense volatility throughout the period. **It also reported sound decarbonisation progress during the period, reducing its GHG emissions to 2.4 MtCO2eq in 2023 from 3.0 MtCO2eq in 2008**. Similarly, there was a sharp fall amounting to a halving in the first year of the period, but unlike in the previous segments, emissions recovered and by 2018 exceeded their base year level. They have moderated once again since this peak, declining uniformly by around 10% annually during the last five years, except 2020. Among the remaining industrial sub-sectors, Manufacture of coke and refined petroleum products is worth a separate mention. Due to the lack of diversification and Bulgaria's reliance on raw material imports, its output is tightly linked to energy market fluctuations. As thse became frequent since 2020, the volatility in emissions in the subsector increased accordingly. **In stark contrast to the energy sector, which saw its emissions cut in half in a single year in 2023, Bulgaria's industrial sector demonstrated significant inertia. Total manufacturing emissions fell only modestly, to 8.5 MtCO2eq in 2023 from 9.7 MtCO2eq a year ago, while mining emissions even increased over the last year.** Thus, with the power sector's sudden progress in decarbonisation, industry's share of the national challenge ballooned, with its share in the aggregate GHG emissions jumping by 3.4 pp to 22.3% within a year, exactly matching its starting point 15 years ago.

Aurubis

Aurubis Bulgaria drives decarbonisation through cleaner power, smarter systems

Aurubis Bulgaria is part of Aurubis AG, one of Europe's leading copper producers and a major contributor to the Bulgarian economy. The company ranks as the largest industrial taxpayer in the country and generates around 7.5% of national exports. With more than 1,000 employees and about 2,500 indirect jobs, Aurubis Bulgaria holds a key position in the local industry. In 2025, it completed the largest plant modernisation in three decades and continues to invest in capacity expansion, decarbonisation through solar power and high-efficiency technologies, and sustainable infrastructure development as part of its long-term "Investment for Progress: Bulgaria 2027" program.

Eng. Martin Katinov, Energy Projects Manager with over 10 years of experience. He leads projects in renewables, electrification, and battery storage, supporting the company's long-term strategy to reduce carbon emissions. He holds a Master's degree in Electronics Engineering from the Technical University of Sofia and an MBA from the New Bulgarian University.

What are the main pillars of your decarbonisation strategy, and how do you prioritise between own-generation, process improvements, and technological innovation?

At Aurubis Bulgaria, decarbonisation is part of our everyday work. It is not a separate project, but a direction that defines how we plan and operate. Our strategy is built on three main pillars: renewable energy generation, process efficiency and technological innovation.

We have already built three PV plants with a total installed capacity of 23 MWp. Another 18 MWp will be under construction next year. We are also looking into waste heat recovery solutions. These projects not only reduce our indirect footprint, but also make our energy supply more predictable.

Process efficiency is equally important. By optimising how we use energy, we lower both our costs and our footprint. Since 2016, we have deployed a steam turbine for the utilisation of waste heat. Currently, we are working on a project for heat recovery in our sulfuric acid plant that could cover around 15% of our needs.

Technological innovation is the third and long-term pillar. We are exploring battery energy storage systems and AI-based energy management solutions.

Regarding prioritisation, we take a balanced approach, evaluating the impact, feasibility, and return on investment of each project. Renewable projects depend largely on local conditions and infrastructure, while process improvements are often implemented first because they bring quick and measurable results. We prioritise process improvements for their quick implementation and high efficiency returns.

By balancing these pillars strategically, we ensure that our decarbonization efforts are both ambitious and achievable.

As Aurubis Bulgaria expands its renewable capacity, what share of the plant's electricity demand will these sources cover, and how will that affect the overall carbon footprint?

All PV Plants will cover about 16% of our consumption and reduce our carbon footprint by 25,000 t of CO_2 emissions, compared to the 2018 baseline.

Aurubis

Eng. Petko Ivanov, Utilities Manager since 2016, oversees energy resources and drives projects improving efficiency and optimisation, reducing carbon emissions across operations. He graduated from the University of Mining and Geology "St. Ivan Rilski" in Mining Electromechanics and previously served as Chief Power Engineer at Dundee Precious Metals.

From a utilities perspective, what are the main sources of emissions, and how do you manage energy resources to boost efficiency sustainably?

The fuels such as fuel oil, gas oil and natural gas, as well as electricity and copper concentrates, which act as process fuel. Managing these efficiently is central to reducing our footprint.

One of the key measures is the replacement of fuel oil and gas oil with natural gas in the boiler plant, anode production and the preheaters in the sulphuric acid plant. The system has been in test operations since February 2025 and delivers annual savings of around 4,700 tonnes of CO_2.

We also track the carbon intensity of purchased electricity, which has decreased steadily over the past three years - from 0.53 t CO_2/MWh in 2022, to 0.31 in 2024.

Aurubis Bulgaria is certified under ISO 50001. This means we monitor the electricity and fuel consumption of all users above 100 kW through the "Grafana" system. It provides both real-time data and detailed analytics. If we detect deviations from the energy baselines, the Production and Maintenance teams review the causes together and take corrective measures.

What are the main challenges in reducing the carbon footprint within day-to-day industrial operations and which technologies do you see as most important in Aurubis' decarbonisation journey?

The biggest challenge for heavy industry is to cut emissions without compromising production efficiency. This balance requires constant optimisation and new technology. For us, the most important tools in this process are renewables and the utilisation of waste heat. Together they form a solid foundation for long-term decarbonization.

Eng. Biser Tsolov has spent over 20 years at Aurubis Bulgaria, playing a key role in major infrastructure projects, overseeing electrical power systems and modernisation projects. A graduate of the Technical University of Sofia, he has led initiatives such as the relay map and virtual model of the plant, modernisation of the electrical network, and substation upgrades that have improved the reliability of production.

How are digitalisation initiatives such as the relay map and the virtual model of the plant supporting Aurubis Bulgaria's sustainable production goals?

Digitalisation has become a key part of how we manage our electrical systems. The relay card schedule shows protection settings at each distribution level. After we introduced a medium-voltage system with directional protections and logical selectivity, reaction times at the highest level improved by several orders of magnitude.

The virtual model of the plant covers all levels of electrical distribution, from high voltage down to lighting. It allows us to calculate protection values under different operating modes, check whether equipment is correctly rated, simulate operational and fault scenarios, and determine exact parameters. Once connected to the Energy Monitoring System, the model will use live data instead of catalogue values, which will make it more accurate and effective.

Following the recent plant modernisation, which electrical systems upgrades have most improved reliability and efficiency, and how have they helped reduce energy losses and emissions?

Over the past years, we have completely replaced the electrical equipment at all levels of distribution. The installation of a medium-voltage system with directional protections and logical selectivity, combined with new cable lines, has led to almost trouble-free operation and faster response times.

We have also replaced all oil-filled power transformers with dry-type and gas-insulated models, creating oil-free substations that significantly reduce risks.

The main low-voltage distribution panels were also replaced with modern circuit breakers that include digital protection and communication functions. These can now be integrated directly into the energy monitoring system.

In total, 56 power transformers have been replaced. This has brought energy savings of about 15,000 MWh annually.

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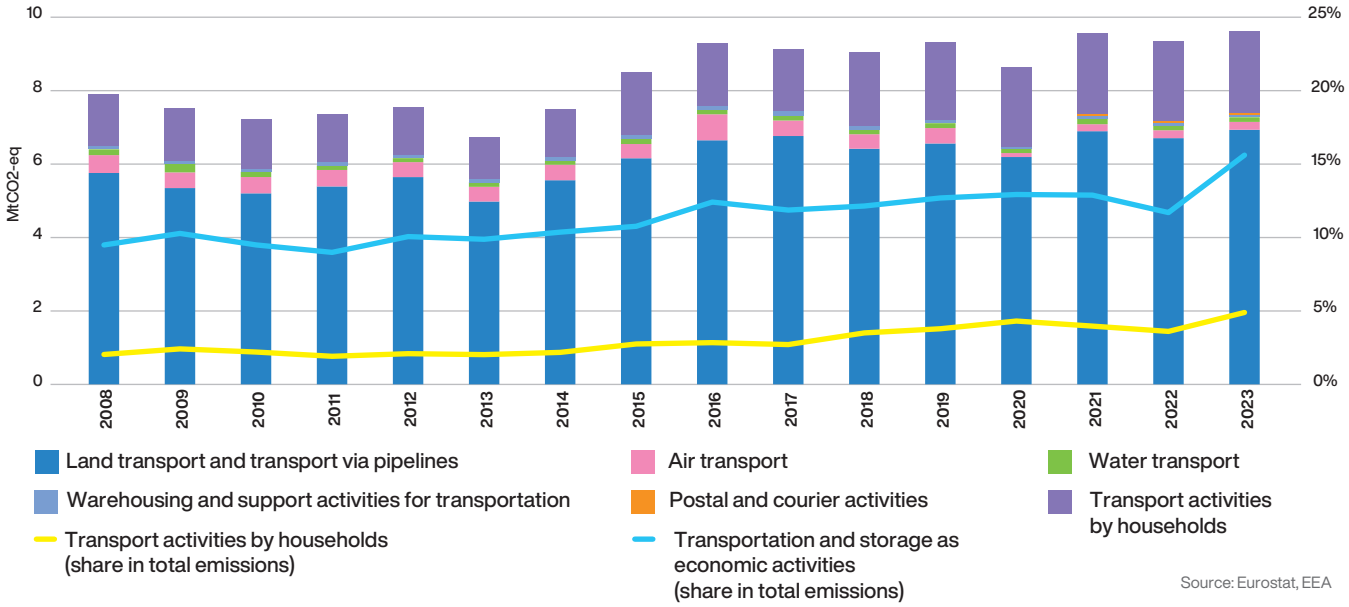
Transport

Unlike the structural decline seen in heavy industry or the recent GHG emissions collapse in the energy sector, **Bulgaria's transport sector represents the most challenging and unabated source of greenhouse gas growth. Data from 2008 to 2023 shows consistent expansion**, driven by both commercial transport and logistics and private household activity, making it a critical and worsening problem for the national decarbonisation goals. **Total emissions from all transport-related activities climbed by 3.0% y/y to a record 9.7 MtCO2-eq in 2023, thus standing at 21% above the base-year figure of 8.0 MtCO2-eq.** While the sector's emissions did not grow uninterruptedly year by year, with three brief dips in 2009-2010, 2013 and 2020, caused by slowdowns in economic activity, the long-term trend over the analysed period points upwards, demonstrating a structural link to economic activity and a lack of effective mitigation policies.

