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Innovation and
Sustainable Growth

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
BAS	Bulgarian Academy of Sciences
BCC	Bulgarian Chamber of Commerce
BNB	Bulgarian National Bank
DIANA	Defence Innovation Accelerator for the North Atlantic Region
EC	European Commission
EIS	European Innovation Scoreboard
EPO	European Patent Office
EU	European Union
eVTOL	Electric Vertical Take-off and Landing Aircraft
FMFIB	Fund Manager of Financial Instruments in Bulgaria
GDP	Gross Domestic Product
GII	Global Innovation Index
ICT	Information and Communications Technologies
NCPR	North Central Planning Region
NEPR	North East Planning Region
NSF	National Science Fund
NSI	National Statistics Institute
NUTS	Nomenclature of Territorial Units for Statistics
NWPR	North West Planning Region
PORB	Patent Office of Republic of Bulgaria
PRO	Public Research Organisation
R&D	Research and Development
SCPR	South Central Planning Region
SEPR	South East Planning Region
SIR	SCImago Institutions Rankings
SME	Small and Medium Enterprises
SWPR	South West Planning Region
USA	United States of America
VCC	Variable Capital Company
WIPO	World Intellectual Property Organisation

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EXECUTIVE SUMMARY

In 2023, the **European economy improved its innovation potential**. The growth (the change in value of the Innovation Index on average for the EU27) for the last seven-year period was 8.5%, and for the last one year – 0.51%. However, the distance of the European Union economy from the US, China and Japan remains significant and **worrying, especially considering the series of global and regional crises** and challenges. The reasons for this comparative backwardness are mainly rooted in the inability of the EU to fully exploit the scale of its common market, to concentrate public and private resources effectively in research and innovation, and to create companies capable of competing on a global level. These limitations were particularly evident in the inability of the EU to quickly increase the capacity of its defence industry and help Ukraine counter Russian aggression. Given the long-term deterioration of the EU's border security environment, the community's long-term development will increasingly depend on the **ability of economies to collectively create and sustain technologies and innovations** ahead of the main strategic competitors, Russia and China. In addition, it is a necessary condition to achieve the EU's long-term objective of **strategic autonomy** and geopolitical clout.

***Innovation.bg* 2023**

Bulgaria registered the most serious improvement of its innovation performance on a one-year basis within the EU27 – nearly 14%, followed by the Czech Republic (11%) and Poland (8%). However, the higher values of the country's innovation index in the last year were not enough to help it catch up with the EU average. **Bulgaria remains in the group of emerging innovators** in penultimate place (before Romania) at a level of 46.7% compared to the EU27 average and even below the average performance of the group (54% compared to the EU27).

The worsening **geopolitical and geoeconomic crises** in recent years and the need to confront their consequences through changes in European and national priorities, the entry into a new programme period (related to the preparation

of a new set of strategic and programming documents), and above all the substantial political instability in Bulgaria deepened **the structural problems of the national innovation system.**

The lack of a sufficient **national funding** for science and innovation (only at 22% of the EU27 average levels for the group of indicators of funding and support in the European Innovation Scoreboard) and the inefficient use of the existing resources, as well as the devaluation of the available human capital (slightly less than a third of the EU27 average levels in the "Human Resources" group) **do not allow the country to achieve the qualitative jump** it needs to move to intensive innovation development. All these challenges require increasingly bold but less feasible innovation policies and make it likely that the comparative backwardness from the EU core will be maintained.

Compared to 2016 (the baseline year in the latest European Innovation Scoreboard report), in 2023 Bulgaria registered the **most significant improvement in the following areas**:

- **share of innovative enterprises that interact** with partners within the innovation process (growth of 51.8%); increased number of **joint publications** between the public and private sectors;
- **process innovations** with a growth of 45% and share of innovative enterprises with product innovations (82.2%);
- **employment in innovative enterprises** (growth of nearly 41%);
- **emissions of fine dust particles from industry**, as well as the development of technologies related to reducing the negative impact on the environment, in terms of which Bulgaria is at the average levels for the EU27.

Thanks to a **highly developing ICT sector**, Bulgaria is getting closer to the average European levels in terms of number of specialists in the field of ICT (83%) and the export of knowledge-intensive services (75%).

According to the European Regional Innovation Scoreboard, **all Bulgarian regions fall into the last group of emerging innovators.** The only indication that the South West Planning Region (SWPP) is doing relatively better than the national average is the positive sign (+) added to the category.