Fig 17. Transport and storage emissions (MtCO2-eq) and share in total emissions (%)



Source: Eurostat, EEA

The sector's GHG emissions are overwhelmingly dominated by two key drivers - **commercial land transport and private household vehicles, together consistently responsible for more than 90% of the total transport GHG emissions in Bulgaria** for the whole period. **The largest single source is Land transport and transport via pipelines** - the backbone of Bulgaria's transport and logistics sector that generated 72% of its aggregate emissions in 2023. **Over the analysed period, its GHG grew to 7.0 MtCO2eq from the initial 5.8 MtCO2eq.** On a positive note, the bulk of this growth happened within a relatively short timeframe between the bottom in 2013 and 2017. In the six years after, land transport emissions stayed almost flat, apart from 2020 and the slightly stronger rebound in 2021, which brought post-pandemic emission levels marginally above the pre-pandemic ones. Even more telling is the explosive growth in emissions in Transport activities by households. **Emissions from private vehicle use surged by over 60% to 2.3 MtCO2-eq in 2023 from 1.4 MtCO2-eq back in 2008.** This almost unbroken upward trend points to a significant increase in personal car ownership and usage, a critical challenge that policy has so far failed to address. Once again, **the most dynamic expansion of emissions from household transportation encompassed a four-year period, between 2014 and 2018**, largely overlapping with the boost in emissions from commercial land transport. It was preceded and followed by five-year periods of barely changing emissions, with the one after 2018 possibly reflecting a noticeable impact of decarbonisation efforts in the transport sector, primarily through an increasing electric and hybrid vehicles uptake.

The other transport sub-sectors have played a second-rate role as sources of GHG emissions throughout the analysed 15-year period. **Air transport provides a clear event-driven narrative - after hovering between 0.4 to 0.7 MtCO2-eq annually, its emissions collapsed to just 0.1 MtCO2-eq in 2020** due to pandemic-related travel restrictions. **It has since stabilised at around 0.2 MtCO2-eq, less than half its pre-crisis level.** Water transport, warehousing, postal and courier activities have all been minor GHG sources with barely changing emission levels and negligible shares in the overall picture.

These unfavourable decarbonisation developments in the transport sector are mirrored by the **increasing share of the sector in Bulgaria's total GHG emissions from all economic activities**. As the industrial sector fluctuated and the energy sector saw its emissions fall, the transport sector's persistent growth has made it a dramatically larger piece of the national climate challenge. **While in 2008 all transport activities together accounted for 11.8% of Bulgaria's total emissions, by 2022 this share had already grown to 15.7%, before skyrocketing to 21% in 2023** due to the drastic decarbonisation progress in the energy sector. Thus, in a single year, transport went from being the third most significant polluter in Bulgaria, considerably behind the first two, to being responsible for more than one-fifth of all greenhouse gases, almost equal to second-placed industry and a potential long-term contender for the top spot, especially if energy builds on its latest decarbonisation progress.

VEOLIA

GreenUp or how Veolia accelerates the ecological transformation

Author: Boris Preslavski, Sofia Wastewater Treatment Plant (WWTP) Kubratovo

The Beginning

Founded in 1853 by decree of Napoleon III, Veolia sets as its first and foremost goal the task of solving the water supply problems of the rapidly expanding cities of that time - Lyon, Paris, and later on other European cities. By the late 1940s, the company had expanded its activities beyond water management to include district heating, and during the 1960s and 1970s, it made another major step toward managing waste and wastewater.

Today, Veolia operates across five continents as a leader in ecological transformation, delivering integrated solutions in three critical sectors: water, waste, and energy management. In 2024, the company's operational footprint includes delivering clean water to 111 million people and wastewater services to 98 million. It also generated 42 million MWh of electricity and processed 65 million tonnes of waste.

The 21st century, however, is heavily marked by a global challenge – climate change. The United Nations, citizens, and businesses worldwide have begun to work actively to address this issue.

Veolia was among the first companies to join the United Nations Global Compact (UNGC) in 2002 – the world's largest corporate sustainability initiative – publicly aligning its activities and reporting its progress (COP) in four key areas, with a special focus on the environment.

Up to Today

In 2024, in its constant approach to adapt and in response to climate challenges, Veolia introduced its GreenUp strategic plan to accelerate ecological transformation – positioning itself as a leader on the path toward a global sustainable economy.

As such, Veolia has prioritized EUR 2 billion of its investments for broadly applicable solutions aimed to decarbonise, depollute and regenerate resources by 2027.

The Ambition

Decarbonisation stands at the core of the company's plan, targeting 18 million tonnes of CO_2 emissions avoided (Scope 4) and following a reduction trajectory aligned with the global goal of limiting warming to below 1.5°C (Scopes 1 and 2).

GreenUp aims to achieve carbon neutrality and a gradual reduction in fossil fuel use, recognising that industries and regions need proven, accessible, and easily replicable solutions. For example, district heating networks managed by the Group in major European cities – in Germany, the Czech Republic, Poland, and others – have drastically reduced their carbon emissions and transformed into green heating systems. A successful Bulgarian example is Veolia Energy Varna, featuring efficient cogeneration, modernised infrastructure, and digitalised management.

The Group is striving to become the water services provider of the future, offering efficient solutions and cutting-edge technologies, including water and pollutant treatment, reuse of purified wastewater, and drinking water production. In Bulgaria in a situation of prolonged droughts and catastrophic seasonal floods, Veolia is cited as a good example of water management in Sofia.

The third pillar of the GreenUp strategic plan involves the treatment of 10 million tonnes of hazardous waste and pollutants. In this field as well, Veolia plans to accelerate the adoption of circular solutions and innovations for recycling lithium batteries and plastics – areas in which the Group is already a global leader, operating more than 30 plants worldwide.

The 170-year history of the company impresses with ***"its remarkable ability to adapt and reinvent itself. In different eras, it has been a pioneer and a driving force behind the development of cities and industries, contributing to human progress,"*** says Francois Debergh, Veolia's Country Director for Bulgaria and Greece.

GreenUp 2027

Decarbonisation

18 mln tons of CO2 erased in 2027 (scope 4) & emission reduction trajectory compatible with 1.5°C warming (scope 1&2).

Regeneration

1.5 bln m^3 of fresh water saved in 2027.

Depollution

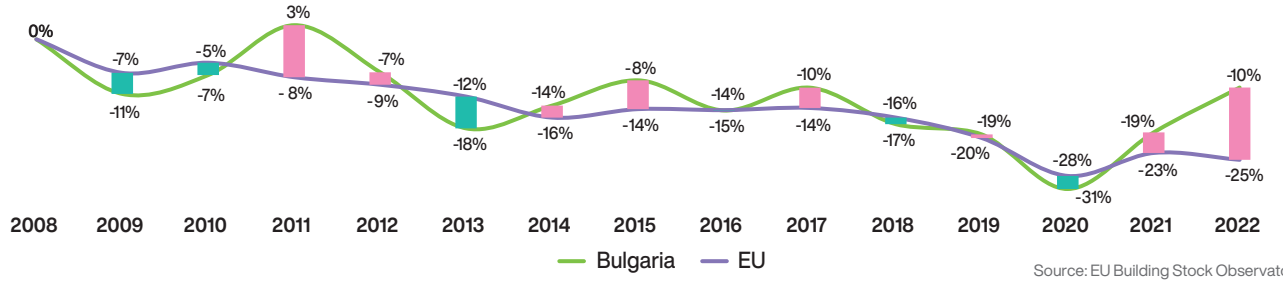
10m tons of hazardous waste and pollutants treated in 2027.

www.veolia.bg

Buildings

Buildings are at the heart of Bulgaria's decarbonisation challenge. As the EU pursues its 2050 net-zero objectives and the 2030 interim targets, decarbonising the heating, cooling and electrification of buildings will determine whether Bulgaria can align with the bloc's long-term climate pathway. **At the EU level, GHG emissions from energy use in buildings are a key contributor to total emissions, accounting for 33% of energy-related GHG emissions in 2023.** These emissions result from the direct use of fossil fuels in buildings and from the production of electricity and heat, or indirect emissions. Reflecting the importance of GHG emissions from buildings, the European Green Deal places a strong emphasis on their reduction. A revised Energy Performance of Buildings Directive (EU) 2024/1275 entered into force in May 2024 and must be transposed into national law by all EU Member States by May 2026. It addresses the need for energy efficiency improvements in the EU's building stock, the acceleration of renovations, the deployment of renewable energy sources, such as solar rooftop systems, and the decarbonisation of heating systems. In addition, all new buildings must be zero-emission by 2030. As of November 2025, Bulgaria has not yet fully transposed the directive into its national law, particularly lagging behind with the development of its National Building Renovation Plan, which is due in a draft form by the end of2025.

Fig 18. Change in GHG emissions from buildings over 2008



Source: EU Building Stock Observatory

Across the EU, emissions from energy use in buildings fell by about 25 % between 2008 and 2022, driven by stricter efficiency standards, electrification of end-use and a cleaner power mix. A general trend toward warmer winter temperatures, and therefore reduced winter heating needs, has also contributed to the emission reductions from buildings. **Bulgaria's reduction over the same period has been far more modest at around 10 %.** However, this significant gap with the EU trajectory appeared only in the last two years of the period. In contrast, up until the onset of the Covid-19 pandemic, the country's GHG emissions reduction progress went roughly hand in hand with the EU average, with a couple of minor slowdowns in 2015 and 2017. Since 2021, GHG emissions rebounded, mostly due to economic recovery from the pandemic. As an additional factor, cooling needs in buildings also increased energy use and emissions respectively, due to more frequent and longer summer heat wavesin recent years, especially in Southern Europe. **While the EU overall continued to see incremental declines in 2022, Bulgaria reported another year of pronounced GHG emissions increases, further reversing the earlier progress as far back as 2012 levels.** The renewed rise of emissions was a consequence of turning back to coal for electricity generation as a temporary replacement of Russian natural gas, which began to be phased out of the market after the beginning of the war in Ukraine. These developments underscored the sensitivity of the buildings sector footprint to shifts in the power mix, illustrating how incomplete electrification without concurrent grid decarbonisation can quickly undermine national targets.

An analysis of the GHG emissions trajectory of Bulgaria's buildings in comparison to the average EU levels over longer periods provides a more complete picture of the drivers behind the varying progress in reduction. **When measured over the longer horizon between 2005 and 2023, EEA reported that GHG emissions from energy use in buildings decreased by 47% in Bulgaria**, positioning the country among the 10 EU Member States with the largest reduction for the period, with a significantly better performance than the average EU reduction of 31%. Potential further reductions in Bulgaria until 2030 also exceed EU projections. In the scenario with additional measures, the **projected reduction in Bulgaria over 2005 would advance by a further 27 pp and equal 74% in 2030, versus a projected 53% cut for the EU.**

When compared against 1990 as a base year, the progress in GHG emissions reduction reveals the country's complex energy legacy. **The steep decline throughout the 1990s was less of a climate policy success and more of a structural transformation.** The post-Soviet collapse of heavy industry in Bulgaria and a switch from coal and oil to natural gas caused a sharp fall in direct combustion emissions from buildings, yet much of the sector's carbon footprint effectively migrated from household chimneys to the national power plants supplying electricity and heat. This is confirmed by Eurostat data, which shows that **electricity accounts for 51.73% of the final energy consumption in the Bulgarian residential sector, more than double the EU average of 25.9%**. Since this electricity is generated by Bulgaria's still highly carbon-intensive coal-reliant grid, the building stock's actual emissions footprint has remained stubbornly high and indirect emissions have offset a large share of on-site efficiency gains. According to the European Commission's Building Stock Observatory, **Bulgaria has made significant progress in the reduction of its GHG emissions from buildings since 1990. The overall level of reduction stood at 37% as of 2022, versus 1990 as a base year, better than the EU average of 30% for the period .** It had even reached 51% in 2020, but the economic slowdown due to the onset of the Covid-19 pandemic can be considered a one-off event that is not representative of the long-term trend. Bulgaria showed a different pattern of emissions reduction progress between 1990 and nowadays – while the EU gradually and uniformly advanced its buildings decarbonisation with the notable exception of the 2020 setback, achieving half of its total progress since 1990 in the past decade, **Bulgaria's momentum has waned and progress in the last 20 years has been much weaker than the initial flying start immediately after 1990.**

Several national programmes now aim to increase the energy efficiency of buildings and thus further facilitate the reduction of their GHG emissions, including **Support for sustainable energy renovation of the residential building stock** within the National Recovery and Resilience Plan (2022-2026), **Replacement of inefficient solid fuel stoves** (2019-2026) and **Financing programme of standalone renewable energy sources measures in single-family buildings and multifamily buildings** (2022-2026). These initiatives mark a notable acceleration in energy efficiency policy after a decade of stagnation, aligning domestic action with the EU's Renovation Wave and the revised Energy Performance of Buildings Directive. However, implementation remains slow, hampered by administrative bottlenecks and low public awareness. In order to succeed in the genuine decarbonisation of buildings, Bulgaria needs not only to upgrade and retrofit the buildings, but also to overhaul its energy system by a decisive phase-out of coal in power generation.