The lack of (significant) progress for Bulgaria, evidenced by the European Innovation Scoreboard, and the additional analysis at the regional level is also confirmed by the data of the Global Innovation Index for 2023. On an annual basis**, Bulgaria retreated by four positions to 38th place** among 132 countries**.** Measured by the index values, the downward move is by 0.5 points, or an innovation index of 39, which is the lowest for the country in more than 10 years. Still, **within the EU**, **Bulgaria ranks 22nd**, ahead of Poland, Greece, Croatia, Slovakia and Romania. In the group of **countries with upper middle-income per capita**, Bulgaria ranks **third**, one position lower than in 2022, after China (12th place in the overall ranking) and Malaysia (36th place in the general ranking).

Technological and research product

Bulgaria **ranks 24th within the EU27** with 45 patent applications to the European Patent Office (EPO) (two more than in 2021), ahead of Cyprus, Croatia and Latvia. Regarding the indicator of the number of patent applications per 1 million people (6.6 patents), Bulgaria is ahead of only Romania (2.4 patents).

For comparison, patent applications to the EPO originating in Sweden are 481.8 per 1 million people (first place in the EU27), and from Slovenia – 58.4 (first place among Central and Eastern Europe countries). **Bulgarian companies and organisations received only 22 patents from the EPO** (one fewer than in 2021), only ahead of Cyprus and Lithuania.

In 2022, the patents issued by the Patent Office of the Republic of Bulgaria (PORB) to **Bulgarian patent holders** were 87, **which is less than half of their number in the previous year**. All institutional sectors had a decrease in the number of patents received. In 2022, the **scientific community** in Bulgaria registered 7,225 documents in the Scopus database, which ranked the country 65th in the global ranking for this indicator. On a one-year basis, there was a **5% drop** in the number of documents with Bulgarian participation registered in the database and a drop of one position in the world ranking. In the region of Eastern Europe, Bulgaria ranks 10th out of a total of 23 countries in terms of scientific production included in Scopus, ahead of three EU member states – Lithuania, Estonia and Latvia. After some growth in 2018, Bulgaria maintained a stable share of about **0.7% of the publication activity within the EU-27**, which allowed the country to maintain its positions from a quarter of a century ago. Bulgaria is in 21st place among other member countries, ahead of Lithuania, Cyprus, Estonia, Luxembourg, Latvia and Malta.

In 2022, **the engineering sciences** became the leading scientific field in Bulgaria (1,628 documents in the Scopus database). This is a result of the increased interest of the scientific community in electrical engineering and electronics, security, risk and control, and mechatronics and automotive engineering.

Entrepreneurship

A recent Eurobarometer study contains positive signs for the future of **youth and social entrepreneurship** in the country. These signs are about activity and, more importantly, about the **attitudes and values of young people**.

Bulgaria is emerging as a **leader in the EU** in terms of attitudes towards entrepreneurship and its implementation among young people (under 30). **The highest share of committed young people** (between 15 and 30 years old) with their own business in Europe is in Bulgaria – 14%, against an average of 9% in the EU, with a minimum level of 5% in Luxembourg. Some of these business ventures are informal, without registering a commercial company: trading on olx.bg and the various meta-channels, Airbnb accommodations, repair crews, etc. This **informal entrepreneurship** creates experience and acts as a market test. The sectors in which young people most often consider starting a business are information and communication technologies (15% of all), trade (11%), marketing (11%), creative industries – art, design and culture (10%). Bulgaria differs from other EU countries in two sectors – **IT and industrial production**. There, Bulgarians have the highest shares of those willing to start a business – 15%, compared to an average of 13% for the EU in the IT sector and 8%, compared to an average of 4% for the EU in industrial production.

In 2023, a new trend is taking shape in the ecosystem supporting entrepreneurship, namely the **focus on smaller towns**, outside the five large cities (Sofia, Plovdiv, Varna, Burgas and Rousse) and more specifically in places where there are no universities or that have limited outsourced training by established universities.

Innovation networks in Bulgaria, including new business associations, international business networks and academic networks, are increasing their intensity and interconnectedness. The Bulgarian section of the **Enterprise Europe Network** continues to be among the leaders in Europe, with activity indicators above the EU average, despite the lack of a national co-financing mechanism, which in one form or another exists in all other EU member states.

Financing

According to the latest data available for 2022, research and development (R&D) spending in Bulgaria reached **BGN 1,266 million**, which is an **increase of nearly 18**% compared to the previous year. However, as a relative share, R&D spending made up only **0.75**% **of GDP – a decrease of 0.02 pp. on an annual basis**, a significant retreat from the "record" year of 2015. **Enterprises** carry out more than **two-thirds of R&D spending** in the country (68%). The total amount of business investments for research and development amounts to **BGN 858 million**, which is a **growth of 21**% on an annual basis. The increase achieved allows business to maintain the GDP share of R&D spending at 0.51%, which, however, remains well below the peak values of 2015.

The GDP share of R&D spending by the higher education sector is also unchanged – 0.05%, which is **the result of an increase in the amount spent by universities for science and technology transfer in the amount of 14**% on a one-year basis. The **public sector** is an exception with a **drop in the GDP share of R&D spending by 2 pp. to 0.19**%. The amount spent on the development of scientific research by public research organisations is BGN 322 million, with a growth of nearly 11% on a one-year basis.

Human resources

The employees engaged in R&D in Bulgaria in 2022 numbered **37 thousand people** after a **growth of 7**% over the last year. Exactly **half of the research workforce is concentrated in enterprises** – the largest share ever after a continuous growth rate since 2013. In the last year alone, the increase in R&D staff in the business sector has been close to 15%. With almost equal positions are the public sector and higher education, respectively 24% and 26%. In both groups of public organisations (with small exceptions for higher education institutions), the number of employed researchers has been relatively stable, which over time has affected their relative weight.

According to the latest available data from 2021, while almost 90% of the EU population use the internet at least once a week, only 54% have basic or above **basic digital skills**. In EU member states, the proportion of people with basic or above basic digital skills is highest in Finland and the Netherlands (79% each), followed by Ireland (70%) and Denmark (69%). At the **bottom of the ranking are Bulgaria and Romania** with respectively 31% and 28%.

In terms of the share of **employed ICT specialists**, business in **Bulgaria is ahead** of Croatia, Poland, Romania and Greece – 3.8% of all employed in the country are ICT specialists compared to an average level for the EU27 of 4.6% (according to the latest data available for 2022). Against this background, only 9.1% of enterprises in Bulgaria provide **training for their staff** in the field of digital technologies, which is **the second lowest result within the Community** after Romania. The share in Finland, which is the leader in the indicator, is 39.8%, while the EU27 average is 22.4%. Most enterprises in Bulgaria (52%) have a very

low level of **digitalisation of business processes** (only ahead of Greece with 58%, with an average of 30% for the EU27). For another 30.3%, the degree of digitalisation is defined as low. However, almost a fifth of the businesses in Bulgaria (18%) have a high and very high level of digital transformation and can serve as a **role model**.

According to the EU's Digital Decade targets, all **key public services** for businesses and citizens must be fully accessible online by 2030. Only 42% of people in the EU who were active online in the previous 12 months used it to receive information about government services (according to the latest data available for 2022). This share varies considerably across EU countries. In 13 of them, over 50% used such information, with Finland (79%), Denmark (74%) and the Netherlands (73%) leading the group. In Bulgaria, the share of people who inform themselves about government services online is **critically low** both as a total share (11.6%) and in relation to individual age categories – 16 to 24-year-olds (7.8%), 25-64 (13%) and 65-74 (5.9%). For the EU27, the proportion is highest among those aged 25 to 64 (45%), followed by 16-24 (37%) and 65-74 (33%).

Introduced in late 2022, **generative artificial intelligence** (AI) ChatGPT is the world's fastest growing information, communication or cognitive technology to date. Bulgarian business is no exception to this trend, although at a much slower pace. A survey in the first half of 2023 among members of the Bulgarian Chamber of Commerce showed that **26% already use AI** in their business processes, and 28% plan to do so in the next three years; 18% of companies believe that they do not need AI and the same number say that it is too expensive; the remaining 10% are not sure what to think about AI. Mirror data for the population, however, show that the Bulgarian society is late with the adoption. A significant part of **Bulgarians (37%) do not know what artificial intelligence is**, and 39.4% have a negative attitude towards it. Only 31% of those surveyed know what artificial intelligence is (self-assessment) and have a positive (and rather positive) attitude.