CHAMBER OF ENERGY AUDITORS IN BULGARIA

Pathways to decarbonisation: Energy efficiency in Bulgaria

Valentina Uzunova
Founder and Chair of the Chamber of Energy Auditors

Established two decades ago, the Chamber of Energy Auditors brings together around 50 certified members dedicated to advancing energy efficiency and sustainable energy development in Bulgaria. The Chamber promotes professional standards in energy auditing, supports policy formation, and collaborates with national and local authorities to improve building and industrial energy performance. Through training, regulatory input, and coordination among its members, it works to reduce greenhouse gas emissions and strengthen Bulgaria's transition toward a low-carbon economy. With over 30 years of experience and a Master's degree in Economics, Valentina Uzunova, Founder and Chair of the Chamber of Energy Auditors, is a leading Bulgarian expert in energy efficiency, renewable energy, and policy development.

What is the link between European decarbonisation policy and energy efficiency?

Decarbonisation encompasses actions aimed at a rapid transition from the use of fossil fuels to carbon-free and renewable energy sources while energy efficiency (EE) is a key tool for achieving decarbonisation targets in the European Union (EU) and Bulgaria. EE improves the quality of energy services at the most acceptable price for society and provides an opportunity to reduce energy consumption through specific energy-saving measures.

European policies such as the European Green Deal, Fit for 55 package, the revised Energy Efficiency Directive (EED), the Renewable Energy Directive, the Energy Performance of Buildings Directive, and the Renovation Wave initiative place energy efficiency at the heart of the emissions reduction strategy. EE reduces energy demand, facilitates the integration of RES and reduces the need for additional capacity, making decarbonisation cheaper and faster.

The European Green Deal aims to make the EU a modern, competitive economy built on efficient resource use and clean innovation. Its energy efficiency standards and financial instruments drive low-emission technologies and infrastructure to help cut emissions by at least 50% by 2030 through practical, results-oriented actions.

Understanding the roadmap and logic of energy efficiency projects is key to maximising the impact of every invested unit of energy saved to ensure verifiable emission reductions and support effective decarbonisation plans. Energy efficiency and decarbonisation are inseparable, driving technological innovation, reshaping our relationship with nature, and redefining how energy is used in the modern world.

A good symbiosis between decarbonisation plans and energy efficiency is the Clean Industry Pact (EC) initiative under which EUR 1 billion in subsidies will be disbursed by the end of 2025 through the Innovation Fund for the decarbonisation of process heat in industry.

How do energy performance certificates for buildings affect the efficiency of the investment process in construction, and can they determine real estate prices and the "green policies" of businesses?

In Bulgaria, the Energy Efficiency Act, in force since 2005, transposes EU requirements on building energy performance and regulates the issuance of energy performance certificates. These certificates provide reliable data on a building's energy condition and classify its energy consumption level.

According to the Energy Efficiency Act, every building in operation should have an energy performance certificate. All advertisements for the sale or rental of newly constructed buildings (commissioned after January 1, 2005) must include the specific annual primary energy consumption indicator kWh/sq m specified in the certificate. Investors in newly constructed buildings are required to obtain an energy performance certificate before the buildings are put into service.

Before concluding the sale or lease agreement, the seller or landlord shall provide the buyer or tenant with the certificate for review. Buyers and tenants are obliged to request the documents for the respective building, prepared in accordance with the Energy Efficiency Act, including the Energy Performance Certificate for the respective property.

It is essential that, throughout the investment project, all construction documents required under the Energy Efficiency Act are available. A common issue in building projects is the failure to install or commission planned energy systems such as boilers, heat pumps, HVAC systems, lighting, or district heating and gas connections. This often leads to energy certificates containing inaccurate data and misleads other stakeholders, including banks, buyers, and tenants.

Energy performance certificates (EPCs) play a key role in improving energy efficiency and decarbonisation by ensuring compliance with construction and renovation standards. Buildings with high energy ratings benefit from lower operating costs, higher market value and access to favourable financing such as green loans and premium incentives. However, inconsistent or inaccurate certificates can undermine trust and distort market signals. Owners of nearly zero-energy or class A buildings may also receive property tax exemptions for up to ten years.

For 25 years, certificates in Bulgaria have gradually established themselves as an important tool in the investment process—they reduce operational risks, influence demand and prices in many markets , and are a key gateway to green financing.

There is a certain risk in real estate appraisals related to the accuracy of a property's energy characteristics and class. To ensure reliable valuations, appraisers should work closely with energy auditors and use up-to-date Energy Performance Certificates (EPCs). EPCs must become a key factor in construction investment decisions, bringing clear benefits for owners and tenants. They also enhance green business practices by guiding strategic investments, improving ESG performance and corporate image, and facilitating access to green finance and favourable lending terms.

How important are energy audits of industrial systems and energy performance certificates for buildings for the needs of credit institutions and investment funds?

For credit institutions and investment funds, energy audits and Energy Performance Certificates (EPCs) are not just an "environmental" accessory, but **a tool for better credit risk management, more accurate collateral valuation, and access to cheaper green sources of capital.** High-quality audits and guaranteed verification make them a reliable gateway to integrated credit policy and investment decisions.

As experts, we advise financing institutions to hire independent energy auditors to review investment projects that have already been submitted and to examine the documentation for the relevant site. For investments requested above a certain value, the site should be visited and some essential checks should be carried out according to the established methodology for energy audits of buildings or industrial systems, depending on the specific site. Only such an approach can guarantee the reliability of the future project and the effectiveness of the investment, thereby reducing credit risk.

Applying up-to-date energy audit reports on industrial systems or buildings, will bring financial institutions benefits such as a more accurate credit risk assessment, a more reliable collateral assessment, reduced operational risk and lower probability of defaults, access to green financing, regulatory compliance, optimal cash flow and improved reputation and attraction of ESG investors or institutional clients.

Many financial institutions skip energy audits to save time and cost, but this short-term gain risks long-term losses, including mispriced risks, declining asset values, lost access to green finance, compliance issues, reputational damage, and greater exposure to energy shocks.

Could you outline the path to achieving decarbonisation and energy efficiency goals for end energy consumers?

Buildings account for about 40% of global energy consumption, making them a key focus for reducing costs and greenhouse gas emissions while ensuring healthy and comfortable living and working conditions.

An extremely important and unpredictable factor determining energy consumption in buildings is occupant behaviour. This directly affects the calculation of a building's energy performance and its assigned energy class. A lack of awareness or motivation to save energy among many occupants has turned energy consumption into a broader social challenge.

Few people feel responsible for following daily habits that reduce energy use at home or work, creating a major challenge. Building energy consumption is closely tied to occupant behaviour, which is hindered by weak energy-saving habits, limited awareness of building systems, and the lack of individual accountability for efficiency.

Key steps toward energy saving and decarbonisation include building awareness and commitment to measurable goals, setting tiered targets, and forming an energy management team. The process should begin with collecting and analysing energy data, commissioning audits, and developing an action plan, starting with low-cost measures such as lighting and energy management, then progressing to more significant upgrades. Maintaining an electronic energy file, monitoring results, and reporting regularly help track progress and secure financing for advanced solutions, including renewables and digitalisation.

How can energy consumers be motivated and united in "energy communities" in order to reduce the amount of primary conventional energy and increase the efficiency of "small" decarbonisation processes at the level of a building, group of buildings, or neighbourhood?

The creation of Citizen Energy Communities is a universal European socio-economic initiative, which is set out as a model and standard in Article 2(11) and Article 16 of Directive (EU) 2019/944 Of The European Parliament And Of The Council

In essence, an "energy community" is a voluntary, locally organised group of end users (households, buildings, small/medium-sized enterprises, municipalities, etc.) who together produce, store, manage, and/or share energy with the aim of increasing energy efficiency, reducing primary conventional energy, and achieving social, economic, or environmental benefits for participants and the region.

An example of an energy community could be a group of neighbours/buildings/businesses that pool resources (e.g., solar panels, batteries, energy-saving measures) and make joint decisions on energy production/use in order to have lower bills, higher energy security, and a smaller carbon footprint.

Energy communities are characterised by collective management and ownership, with participants jointly deciding on investments and distribution. They operate locally within a building, neighbourhood, or community, combining activities such as renewable energy production, storage, sharing/distribution, efficiency, and load management. While these activities can generate profits, their objectives extend beyond commercial interests, focusing on social and environmental benefits while maintaining transparency, clear participation rules, and accountability to members.

First and foremost, in order to implement energy efficiency activities, participants in the process need to be sufficiently informed and motivated, as well as have a vision and a new worldview of the new complex challenges associated with unfamiliar agreements and the resulting risks and benefits.

In this regard, it is imperative to conduct training and information campaigns at the level of floor ownership, building groups, business representatives, etc. For the purposes of this process, the Chamber of Energy Auditors is launching a series of training courses, starting with the training of the energy auditors themselves, who will act as natural energy efficiency consultants to potential participants in energy communities.

Building trust among citizens and businesses is essential for developing energy communities through clear, low-risk models tailored to specific properties and participants. Competent consultants, including energy auditors, economists and lawyers, should guide the process.

Public interest in such initiatives is growing due to media coverage, though Bulgaria still lacks a functional model. Pilot projects in Gabrovo and Burgas partly meet EU and national requirements but future legal structures must align with each community's goals, technical conditions, and potential investor partnerships, supported by thorough legal analysis.