Information and communication technologies

One of the **strongest points of the innovation environment** in Bulgaria is the access to information and communication technologies (ICT). As a result, Bulgaria is positioned 24th in the Global Innovation Index 2023, much better than the overall innovation performance. Having a large enough community of developers of new software technologies in leading areas such as fintech, regtech, insurtech, automotive electronics and management, cobots, etc., gradually leads to the **accumulation of external positive effects** and to the development of other businesses, including in traditional sectors such as agriculture.

Bulgaria continues to perform well as an **exporter of telecommunications, computer and information services**, albeit reaching a plateau in 2023. The slowdown in growth is linked to the slowdown of economies in the European Union in the second half of 2023. There were also several changes in the ownership of businesses in the sector, which may have led to optimisation and/or reduction of output and employment in the second half of the year.

Special focus 2023: Research and development in the defence industry

In the last two years, the Bulgarian defence industry had the **largest growth in production** for the entire period since 1989. The reason is the Russian

Federation's unprovoked war of aggression against Ukraine and the fact that, despite unprecedented international military aid to the Ukrainian armed forces, they continue to use many weapons systems of Soviet standards – from small arms to aircraft, artillery and armoured vehicles. As a result, in 2022 Bulgaria exported **defence-related products worth more than EUR1.6 billion,** which is **a 200**% increase compared to the previous year. Thus, Bulgaria is becoming one of the largest producers of armaments according to Soviet standards within NATO and beyond.

The growth in military production is also due to the fact that some **traditional markets have been preserved and even expanded,** such as those in Africa and the Middle East established in the 1970s and 1980s, where demand was kept up by a series of ongoing conflicts in Syria, Iraq, Yemen, North Africa, and also the rearmament in India, etc. At the same time, thanks to Bulgaria's membership in NATO, the country's defence industry has managed to master production according to NATO standards, including by developing **new original products** such as means of electromagnetic warfare, anti-tank mines, etc.

The modernisation and expansion of production is carried out along two main lines – **technological transfer** and mostly **auxiliary (not radical) innovations** for digitalisation and automation of the available capacity or such under development, including acquisition and implementation of new licenses according to NATO standards. The main obstacle faced by the Bulgarian defence enterprises is common to both Europe and the US and concerns the lack of medium and highly-qualified personnel.

Defence spending in Bulgaria in the period 2018–2023 remained on average **1.60**% **of GDP**, save for 2019 when it reached 3.1% due to the cost of purchasing a new combat aircraft. This is below the target set by the political commitment made as a NATO member country to increase spending to 2% of GDP by 2024, and even below the intermediary target for this period of 1.70% of GDP set in the National Plan to increase spending on defence. In 2023, the spending is expected to reach 1.84% of GDP (rather than the 1.88% set in the draft budget for 2023). Another ongoing negative trend is that **capital expenditures** in Bulgaria have been mainly aimed at maintaining the old and, to a much lesser extent, at **acquiring new equipment and armaments.** Thus, except in the years when earmarked payments are made, Bulgaria does not meet the commitment undertaken by all NATO member states for 20% of capital expenditures to be spent for the acquisition of new weapon systems and equipment each year. According to both indicators, in 2023 **Bulgaria is significantly behind** other countries in the region, such as Poland, Greece, Romania and Hungary. This also has a negative effect on the **opportunities for R&D and innovation** in defence and stymies the increase of public spending for these purposes.

In the last two years, despite the existing imbalances in defence investments **institutional cooperation in this area has been strengthened**, both within NATO and with civilian research units in Bulgaria. The lack of long-term policy for sustained public investment in defence R&D and for the interaction between civilian and military industry, including in the development of dual-use technologies, is made up by, to some extent, the work of **private business and civilian scientific organisations in these fields**. Along with the legacy enterprises in the defence industry, which have been performing R&D for decades, including in cooperation with civilian industry and academic research institutes, new enterprises manufacturing **innovative products or such based on their own R&D** have established themselves on the international market.

INTRODUCTION

The *Innovation.bg* report provides an annual assessment of the innovation potential of the Bulgarian economy in Europe and of the status and opportunities for development of the Bulgarian innovation system. It makes recommendations for improving public policy on innovation in Bulgaria and the EU, drawing on the latest theoretical and empirical research and taking into account the specific economic, political, cultural and institutional framework within which the country's innovation system is developing.

Over the last 19 years *Innovation.bg* has made a number of concrete proposals for improving the innovation policy and practice in the country, which have been supported by the government, business, the scientific community and the European Commission. Still, there has been no breakthrough in national innovation policy so far, as it remains almost entirely dependent on EU vision, instruments and funding. The country's membership in the EU led to the development and implementation of the first comprehensive innovation strategy of the country – the Innovation Strategy for Smart Specialisation 2014-2020. Its successful continuation and achieved sustainable economic growth through innovation requires upgrading private sector efforts and overcoming the serious institutional weaknesses in the development and implementation of public policies in this area.

As in its previous editions, *Innovation.bg* 2023 analyses the state and opportunities for development of the national innovation system on the basis of five groups of indicators:

- gross innovation product;
- entrepreneurship and innovation networks;
- investment and financing of innovation;
- human capital for innovation;
- information and communication technologies.

The thematic focus of the *Innovation.bg* 2023 report is on the R&D activity and innovations in the defence industry. It analyses the trends in recent years under the impact of geopolitical challenges in the region, as well as the potential of new technologies in the military field to be implemented in the civilian industry and become a factor for increasing national competitiveness.

Innovation in the defence industry

Some of the great technological breakthroughs in the industrial history of the world came as consequence of the adaptation of military technologies for civilian purposes, before and during conflicts. This happens because of the significant mobilisation of human, financial and political resources in the pursuit of dominance in short periods of time. In addition, the resources that are devoted to defence worldwide are often difficult to justify if they do not also lead to advancement in the scientific and technological development of civilian industry. That is why one of the important priorities of innovation policy in many countries, including Bulgaria, which are going through a period of serious increase in public spending on defence and security, is to encourage scientific and innovative development in the economy through these additional funds.

Over the past two years, the Bulgarian defence industry has seen its largest production growth since 1989. The reason is the Russian Federation's unprovoked war of aggression against Ukraine and the fact that, despite unprecedented international military aid to the Ukrainian armed forces, they continue to use a large number of weapons systems of Soviet standards – from small arms to aircraft, artillery and armoured vehicles. In 2022, Bulgaria exported defense-related products worth more than EUR1.6 billion, which is an increase of 200% compared to the previous year and 220% compared to 2020.[1] Thus, the country became one of the largest producers of armaments to Soviet standards within NATO and beyond.

The growth in military production is also due to the fact that some traditional markets have been preserved and even expanded, such as those in Africa and the Middle East established in the 1970s and 1980s, where demand was kept up by a series of ongoing conflicts in Syria, Iraq, Yemen, North Africa, and also the rearmament in India, etc. At the same time, thanks to Bulgaria's membership in NATO, the country's defence industry has managed to master production according to NATO standards, including by developing new original products such as means of electromagnetic warfare, anti-tank mines, etc.

[1] "200% growth in arms industry exports in Bulgaria", *Money.bg,* 17.07.2023.

Box 1. FIVE TRENDS IN THE AEROSPACE AND DEFENCE INDUSTRY IN 2023

Focus on supply chain visibility and sustainability

The Covid-19 pandemic, labour shortages and the Russian invasion of Ukraine have exacerbated the complexity of supply chains in the aerospace and defence industries. Given these challenges, the next year is likely to accelerate the shift from global to regional sourcing, including the exchange of raw materials, parts and finished goods for these industries worldwide. Most companies in this industry are also expected to focus on increasing transparency along the supply chains to improve supply control and coordination and better manage third-party risk.

Accelerating digitization and introducing smart factories as a factor to increase efficiency

Digital technologies and capabilities are expected to be a source of competitive advantage and, in some cases, a requirement to compete for specific government programmes. As new participants enter the market, aerospace and defence companies are likely to increasingly use digitisation and smart factory solutions to streamline product design and development and improve efficiency.

Attracting, retaining and developing top talent

Although most of the jobs lost in 2020 have been recovered, the labour turnover rate is still high and aging is contributing to labour shortages. Automation and the use of advanced digital technologies are changing the composition of the industry's workforce, creating a need for a workforce with more advanced skills than before in aerospace engineering, mathematics, data science and digital technology. To take advantage of growth opportunities, companies in the sector need to focus on fostering a culture of innovation and building digital skills.

Reduction of emissions and implementation of sustainable production

As one of the industries with the most serious decarbonisation challenges, the aerospace and defence industry needs to be at the forefront of introducing new and advanced manufacturing technologies that can help address sustainability challenge. The industry is likely to transition to using sustainable aviation fuels on a large scale. There is a high probability that the military actions in Ukraine and the threat to the security of Europe, however, will change the focus from resilience to ensuring the capacity for immediate reaction and combat capability. Strategically, progress in reducing emissions can prove to be a comparative advantage.