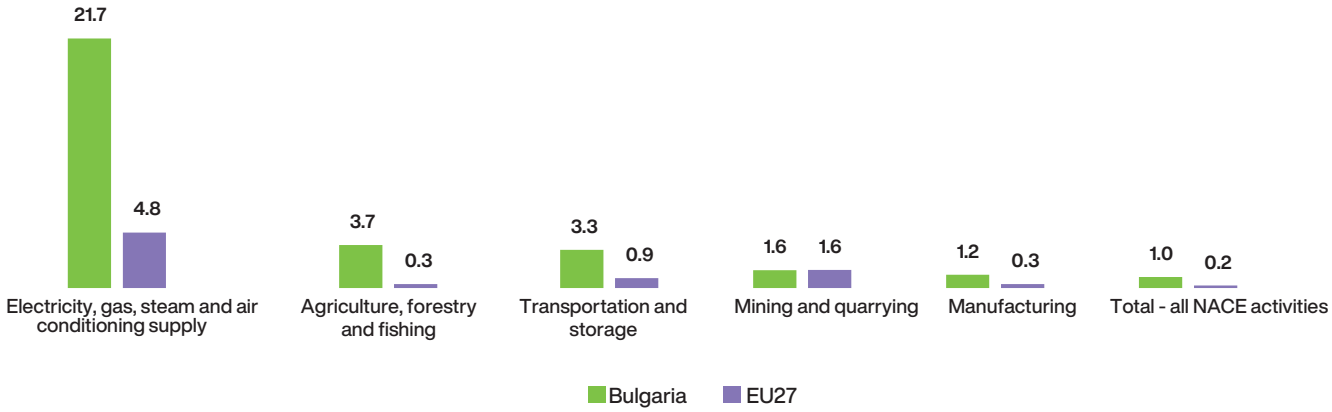
Economic perspective

Emission intensity

GHG emission intensity reflects an economy's climate performance, or how efficiently it generates economic value relative to its emissions. Measuring emissions per unit of gross value added (GVA) provides a clearer picture of carbon efficiency, as it reflects productivity while avoiding distortions from long supply chains. In this regard, **Bulgaria is the most carbon-intensive economy in the EU, averaging over 1.5 kgCO2-eq per EUR of GVA between 2008 and 2023**, about 25% higher than Estonia, the distant runner-up in carbon intensity. The EU average for the same period was gauged at just 0.3 kgCO2-eq per EUR, making the bloc's economy roughly 78.5% more carbon-efficient than Bulgaria's. The average reflected consistency throughout the entire period, as Bulgaria recorded the highest GHG intensity every year from 2008 to 2023. **However, the country achieved strong efficiency gains since 1990, reducing its GHG intensity by 48.9% to 968 gCO2-eq per EUR in 2023. This achievement placed Bulgaria fourth in the EU for improvement, only behind Estonia, Romania, and Malta. By comparison, the EU as a bloc recorded efficiency gains of 40.4%.**

By economic activity, electricity, gas, steam and air conditioning supply was the most carbon-intensive branch of the Bulgarian economy, averaging 25.7 kg CO2-eq per EUR in the 2008-2023 period and recording 21.7 kg CO2-eq per EUR in 2023 alone. This contrasts sharply with the EU average of 4.8 kg CO2-eq per EUR, making Bulgaria's energy sector 77.7% less efficient. Agriculture, forestry and fishing followed, averaging 3.4 kg CO2-eq per EUR over the period and registering 3.7 kg CO2-eq per EUR in 2023On the other hand, the EU's entire agriculture sector stood at 0.3 kg CO2-eq per EUR in 2023, revealing a 90.8% efficiency gap. Transportation and storage was third on the Bulgarian podium in terms of carbon intensity, generating 3.3 kgCO2-eq per EUR, both on average and in 2023 alone. The EU stood at 0.9 kgCO2-eq per EUR in 2023, reflecting efficiency gains of 74.2% compared to Bulgaria. Mining and quarrying averaged 1.9 kg CO2-eq per EUR between 2008 and 2023, producing 1.6 kg CO2-eq per EUR in 2023 and roughly matching the EU average and pointing to the limited potential for current efficiency gains in this hard-to-abate sector. Manufacturing recorded an average of 1.7 kg CO2-eq per EUR for the period and 1.2 kg CO2-eq per EUR in 2023, compared with 0.3 kg CO2-eq per EUR in the EU, highlighting the wide gap in the adoption of low-carbon technologies and practices.

Fig 19. GHG emissions intensity (kg/EUR) (2023)



Note: GVA in chain linked volumes (2010)
Source: Eurostat

Sectoral decarbonisation was uneven in Bulgaria, with the most pronounced efficiency gains recorded in manufacturing, where GHG intensity fell by 56.4% in 2023 compared to 1990 levels. Mining and quarrying improved by 28.2% and the electricity, gas, steam and air conditioning supply sector by 17.8%. In contrast, agriculture, forestry and fishing recorded a 72% increase in GHG intensity over the same period, while transportation and storage rose by 10.2%, likely due to increased fertiliser use and growth in freight and passenger transport.

SUNOTEC

Renewable growth is now market-driven and sustainable

Dimitar Dimitrov
Head of Sustainability at SUNOTEC

SUNOTEC is a leading European company in the development and construction of large-scale solar power plants, specialising in the end-to-end delivery of future-ready energy infrastructure. Headquartered in Sofia, Bulgaria and active across more than 20 countries, the company has delivered more than 650 utility turnkey PV solar plants with a total capacity exceeding 11 GWp. With a sustainability strategy built on Climate, Land and Resources, and People, SUNOTEC demonstrates a commitment to decarbonisation, circular resource use, and community impact that goes beyond renewable energy generation. Dimitar E. Dimitrov, PhD, is Head of Sustainability at SUNOTEC.

SUNOTEC's latest Sustainability Report expands the company's focus from renewable energy production to circularity, biodiversity, and community impact. How does that broader perspective influence the way you build and operate solar projects?

It is a natural evolution for us. There were a few drivers behind structuring the 2024 Sustainability Report and the overall sustainability strategy for the entire SUNOTEC Holding in this way. Some of them come from changes within our business - not all from this year specifically, but developments that had taken shape and matured by 2024.

For example, our services portfolio has expanded beyond EPC (engineering, procurement, and construction) activities to include owning and operating our own PV and co-location plants as an independent power producer. We also added battery storage systems to our portfolio and started manufacturing steel mounting systems for our projects to promote low-carbon production. Both areas are environmentally-intensive in their own ways, so we embraced a more comprehensive approach.

This broader strategy now shapes how we plan, construct, and operate PV and energy storage projects. Sustainability is not a standalone topic - it is integrated across operations, from procurement and design to land use and end-of-life considerations.

You have already delivered over 11 GW of installed solar capacity and aim to reach 25 GW by 2030. How is that goal progressing, what role does Bulgaria play in it and how strong is the current demand for battery storage?

We are operating in a wide range of geographies across Europe and Bulgaria remains one of our important markets. We are close to meeting our interim target of 3 GW of installed capacity additions for 2025. With two months still left in the year - and considering the speed at which we typically build - the picture can change quickly. Achieving this target will be a major milestone for us.

Development has been very dynamic in Bulgaria in recent years. There are always permitting and administrative challenges; that is true for most markets, but what is remarkable here is the pace of new installations. According to some expert projections, Bulgaria is expected to surpass the European average for installed solar capacity per capita in the very near term.

Economically, renewable energy, especially photovoltaics, has become so viable that growth is increasingly market-driven. It is hard to stop now, given the momentum.

As for the appetite for battery storage, it is very strong. A large portion of Bulgaria's National Recovery and Resilience Plan is focused on storage capacity. In a year or two, Bulgaria could become one of Europe's leaders in installed battery systems.

We are seeing both hybrid solutions and standalone storage projects, but most of the investment today goes toward independent battery systems. Going forward, I believe virtually all PV plants will include battery storage to remain competitive. Batteries are now essential for integrating more solar capacity and addressing intermittency challenges.

You are committed to achieving net-zero emissions by 2050 and a 30% reduction in Scope 1 and 2 emissions by 2030. How is that progressing, and how are you approaching Scope 3 emissions across the broader supply chain?

We have high ambitions in this area and are scaling up our efforts to match them. One of the big developments underway is our decarbonisation strategy and climate transition plan, which we will publish early next year. These will align with the company's overall business trajectory to make sure our goals are not only ambitious but achievable
.
Integrating decarbonisation into the core business is key and that is often where companies struggle. So we are

SUNOTEC

making sure that our approach to emissions reduction is embedded in how we plan, invest, and operate, rather than being treated as an add-on.

While energy use makes up a relatively small part of our footprint, product purchases are the main source of our GHG emissions. That largely consists of Scope 3, which is much harder to manage and represents about 97% of our total footprint.

Because we are an integrated solution provider, our work involves procuring large quantities of materials and components. Construction itself is highly material-intensive. Every fence, aggregate, or piece of machinery we purchase carries its own footprint. That is why supplier engagement is critical.

We have recently introduced a sustainability supply chain management system that helps us assess and manage suppliers based on risk level and sustainability maturity. We start by collecting emissions-related data and then encourage or require suppliers to develop decarbonisation plans of their own.

There's no one-size-fits-all approach, but we apply due diligence and rank suppliers accordingly. A good example is steel, which is one of the most carbon-intensive materials globally. Since we manufacture steel components for mounting structures ourselves, we select suppliers who can demonstrate how they are managing and reducing their emissions. Their progress directly affects our own.

The road ahead is long and involves a process that requires careful measurement and calibration, which is why our net-zero target extends to 2050. Our supply chain is large and complex, and meaningful change takes time but we are moving firmly in that direction.

How do avoided emissions through new solar capacity installation measure up to your own operational footprint and how do you expect this balance to evolve?

In 2024, our avoided emissions amounted to around 526,000 tonnes of CO_2e, compared to roughly 301,000 tonnes of our own footprint, including Scope 3. So in effect, the avoided emissions are almost double.

We use a recognised and consistent methodology for calculating these figures, including lifecycle emissions from producing renewable energy and the carbon intensity of the national grid in each project's location. We take those baselines seriously to make the comparison as realistic as possible. That said, the figure includes projects we built or delivered turnkey services for, not only those we own and operate ourselves. The avoided-emissions number therefore reflects both our direct assets and our broader impact as a developer and constructor.

Going forward, this balance will depend heavily on how fast the grids in the countries where we operate decarbonise. For example, building a small solar plant in Poland, where grid carbon intensity is still high, results in more avoided emissions than building one in Sweden or France, where the grid is already clean.

So even if the relative gap between avoided emissions and our footprint narrows, that wouldn't necessarily be a negative. It would mean that national energy systems have become cleaner overall. What matters most is maintaining that positive correlation while continuing to grow.

SUNOTEC's sustainability strategy brings together climate, land and resources, and people. Where have you seen the strongest impact in land use?

The Land and Resources pillar addresses how we build from the materials we use to the circularity of our processes and our impact on the environment. We have already seen how significant this can be. For instance, our projects in Pernik and Bagrentsi in Bulgaria demonstrate how degraded or abandoned land can be turned into productive solar sites. The Pernik project was built on an old industrial landfill deliberately selected for its low environmental value or even positive rehabilitation potential.. The Bagrentsi project applied circular-economy principles from the start. The site was an unused agricultural management facility with old, derelict buildings. We demolished those structures, crushed the materials into aggregate, and reused them to level the land and build internal roads. This avoided waste, reduced the need for new materials, and gave the terrain a new purpose - a solar plant generating clean power.

Is large-scale decarbonisation in Bulgaria now economically self-sustaining, or does the clean-energy transition still have to rely on stronger policy and incentives? Do you think current regulations strike the right balance between ambition and productivity?

Sustainability used to be seen as something "nice to have" or a matter of reputation rather than economics. But that perception is changing quickly.

Renewable energy is a perfect example of how the balance between environmental and economic goals can be achieved. Solar and wind are now cost-competitive, so the market itself drives decarbonisation. At the same time, policy still plays a key role.

Regulation is important in moderation. Take the EU's Corporate Sustainability Reporting Directive, for instance. It's a good step overall, but its initial version was probably too ambitious and complex for many companies just beginning their sustainability journey. The recent decision to simplify it slightly was the right one, allowing businesses to adapt more effectively before moving to a deeper level of reporting later. The EU Taxonomy, which defines technical criteria for sustainable activities, is a specific example. It's highly detailed and has advanced the field, but it can be overwhelming, especially for smaller or less mature companies. Simplifying, streamlining and phasing such requirements helps ensure real progress and prevents compliance fatigue.

Ultimately, regulation provides the nudge that markets and governments sometimes need to move faster. Without it, some countries might delay key decisions. But the balance between net-zero goals and economic growth is essential.

If the economy is strong, society can sustain the transition. If it weakens, decarbonisation becomes harder to prioritise. The challenge and the opportunity lie in keeping both on track.

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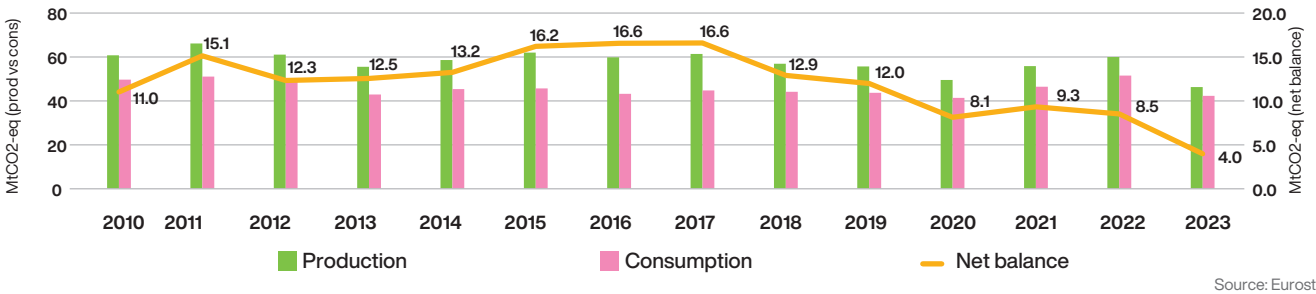
Production and footprint perspectives

Fig 20. Production vs Consumption of GHG emissions Bulgaria



Source: Eurostat

Consumption-based GHG emissions, commonly referred to as the GHG footprint, encapsulate emissions related to the final consumption of goods and services. The footprint does not take into consideration the country or industry of origin, aggregating all the emissions generated across the production chain of a product that reaches Bulgaria for final use. Conversely, the production perspective reflects emissions from economic activities and households residing in Bulgaria, regardless of where the goods and services were consumed. Comparing production and consumption-based accounting reveals whether emissions are outsourced, as some countries may benefit from lower production emissions due to a higher carbon footprint that relies on importing carbon-intensive products.

Bulgaria, alongside Poland, was the only EU member state to remain a consistent net exporter of GHG emissions from 2010 to 2023, with emissions stemming from production outweighing its domestic footprint each year. The average annual net balance between production and consumption-based emissions was positive in seven of the 27 EU member states during the same period, with Bulgaria ranking third in this roster, at 12 MtCO2-eq. In 2023 alone, Bulgaria was one of five net exporters of GHG emissions, recording the third-largest net balance of 4 MtCO2-eq, behind Poland and Denmark.

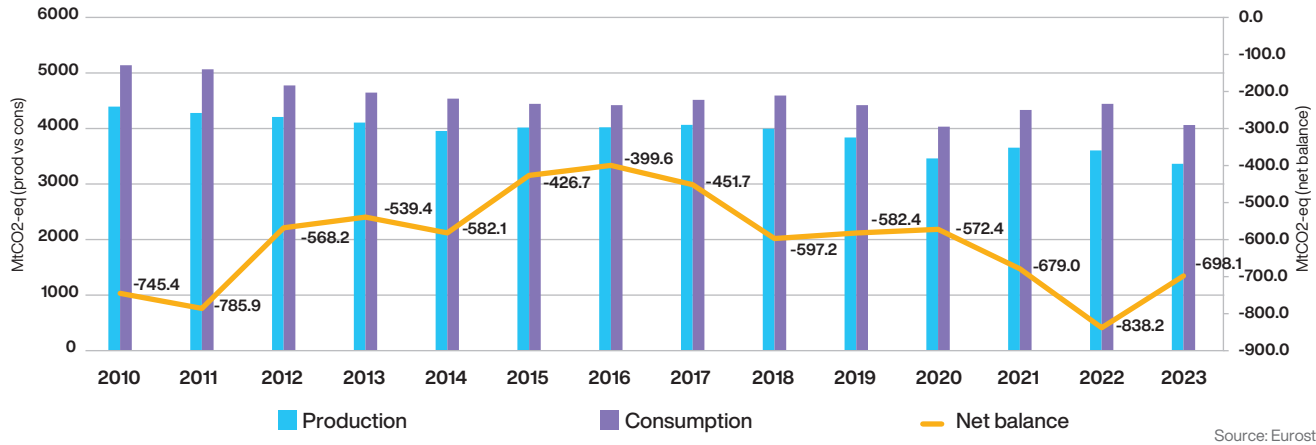
When adjusted for population size, the net balance of emissions reveals a slightly different dynamic. Of the four net exporters of GHG emissions in 2023, Bulgaria registered the fourth largest balance of 0.6 tCO2-eq. From a production perspective, Bulgaria registered the 13th lowest average annual GHG emission footprint per capita in the EU between 2010 and 2023, at 8.4 tCO2-eq. From a footprint perspective, the country recorded the second lowest average after Romania, at 6.6 tCO2-eq per capita, suggesting a carbon-intensive export structure. Moreover, Bulgaria's average annual balance between 2010 and 2023 stood at 1.7 tCO2-eq per capita, marking the second-largest value among the seven net exporters for the same period and outranking Poland, whose gap between production and consumption at the individual level was only gauged at 0.6 tCO2-eq. This indicates that **Bulgaria has had a disproportionate share of production emissions relative to its size, but its role as a net exporter has recently moderated.**

In light of trade dynamics that have placed Bulgaria as a net importer by value of goods during the 2010-2023 period, its emission-exporting status is rather paradoxical. The country was a net importer of raw materials, mineral fuels, lubricants, chemicals, machinery and transport equipment, while other manufactured goods, along with food, drinks and tobacco, generated a positive trade balance but failed to offset the overall deficit. **This suggests a potential structural imbalance whereby Bulgaria's export base is defined by carbon-intensive industries while relying on imports for high-value-added goods which account for fewer emissions.**

Since 2017, the net balance of Bulgarian emissions has been on a general downward trajectory, indicating a narrowing gap between the carbon intensity of what the country produces and what it consumes. The exception to this period was an annual spike in the net balance in 2021, likely driven by a statistical rebound registered a year earlier following on the back of the economic cooling effect of the pandemic, which saw consumption emissions plummet faster than those generated from domestic production.

In contrast to Bulgaria, the EU as a bloc is a net importer of emissions. Between 2010 and 2023, the Union recorded a negative balance between production and consumption-based emissions each year, averaging –604.7 MtCO2-eq, or –1.4 tCO2-eq per capita. The historical trend reveals a narrowing gap between the EU's production-based emissions and its footprint until 2016, widening for the most part thereafter due to higher consumption-based emissions. However, in 2023 alone, emissions from production fell faster rate than the bloc's footprint, leading to a further tightening of the gap and indicating the increased impact of intra-EU mitigation efforts.

Fig 21. Production vs Consumption of GHG emissions EU27



Source: Eurostat

Turning renewables into returns: TOKI's model for industrial decarbonisation

Georgi Pulev
COO, KER TOKI Power

KER TOKI POWER is a leading electricity trader and green energy aggregator in Southeast Europe, part of Renalfa – one of the region's largest clean-energy investment groups. The company develops innovative solutions for electricity supply, trading, balancing and storage, serving thousands of renewable producers and corporate clients across Bulgaria and the SEE region. The compa

Georgi Pulev is Chief Operations Officer and Member of the Board of Directors at KER TOKI Power. Drawing on an extensive background in finance, and strategic operations, he leads the company's operational and strategic development, focusing on efficiency, innovation, and the expansion of TOKI's regional leadership in renewable energy trading and ancillary services.

Bulgaria's power mix is changing rapidly, with renewables now accounting for more than half of installed capacity. Volatility is higher, yet so is the opportunity to extract value from flexibility, aggregation and storage. For corporate energy buyers and asset owners, the investment case lies in turning intermittency into predictable costs, measurable hedges and diversified revenue streams. TOKI's COO, Georgi Pulev explains how the company prices that value, scales it across portfolios and extends it to smaller consumers through a proprietary multi-buyer PPA product.

How can businesses turn RES variability into predictable returns?

Flexibility, in energy terms, means the ability to adjust production, storage and consumption close to real time. Because renewable output is irregular and hard to forecast precisely, producers and consumers face exposure to timing mismatches and imbalance costs. The opportunity is to turn that variability into measurable value. At TOKI, we help clients do this by aggregating assets – generators, batteries and flexible demand – into large balancing portfolios, optimising dispatch intraday and settling imbalances with precision. This lowers imbalance costs, improves hedge effectiveness and stabilises cash flows while opening new revenue streams from balancing and ancillary markets. In essence, flexibility is a risk-control tool first and an earnings lever second.

Can Battery Energy Storage Systems (BESS) bring savings for industrial users by adding flexibility to their demand?

A battery creates value only when operated to match a client's specific objectives. For one site, that may mean shifting consumption away from expensive hours and reducing peaks to lower bills; for another, smoothing output alongside on-site renewables to minimise timing losses and imbalance; in some cases, it may also participate in short-term markets to generate an additional, measured revenue stream. The right approach depends on load shape, connection limits, local price dynamics and risk appetite. Our role is to analyse each case, model scenarios and then run the BESS accordingly – from behind-the-meter optimisation focused on cost and resilience to full market co-optimisation with automated dispatch and disciplined cycle management. Managed this way, the battery evolves from a static capital expense into a flexible asset that reduces total energy cost, improves predictability and, when appropriate, creates new income.

What about SMEs - how do they manage the transition to renewable energy?

For smaller businesses, the challenge is access and simplicity. Many cannot justify stand-alone trading or bespoke optimisation, yet they still need price stability and credible green sourcing. We absorb the complexity at the portfolio level and return it as clear commercial terms, aggregating thousands of consumers and renewable producers to spread variability, lower transaction costs and open participation to clients who previously stayed outside the market. PPAs remain the anchor for long-term stability and our proprietary "Shared Energy" model extends that advantage to smaller buyers. It enables several consumers to contract portions of generation under one framework while we manage allocation and balancing. In 2024, we executed more than thirty such agreements, proving the model's efficiency and operational fit.

What differentiates TOKI as a partner?

Scale, integration and measurability. We manage more than 3 TWh of energy annually with aggregated capacity above 1 GW across a regional footprint. That scale matters for liquidity, optimisation and risk transfer. We combine trading, balancing and storage under one operating stack and measure outcomes in the metrics that matter to finance teams: hedge effectiveness, avoided imbalance, achieved spread and contract traceability. Clients choose TOKI because we turn market complexity into predictable financial performance and clear risk visibility.

Where will returns be created next?