Innovation to accelerate growth in emerging fields

Emerging markets such as aerospace and advanced air mobility gained further strength in 2022 with more electric vertical takeoff and landing (eVTOL) flight testing and certification of such aircraft and pilots. Currently, 347 organisations worldwide are working on more than 700 eVTOL concepts and projects, highlighting the industry's focus on the future of mobility. Meanwhile, the involvement of private companies in the space sector has led to solid growth in space economy in recent years.

Source: Deloitte, 2023 aerospace and defense industry outlook, 2023.

The deterioration of the international security environment in the last two years has led to a sharp increase in defence spending worldwide. In 2022, spending in the EU jumped by more than 13% to EUR345 billion, although most of the countries of the community, which are also members of NATO, still do not meet the Alliance's target of 2% of GDP.[2] However, some countries plan to exceed it in 2023, and even double it. Among them are Poland, which announced that it will reach 4% of GDP for military spending in 2023, while Germany created a special fund for military spending worth EUR100 billion.[3] At the same time, the EU has been unable to fulfil its intention to deliver 1 million artillery shells

[2] "The US wants Europe to buy American weapons; the EU has other ideas", *Politico.eu*, 14.06.2023.

[3] Ibid.

to Ukraine, despite the state aid and the political will to do so – a serious sign of the challenges facing the common defence policy and the ability of the continent's defence industry to maintain high-tech readiness. In this situation, the growth of military production in Bulgaria results not only in an increased amount of products, but also in investments in the modernisation and expansion of the production base. For now, this is mainly done through reinvestment of part of the profit, but according to official announcements from the Ministry of Defence (MoD), it is expected that by the end of the year at least 2 or 3 companies will receive investments from a European programme to expand their production capabilities.[4] On this occasion, the European Commissioner for Internal Market, Thierry Breton, visited three Bulgarian plants as part of his tour of all EU countries in 2023 (the state-owned VMZ-Sopot and the private ones EMCO and Transmobil) to find out whether the country's industrial capacity for the production of weapons and, above all, ammunition for them can be increased.[5] The modernisation and expansion of the production capacity is aimed both at traditional products for Bulgarian companies, such as the 122 mm ammunition for the rocket launchers of the Grad type (widely used on the Ukrainian front by both sides) manufactured, for example, at the new workshop of the state-owned military enterprise Terem-Tsar Samuil,[6] as well as for the acquisition of new products according to NATO standards, such as 155 mm artillery shells, being developed by the private Transmobile and the state-owned VMZ-Sopot.[7] The latter launched a test production line, although according to unofficial data they have not yet started mass production.

The modernisation and expansion of production is carried out along two main lines – technological transfer and mostly auxiliary (not radical) innovations for digitalisation and automation of the available capacity or such under development, including acquisition and implementation of new licenses according to NATO standards. The main obstacle faced by the Bulgarian defence enterprises is common to both Europe and the US and concerns the lack of medium and highly-qualified personnel.[8] The main reason globally is the aging of the workforce in the aerospace and military industry, with the US leading this trend – about a third of employees there are aged 55 or over. In Europe they are about one fifth.[9] Among the factors for this process, specifically in the defence sector, are the unattractiveness of working in an "aging working environment", as well as the personal expectations and attitudes of young talents formed in an educational, business and social environment, which differ significantly from the existing culture in the far more conservative and "old-fashioned" defence enterprises. These contradictions are particularly evident when comparing the aerospace and military industries, and especially in terms of their defence sector, with their ICT and automotive competitors.[10] In the context of the wider workforce challenges across Europe, this poses a significant risk to the ability of the EU to meet the growing demand for skilled labour in the aerospace and military industries. This is particularly relevant in the short and medium term given the increased demand in the defence sector as a result of the changed security environment. Attracting, retaining and developing the best talent has been identified as one of the five

[4] "Tagarev: There will be orders to the military industry in Bulgaria for the war in Ukraine", *offnews.bg*, 14.11.2023.

[5] The "Fuel" of War | Bulgarian projectiles may go to Ukraine through "triangular deals", *Capital* newspaper, 16.03.2023.

[6] Ibid.