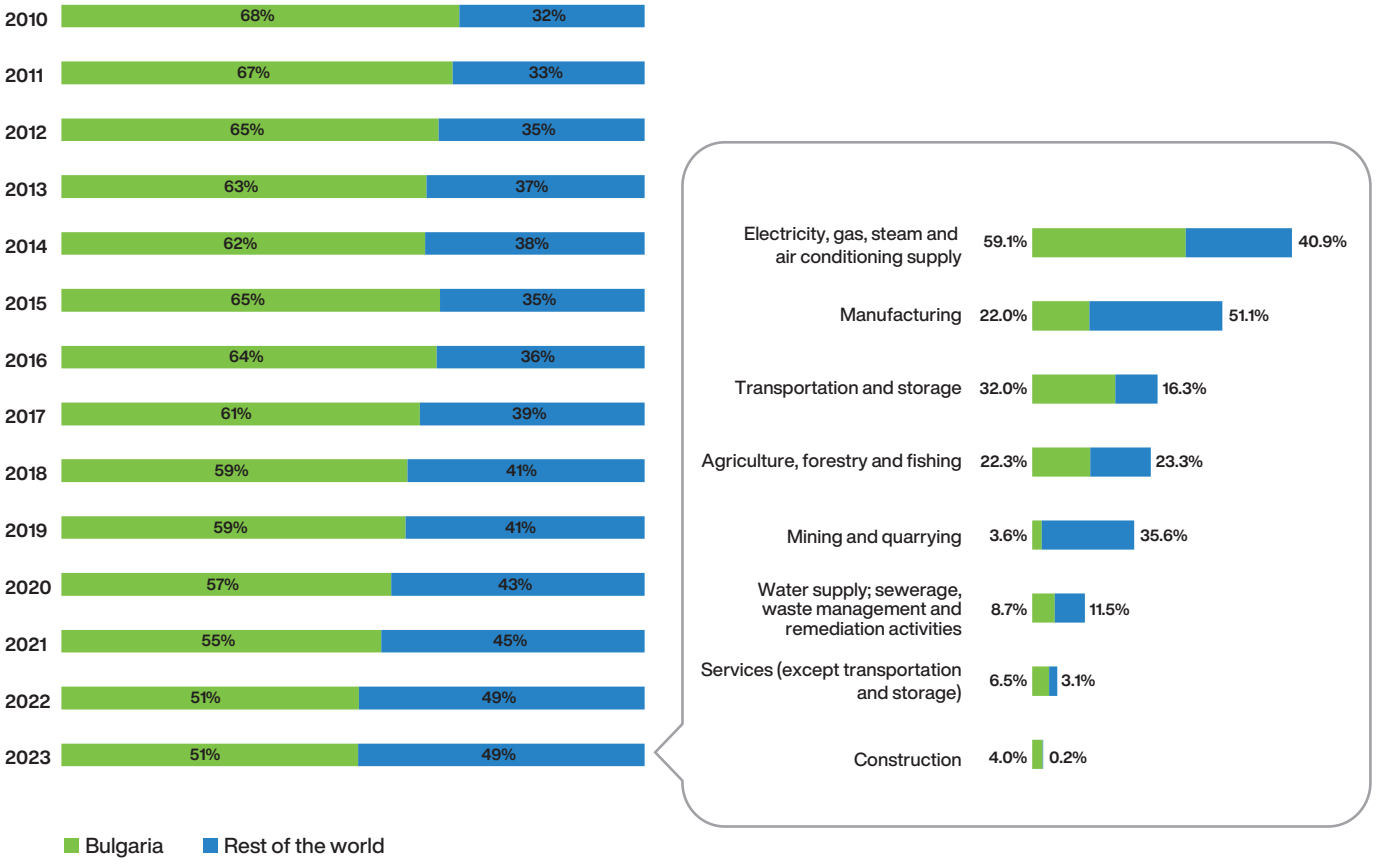
Three main areas will define the next phase of returns. First, deeper integration of BESS with intermittent generation and flexible demand to capture intraday opportunity and smooth cash-flow volatility. Second, wider adoption of multi-buyer PPAs through our Shared Energy product, extending long-term hedges to SMEs while securing producers' revenues. Third, data-driven optimisation at the edge – from site-level forecasting to automated nominations – which compounds marginal gains across large portfolios. Ultimately, the winners will be those who can convert volatility into a repeatable earnings engine.

toki.bg

Origin of national footprint

Bulgaria's GHG emission footprint has mostly been of domestic origin between 2010 and 2023, averaging an annual domestic share of 61% over the period. However, reliance on external supply chains expanded over the period, with the share of foreign-sourced emissions jumping to 49.1% in 2023 from just 31.8% in 2010. Excluding emissions generated domestically, Bulgaria's EU peers accounted for 25% of its foreign-sourced GHG footprint, with Romania, Germany and Poland as the top three sources of intra-EU emissions at 4.4 pp, 3.8 pp and 3.1 pp, respectively. Of the extra-EU sources which collectively represented 75.1% of Bulgaria's imported GHG footprint, China, Russia and Turkiye sliced the largest shares at 14.6 pp, 13 pp and 4.8 pp, respectively. **This reveals a carbon footprint profile that is largely driven by non-EU supply chains for carbon-intensive goods.**

Fig 22. Origin of Bulgaria's GHG footprint



The electricity, gas, steam and air conditioning supply sector accounted for the majority of Bulgaria's GHG footprint in 2023, at 11.4 MtCO2-eq or 27% of the aggregate. Of these emissions, 59% were generated domestically. The manufacturing sector was the second largest contributor to the country's GHG footprint, accounting for 8.3 MtCO2-eq or 19.7% of the total. Unlike the energy supply sector, the manufacturing footprint was more reliant on external partners, with 70% of emissions originating from outside Bulgaria. Transportation and storage activities sliced a share of 13%, amounting to 5.5 MtCO2-eq in the total footprint, with most emissions occurring domestically, at 66%. Agriculture, forestry and fishing, which generated 5.2 MtCO2-eq or 12.3% of the total footprint, saw 51% of its emissions originating from outside Bulgaria. Mining and quarrying produced 4.5 MtCO2-eq or 10.6% of Bulgaria's GHG footprint and was the most heavily reliant on foreign supply chains, with 91% of emissions originating outside of Bulgaria. Other economic sectors sliced single-digit shares in Bulgaria's GHG footprint. Of these, water supply, sewerage, waste management and remediation activities produced 2.3 MtCO2-eq or 5.5%, relying more on foreign-sourced emissions, which accounted for 57%. Conversely, the construction sector, which only generated 0.5 MtCO2-eq or 1.1% of the aggregate footprint, was the most autonomous, with 95% of emissions generated domestically. The footprint of household activities was, as expected, entirely domestically generated, accounting for 8.2% or 3.5 MtCO2-eq of the aggregate.

T. Georgieva, ICGB: We're turning energy independence into regional resilience and climate leadership

Teodora Georgieva
Executive Officer and Board Member of ICGB

ICGB is the independent transmission operator of the 182 km Greece-Bulgaria natural gas interconnector (IGB). ICGB is held equally by state-owned Bulgarian Energy Holding (BEH) and IGI Poseidon, a joint venture of the Greek DEPA and the Italian Edison. Teodora Georgieva serves as Executive Officer and Board Member of ICGB, bringing over 25 years' experience in energy and industrial management across Southeast Europe. Since 2015, she has led ICGB in establishing the IGB pipeline as a key EU diversification asset.

How does ICGB see its role in supporting Bulgaria's decarbonisation pathway, particularly in ensuring that today's diversification efforts lay the groundwork for a fair and secure energy transition?

I believe the IGB pipeline is more than infrastructure - it is a geopolitical and economic turning point. Since commissioning in October 2022, IGB has provided Bulgaria with direct access to non-Russian natural gas for the first time in history. This achievement fundamentally reshaped the country's energy architecture, strengthening both security of supply and market resilience.

As Europe moves toward low-carbon future, ICGB is committed to ensuring the transition is fair, secure, and strategically sequenced. Natural gas remains a critical transitional fuel, enabling countries like Bulgaria to reduce emissions responsibly while scaling up renewables. IGB is already delivering on this promise, serving as the backbone of diversification today and as a launchpad for tomorrow's low-carbon solutions. This is not a passive role. By securing stable access to reliable and affordable energy, we are laying the groundwork for a transition that does not compromise competitiveness or security.

With IGB serving as a key element of the Vertical Gas Corridor, how do you envision its long-term contribution to regional energy security, market stability and sustainability?

IGB serves as a key pillar of the Vertical Gas Corridor and its long-term contribution is also relevant to shaping the future of energy diplomacy in the region. The VGC now links seven countries, including Moldova and Ukraine, creating a flexible north–south axis that complements and strengthens traditional east–west flows. IGB is one of its foundational building blocks, physically and operationally connecting the Southern Gas Corridor to the broader European network.

Looking ahead, IGB is positioned to enable multidirectional gas flows, enhancing system resilience and driving market integration. This is critical as Europe accelerates its diversification away from traditional suppliers and as demand patterns evolve. We have demonstrated that this infrastructure can deliver under pressure, and we are ready to scale further. For Bulgaria, IGB has transformed energy independence from aspiration to reality.

For me, this is a professional mission and a personal cause. I believe deeply in the power of infrastructure to transform economies, strengthen alliances, and deliver real resilience. IGB embodies that belief.

What is the impact of interconnections with Greek LNG terminals on supply flexibility?

IGB's connectivity with Greece's national gas transmission system provides Bulgaria and neighbours with direct access to multiple LNG entry points, significantly enhancing supply flexibility. Proximity to key terminals - such as Revithoussa and the Alexandroupolis FSRU - enables gas from global suppliers, including the US, Qatar, and others, to reach markets across South-East and even Central Europe. In an era marked by geopolitical volatility and price fluctuations, this flexibility is a strategic necessity.

LNG cargoes can be rerouted swiftly in response to market dynamics and IGB ensures these opportunities are fully actionable. For Bulgaria, this means access to a broader, more competitive supplier portfolio. For the region, it means greater resilience and a tangible step toward a better integrated and diversified energy landscape. In line with our commitment to solidarity - particularly in support of Ukraine - ICGB is preparing to launch new products with the highest available discount -46%, to facilitate access and enhance competitiveness.

How is the IGB's capacity expansion progressing?

The expansion from 3 to 5 bcm/y is a high-impact initiative we are driving forward. We continue to coordinate closely with our partners in Bulgaria and Greece. Although the non-binding phase of the 2025 incremental capacity process reflected limited market interest due to geopolitical uncertainty and a shift toward short-term contracts, our commitment remains firm. The long-term need for flexible, interconnected energy infrastructure is indisputable.

We have not waited for market signals to validate our vision. The construction permit for the Stara Zagora extension is secured, the contracting strategy is finalised, and we are ready to launch procurement pending corporate approvals. Now, with the European Commission's decision to phase out Russian gas, the relevance has only intensified. Europe faces the challenge of replacing up to 59 bcm/y of supply, and our infrastructure is positioned to deliver.

www.icgb.eu

Financing the transition

Environmental expenditure

Bulgaria's decarbonisation efforts are supported by two pillars – the stable but insufficient domestic environmental spending, complemented by access to massive financial firepower from the EU's mechanisms. The **national expenditure on environmental protection (NEEP)** measures the resources devoted by the Bulgarian government, business sector and households to protecting the natural environment and represents the **sum of use of environmental protection services, gross fixed capital formation for environmental protection activities and net transfers to the rest of the world for environmental protection**.

Eurostat's latest available data shows that **in 2022, Bulgaria spent nearly EUR 1.6 bln on environmental protection**. **This corresponded to 1.8% of the country's annual GDP, placing Bulgaria around the middle of the EU Member States ranking on this indicator and just short of the EU average of 2.1%.** Behind the seemingly consistent expansion of Bulgaria's climate-related spending over time, hand in hand with the country's GDP growth, the picture in the last five years was far more nuanced. **The private sector significantly stepped up its efforts and more than doubled its aggregate environmental protection expenditure between 2018 and 2022, reaching EUR 961 mln, or nearly two-thirds of the national total.** Conversely, **government climate-related spending** grew much more slowly during this period, **peaking at EUR 478 mln in 2020 and then declining for two consecutive years to as low as EUR 409 mln in 2022**. Households also saw their environmental protection expenditure climb in absolute terms, albeit marginally at EUR 214 mln in 2022.

The recent **shift of financing environmental protection from government towards businesses** has likely been driven less by cumbersome domestic policy and more by market forces, such as corporate ESG reporting efforts and peer pressure from EU supply chains.

BULGARIAN DEVELOPMENT BANK

BDB: A catalyst for sustainable growth and decarbonisation in Bulgaria

Tsanko Arabadzhiev
Executive Director of BDB

The Bulgarian Development Bank (BDB) is a state-owned financial institution established in 1999 to support small and medium-sized enterprises (SMEs) and foster sustainable economic growth. As Bulgaria's only bank providing both direct and on-lending financing, the BDB is guided by its mission to stimulate economic growth and sustainable investment by supporting SMEs, the public sector and the implementation of national policies. The BDB plays a key role in supporting decarbonisation by promoting energy efficiency and backing projects in support of a green and circular economy.

Tsanko Arabadzhiev is senior finance executive with deep expertise in capital markets, banking, insurance and asset management. With two decades of leadership experience, he has built a strong track record in investment strategy, risk management and financial governance. He holds a Master's degree in Finance from the University of National and World Economy and is a certified Investment Advisor. He has held senior roles at United Bulgarian Bank, UNIQA Insurance and since 2019 has been with Pension Assurance Company Doverie, overseeing the internal control of its investment activities. Mr. Arabadzhiev is also a long-serving member of the Management Board of the BDB. In this position, he contributes strategic leadership and market expertise to advancing BDB's role as Bulgaria's national promotional institution, driving sustainable growth, SME development and the country's green transition in line with European and global policy priorities.

Mr. Arabadzhiev, how do you see BDB's role in Bulgaria's decarbonisation journey and what types of projects define the bank's current green portfolio?

At the Bulgarian Development Bank, we see ourselves as a facilitator of national green policies and programmes. Our role is multifaceted: as a financier, a de-risking partner, a capacity builder and an institution committed to aligning public finance with long-term environmental sustainability goals.

We support Bulgaria's decarbonisation ambitions by facilitating investments that help reduce greenhouse gas emissions, improve energy efficiency, expand renewable energy generation and promote sustainable practices among businesses and households. These goals are directly aligned with the EU Green Deal, Bulgaria's National Energy and Climate Plan and the Recovery and Resilience Facility.

A significant share of our green portfolio is dedicated to financing photovoltaic installations. In late 2021 and 2022, we launched a dedicated programme for solar projects, which proved highly successful. Commercial banks subsequently replicated the model after seeing its potential, thereby confirming BDB's catalytic role in addressing a market gap, demonstrating the viability of such a portfolio and encouraging other financial institutions to scale it up.

Our green loans target:

- Energy efficiency improvements in buildings and industrial processes, such as insulation upgrades, efficient heating systems or green manufacturing equipment.

- Renewable energy for households and SMEs, particularly rooftop photovoltaic systems and solar thermal installations.

- Public infrastructure projects that integrate clean energy, especially solar power installations on schools, hospitals and municipal buildings.

The Bank is also open to finance circular economy initiatives, waste reduction solutions and digital innovations that enable smarter resource use. It is important to say, that we support both, larger projects and SMEs in the adaptation to climate change. BDB is committed to enabling access to clean energy and efficiency upgrades for individuals, small enterprises and local governments.

Since development banks often back riskier, long-horizon projects, how does the BDB evaluate the viability and investor appetite for decarbonisation investments and what financial instruments help make them more appealing to investors?

As a development bank, we are uniquely positioned to support investments that may be risky or too long-term for traditional banks. Decarbonisation projects often fall into this category, particularly those involving early-stage technologies, public infrastructure or small-scale borrowers like households.

We assess not only financial viability but also social and environmental impact, while applying a conservative risk framework.

To make green projects more attractive to investors, we use instruments such as guarantees, on-lending through intermediaries, preferential loans, leasing and blended finance. As an implementing partner of the European Commission, commercial banks and other intermediaries, BDB amplifies the effect of public resources by leveraging private capital. This ensures enhanced access to finance through lower financing costs, extended maturities, reduced collateral requirements and tailored repayment terms.

Our InvestEU portfolio prioritises SME financing for green transition, sustainable infrastructure, including waste, wastewater and clean air projects, multimodal transport, encouraging a shift towards sustainable modes of transport and reducing greenhouse gas emissions and pollution.

Through these instruments, BDB addresses clear market gaps – where commercial finance alone is insufficient – while catalysing long-term investment flows into Bulgaria's green and circular economy.

Could you share some of the bank's European and international partnerships and how their resources are leveraged to support projects related to decarbonisation?

Our partnerships with European and international financial institutions are crucial for amplifying impact and aligning Bulgaria's decarbonisation journey with global goals. They provide not only capital and risk-sharing mechanisms but also know-how, standards and credibility.

We work closely with the European Investment Bank, with whom we have a EUR175 million loan agreement, part of which is dedicated to green and sustainable investments, including SMEs, energy efficiency and environmental projects. We also partner with the Council of Europe Development Bank, with a EUR175 million facility targeting micro, small and medium-sized enterprises, green companies, family businesses, social entrepreneurship and vulnerable groups. Under the InvestEU programme, we signed a EUR 40 million guarantee agreement with the European Commission to support SMEs and mid-caps investing in green technologies, digitalisation and innovation.

In addition, under the 2025 State Budget framework, which authorises BDB to mobilise up to BGN 2.5 billion with a state guarantee for the implementation of the National Energy Efficiency Programme, we have launched active negotiations with international lenders. Talks with KfW, KBC, ING, UniCredit and others are already at an advanced stage.

What motivated the partnership between the BDB and Bulgaria's electricity system operator, ESO, and how is their joint programme designed and implemented to promote decarbonisation?

Our joint programme with ESO provides financing for renewable energy installations and energy storage systems on public buildings helping reduce carbon emissions, operating costs and ensuring energy security in critical sectors such as healthcare and education.

Bulgaria's public infrastructure – schools, hospitals, kindergartens and municipal buildings – offers a huge yet underused opportunity for energy independence and decarbonisation.

The programme was designed to lower energy costs for public institutions, expand distributed renewable energy and foster public-sector leadership in the green transition.

Importantly, the mechanism leverages public resources to attract private capital. Through a special purpose investment company (SPIC) listed on the Bulgarian Stock Exchange, private investors can participate directly, while BDB fulfills its role as a market-based creator of financial instruments that address gaps and operate on purely commercial terms.

BDB provides the financial tools and advisory support, while ESO ensures technical implementation, grid compatibility and efficient integration of the system.

Looking ahead, how does BDB plan to expand its role in financing Bulgaria's green transition, and what emerging areas of decarbonisation do you see as priorities in need of financing?

BDB will continue to be a key partner of the Bulgarian state in implementing the second stage of the National Energy Efficiency Programme, which remains central to reducing emissions and energy costs nationwide. A major priority in the coming years is the promotion and scaling-up of our joint programme with ESO, which plays a key role in optimising electricity costs for public users. The programme will deliver high environmental value and foster the active participation of public institutions and enterprises in the transition to a circular economy.

We are also actively financing battery storage projects under the Recovery and Resilience Plan, recognising storage as critical for grid stability and renewable integration. In parallel, BDB continues to offer preferential financing for green and sustainable transformation under the InvestEU programme, supporting SMEs and mid-caps in adopting low-carbon technologies.

Our strategy is to expand access to green finance for both public and private stakeholders, while developing market-driven instruments that unlock investment in emerging areas such as energy storage, distributed renewables and energy efficiency at scale.

Funding mechanisms

Recovery and Resilience Facility

The **European Commission's Recovery and Resilience Facility (RRF) is one of the major mechanisms for funding decarbonisation activities in Bulgaria**. Its aim to make EU economies more sustainable, resilient and prepared for the green and digital transitions, and to help implement the REPowerEU plan for overcoming the energy markets disruption caused by Russia's invasion of Ukraine, is in line with Bulgaria's vision of reducing the energy intensity of its economy and integrating cleaner sources in its energy mix.

Although in a broader sense multiple RRF pillars contribute to various extents to decarbonisation, the **Green transition is the main pillar facilitating the mainstreaming of climate action and environmental sustainability**. The Green transition pillar is the plan's single largest component, with **49.9% of the total allocation, or approximately EUR 3.1 bln, dedicated to climate-related measures**. **Under the Green transition pillar, Bulgaria has put forward a total of 105 milestones and targets, of which 71 are investments and 34 reforms, with 38 measures for their implementation. As of November 2025, the fulfilment status of the targets stands at 27%**, with the rest not having been assessed yet. Bulgaria's updated plan under the RRF also contains **a new REPowerEU chapter, which provides an additional EUR 479 mln specifically for measures to promote renewable energy deployment and storage and support electricity market liberalisation**, which should both boost decarbonisation of the economy.

Cohesion Policy 2021-2027

Beyond national environmental expenditure and RRF funding committed to climate-related spending, several other EU financing envelopes support environmental endeavours. **The 2021-2027 Cohesion Policy investment strategy planned a total allocation of EUR 10.7 bln for Bulgaria, representing 2.9% of the allocation for all member states, according to the EC. Of this total amount, over EUR 2 bln has been allocated to climate programmes in Bulgaria through the PO2 Greener Europe policy objective. This slices a share of 36% in Bulgaria's total Cohesion Policy funding, above the EU's aggregate 25.5%.** Of the total budgeted amount, EUR 1.4 bln or 69% has been formally committed or approved by the managing authorities, with only EUR 84.5 mln or 4% disbursed to selected projects thus far. The largest planned allocation of EUR 607 mln targets sustainable water, followed by circular economy and nature protection and biodiversity measures, which account for EUR 598.3 mln and EUR 483 mln, respectively. Climate change adaptation ranks fourth with EUR 186.2 mln, while energy efficiency and sustainable urban mobility programmes follow with planned budgets of EUR 114 mln and EUR 40 mln, respectively.