[7] "The US has struck a deal with Bulgaria for 155mm shells for Ukraine, according to the Financial Times", *Free Europe*, 01.08.2023.

[8] *Europe's gray-to-green workforce transition in aerospace and defence*, McKinsey & Company, 12.11.2023.

[9] Ibid.

[10] Ibid.

main challenges facing aerospace industry globally, but also in Europe, in the current year.[11] Of particular concern to the EU is the fragmentation of the labour market, which further exacerbates the shortage of employees and especially in the countries of Central and Eastern Europe, which are closest to the military actions in Ukraine and most directly threatened by Russia's aggressive policy on the continent. In this regard, Russia's comparative population superiority over individual EU countries becomes an advantage, despite the supposed technological supremacy of European economies.

In Bulgaria, defence spending in the period 2018-2023 remained on average 1.60% of GDP, save for 2019 when it reached 3.1% due to the cost of purchasing a new combat aircraft.[12] This is below the target set by the political commitment made as a NATO member country to increase spending to 2% of GDP by 2024, and even below the intermediary target for this period of 1.70% of GDP set in the National Plan to increase spending on defence.[13] In 2023, the spending is expected to reach 1.84% of GDP (with 1.88% set in the draft budget for 2023),[14] which is again related to investment for acquisition of a multifunctional modular patrol ship, the second stage of acquisition of a new type of combat aircraft and of basic equipment for the creation of battalion combat groups from the composition of a mechanised brigade.[15] Despite the nominal increase in spending in absolute terms throughout the period, still the negative trend of over 60% of costs covering staff expenses cannot be reversed. Sharp changes in capital spending remain dependent on political decisions to acquire new equipment and armaments. Another ongoing negative trend is that capital spending in Bulgaria in most years is mainly aimed at maintaining the existing ones and, to a much lesser extent, at acquiring new equipment and armaments. Thus, except in the years when earmarked payments are made, Bulgaria does not meet the commitment undertaken by all NATO member states for 20% of capital expenditures to be spent for the acquisition of new weapon systems and equipment each year.[16] On both indicators, in 2023 Bulgaria lags significantly behind other countries in the region, such as Poland, Greece, Romania and Hungary. This also has a **negative effect on the opportunities for R&D and innovation** in defence and stymies the increase of public spending for these purposes.

On the other hand, the acquisition of new systems, especially when it comes to complex technological solutions requiring the construction of new capabilities and infrastructure, such as new aircraft, new armoured vehicles for the infantry, communication systems, etc., channels a significant part of the budget in building the necessary capacity in R&D and modernisation needed for the adoption of these systems. Investment plans often include **R&D as a component of offset programmes** that are negotiated as part of the acquisition of new defence systems. However, due to the lack of long-term planning and political commitment to the development of R&D in the field of defence and security in Bulgaria, offset programmes, and specifically R&D, are reduced or **not provided for financially and organisationally.**

[11] Deloitte, 2023 aerospace and defence industry outlook, 2023.

[12] Report on the state of defence and armed forces of the Republic of Bulgaria, 2022, Ministry of Defence.

[13] Adopted by Decision of the Council of Ministers No. 3/04.01.2018.

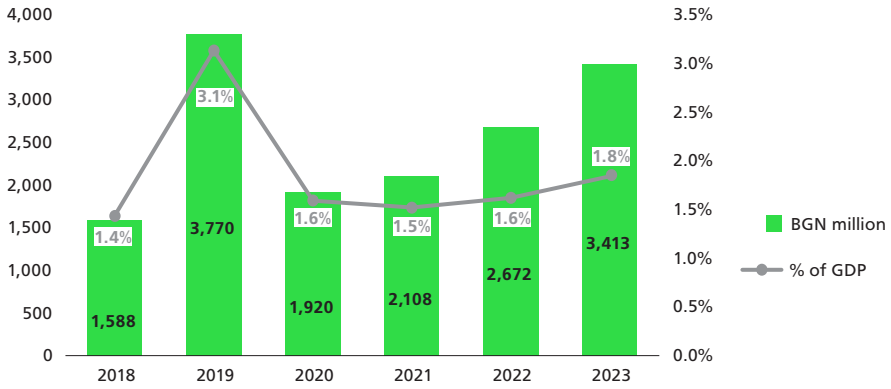
[14] The draft law on the state budget of the Republic of Bulgaria for 2023 and the updated mid-term budget forecast for the period 2023-2025 have been published, Ministry of Finance, 27.06.2023.