Modernisation Fund

The EU's Modernisation Fund (MF) supports thirteen lower-income member states to achieve their climate targets and the broader objectives of the EU Green Deal. Eligible projects are related to the uptake of renewable energy, energy efficiency, energy storage, energy networks, as well as social support enabling a just transition in carbon-dependent regions. Established in 2018 for the 2021-2030 period, the fund is financed by revenues from the auctioning of 2% of all EU ETS allowances between 2021 and 2030, an additional 2.5% between 2024 and 2030, as well as allowances transferred by member states from solidarity, growth and interconnection objectives, or from free allocations to electricity generators. **Bulgaria has so far been the beneficiary of disbursements amounting to EUR 261.8 mln or around 1.4% of the total distributed to the thirteen member states through the MF.** The funding targeted five projects related to rolling out smart meters and related infrastructure, integrating the Metering Data Management (MDM) System, as well as modernising, digitalising, and developing the country's electricity distribution infrastructure.

Innovation Fund

The EU's Innovation Fund also serves as a key enabler of decarbonisation, supporting the development of innovative low-carbon technologies. Also financed through the Union's ETS revenues, the fund has an estimated budget of EUR 40 bln, based on a carbon price of EUR 75/tCO2. So far, EUR 12.9 bln have been disbursed across the EU to 492 participants for 222 projects. The largest share was claimed by hydrogen projects (15.3%), followed by chemicals (10.4%), cement and lime (7.2%), refineries (6.9%) and the manufacturing of components for renewable energy or energy storage (6.3%). **Bulgaria only tallied one project on this roster, in the cement and lime sector, with a projected GHG emission avoidance of 7.8 MtCO2-eq.**

identrics

Responsible AI: (Choosing) Intelligent over infinite growth

Yolina Petrova
Chief Operations and AI Officer of Identrics

Identrics is an applied AI company curating and creating knowledge for Governance, Risk & Compliance Providers and Media Intelligence organisations. Blending in-house artificial intelligence with client data and subject expertise, its off-the-shelf models are tuned to specific back-office automations and end-client use cases. Beyond technology, Identrics is partnering with Academia, Government, Civil Organisations and the Media in promoting information integrity practices and understanding and measuring AI and its impact on communications.

Artificial Intelligence is often seen as a tool for efficiency and decarbonization, but few talk about AI's own carbon footprint. What is your perspective on that?

The environmental footprint of AI is one of the industry's quiet taboos. We often talk about how AI can optimise energy grids, decarbonise logistics, and drive efficiency. And that's true. But we rarely pause to ask what fuels artificial intelligence itself. Behind every generative model lies a chain of high-energy computations, massive data centres, and repeated training cycles.

Training a single large AI model can emit as much CO_2 as five cars over their entire lifetimes, and most organisations train not one, but dozens of models before deployment. These emissions are not merely a side effect of technological progress; they reflect how we approach the very implementation of our AI solutions.

As Karen Hao points out in The Empire of AI, "**AI doesn't exist in a vacuum; it mirrors the economies and infrastructures that build it.**" I completely agree. If we want AI to be a genuine force of progress, we must make it a responsible citizen of the planet. That means building AI strategies that prioritise efficiency and transparency and treating energy as a design parameter, not an afterthought.

What can the industry do to reduce the emissions associated with AI without slowing innovation?

It starts with strategy. The biggest environmental impact doesn't come from the next algorithmic breakthrough, it comes from how thoughtfully we plan, train, and scale our AI. At Identrics, the AI strategy guiding principle is simple: **start small, scale smart**. Before investing in massive computational resources, we build and test lean prototypes using focused datasets and smaller, domain-specific models. We only scale once we're certain that these solutions cannot meet the desired performance goals efficiently. This prevents wasted computation cycles and avoids the 'train first, think later' mindset that has become common in the industry.

This approach is not only environmentally responsible; it's also economically reasonable. If we view AI through the lens of energy intensity - output per unit of energy - we find that resource-efficient AI can actually strengthen productivity growth. Just as economies aim to decouple GDP from emissions, the AI sector must decouple intelligence from energy waste. That means carefully planned training schedules, using renewable-powered cloud infrastructure, and re-using pre-trained models with a bit of tweaking whenever possible. AI should not be treated as an unlimited resource, but as an evolving system that demands precision and discipline.

If you could send one message to the global AI community, what would it be?

AI's footprint is part of a larger feedback loop between technology, productivity, and emissions. Historically, economic growth has been tied to rising energy use. But in the digital era, we have the chance to rewrite that equation. Smarter AI can optimise industry, predict failures, and cut waste. But these gains lose meaning if AI itself becomes an energy-hungry engine of growth. And right now, that's where the trend is going.

That's why AI strategies must be integrated into national decarbonisation frameworks. When governments and companies assess emissions, AI should no longer remain a blind spot. Transparent reporting of model training emissions and lifecycle impact must become as standard as financial audits. The EU's AI Act is an encouraging step in that direction.

My message to the AI community is simple: **the race for larger models and faster benchmarks is exciting, but true innovation lies in careful planning with scientific discipline, efficiency, adaptability, and purpose.** The current AI hype risks drowning out the scientific discipline that makes technology resilient. Just as rigorous science depends on method and measurement, sustainable AI depends on strategy and restraint. Starting big without solid foundations isn't progress, it's waste. **Our goal shouldn't be infinite growth, it should be intelligent growth.**

Methodology

The analysis assesses Bulgaria's progress towards decarbonisation targets within the broader EU policy framework. GHG emission trends are interpreted in light of major policy milestones such as the first commitment period of the Kyoto Protocol, which paved the way for later climate initiatives such as the Paris Agreement and the European Green Deal. External shocks such as the global financial crisis of 2008, the Covid-19 pandemic and the war in Ukraine, coupled with domestic structural changes such as Bulgaria's transition towards a market economy and its demographic decline, were also considered to distinguish how policy and externalities shaped Bulgaria's decarbonisation path.

Decarbonisation trends were assessed through complementary lenses, differentiating between technical processes responsible for emissions and the economic activities generating them. The former draws on GHG emission inventories collected by the European Environment Agency (EEA) on behalf of the European Commission, while the latter reflects the System of Environmental-Economic Accounting (SEEA), whose air emission accounts reflect the breakdown by economic activity according to the EU's NACE Rev.2 classification. Both accounting methods are compiled by Eurostat. While inventories classify emissions by technical processes using the territory principle, air emissions accounts assign them to economic activities by the residence principle.

Beyond aggregate trends, the analysis highlights key sectors responsible for GHG emissions in Bulgaria. As a general sectoral framework, the country's emissions profile was viewed through the EU's two-pillar policy framework comprising the main emissions curbing market mechanisms - the Emissions Trading System (EU ETS), whose scope encompasses hard-to-abate, heavy industries and the Effort Sharing Regulation (ESR), which assigns targets to the remaining sectors. The energy, industry, transport and buildings sectors, along with corresponding household emissions, were examined individually due to their key role in Bulgaria's decarbonisation trajectory.

The intersection of economic performance and decarbonisation was also assessed. To this end, several metrics were employed, including emission intensity (calculated as GHG emissions per unit of gross value added - GVA), energy productivity (calculated as EUR per kilogramme of oil equivalent - kgoe) and a footprint-versus-production approach to distinguish consumption-based emissions from domestic production and determine Bulgaria's status as a net exporter of emissions. The origin of Bulgaria's GHG footprint was also analysed to identify supply chain dependencies. Financing mechanisms supporting decarbonisation were also reviewed through the lens of environmental expenditure statistics, as well as EU fund allocations and disbursement data.

Limitations

Accounting differences between the two emissions inventories may cause discrepancies in aggregate emission values due to the territory versus residence principles and the inclusion of memorandum items. Targets and national trajectories rely on Bulgaria's National Energy and Climate Plan (NECP) modelling scenarios and may be revised in the future, while financing data reflect available disbursement information and may not capture pending commitments.

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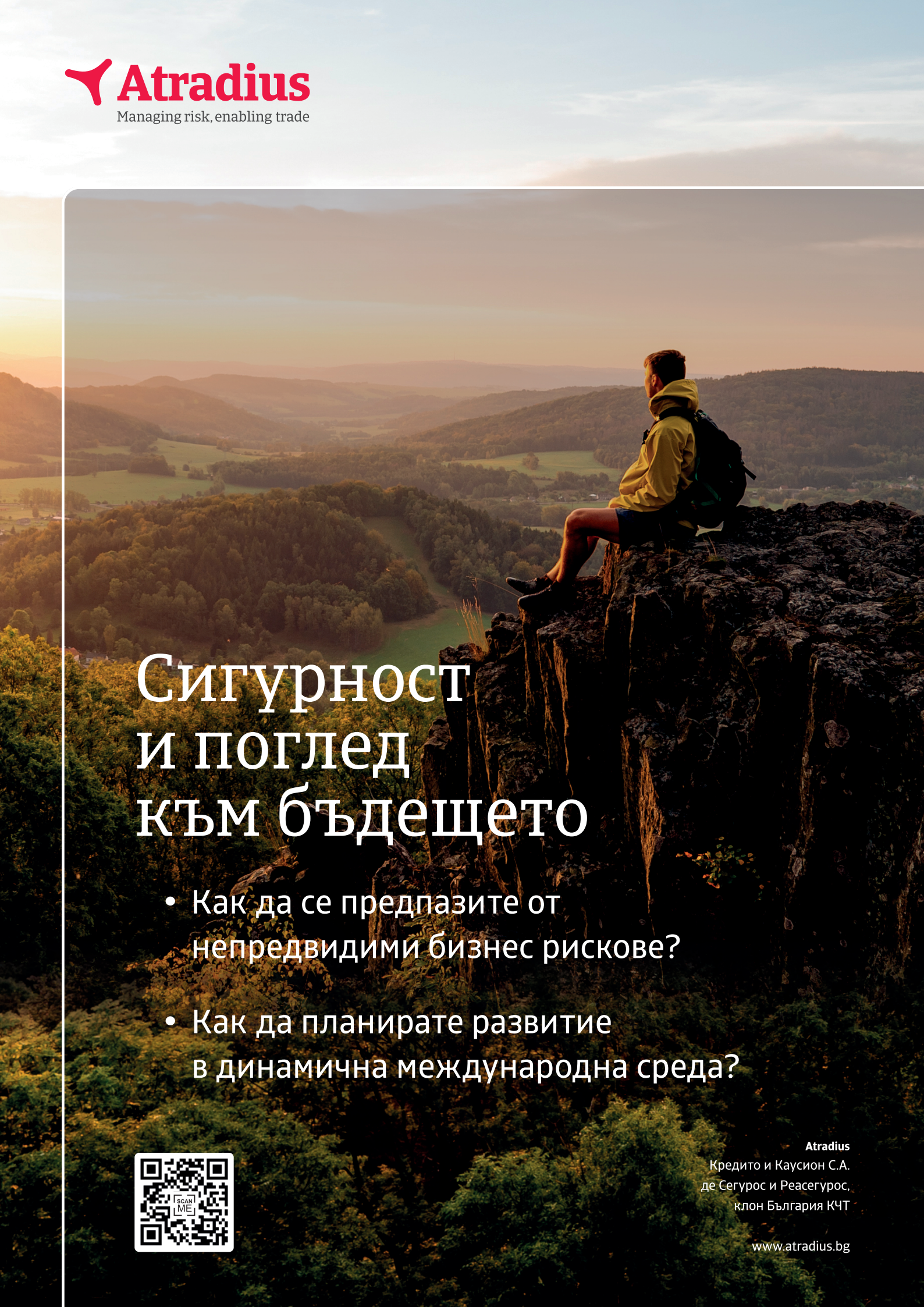
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