[15] Draft state budget for 2023: 1.88 percent of GDP is for defence spending, Information centre of the MoD, 28.06.2023.

[16] Report on the state of defence and armed forces of the Republic of Bulgaria, 2022, Ministry of Defence.

Following the closure of the departmental and academic research institutes in the field of defence in the mid and late 1990s, there is now **no government policy and public investment in defence R&D,** including in dual use technologies. In recent years, the measures in this area have been limited to minimal funding from the defence budget for research projects implemented by the Defence Institute "Prof. Tsvetan Lazarov" and the military academies. The lack of support for R&D in the field is also evidenced by the frequent reduction of the financial resources initially planned for this purpose, as happened in 2021 when they were reduced by 20%. Added to the effects of the Covid-19 pandemic, this led to an extension of the implementation period of two out of the eight projects by one year.[17]

Figure 1. DEFENCE SPENDING (2018-2023)



Source: Report on the State of the Defence and Armed Forces of the Republic of Bulgaria, 2022; Data for 2023 are preliminary, source: Defence Expenditure of NATO Countries (2014-2023), 07.06.2023, NATO Public Diplomacy Division Press Release.

In the last two years, despite the imbalances in defence investments **institutional cooperation in this area has been strengthened**, both within NATO and with civilian research units in Bulgaria. In 2022, the Defence Institute and the Big Data for Smart Society Institute (GATE) at Sofia University have been selected as **NATO test centres** for the development of new technologies in the field of big data and artificial intelligence.[18] As such, they are also included in the Defence Innovation Accelerator for the North Atlantic region (DIANA), created a year earlier and aimed at strengthening NATO's overall technological potential to respond to new challenges. DIANA supports technological cooperation between Alliance countries on critical technologies, including those with possible dual use, encouraging interaction between industry, academia and the defence sector. According to data from the Ministry of Defence and the Ministry of Innovation and Growth, a total of 18 companies with 21 projects applied to the accelerator competition.[19] In 2022, Bulgaria also joined the **NATO Innovation Fund**, which supports start-up companies working to develop next generation technologies in this field.

The lack of long-term policy for sustained public investment in defence R&D and for the interaction between civilian and military industry, including in the development of dual-use technologies, is made up by, to some extent, the work of

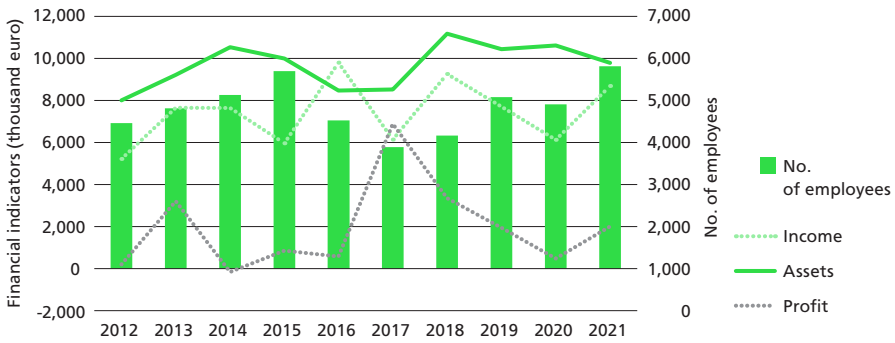
[17] Ibid.

[18] "Bulgarian scientific institutes were selected as NATO test centers for new technologies", DARIK News, 7.04.2022

[19] Companies can apply for up to 300,000 euros for defence innovations, Ministry of Innovation and Growth, 16.08.2023.

private business and civilian scientific organisations in these fields. Along with the legacy enterprises in the defence industry, which have been performing R&D for decades, including in cooperation with civilian industry and academic research institutes, (e.g. Arkus, Arsenal, Dunarit, Samel-90, Terem, VMZ-Sopot, Black Sea, etc.), new enterprises manufacturing **innovative products or such based on their own R&D** have established themselves on the international market. The latter include both the well-positioned Optics and Optikoelectron Group (producing original products for military and civilian purposes), EMCO Group (munitions production), MTG-Delfin (production, repair and conversion of ships for military and civilian needs), and recently established ones such as Mars Armor (an innovative company specialising in the production of ballistic protection and body armour and a supplier to the military and police forces of many NATO countries) or High-Tech IMS Ltd (a spin-off of the Institute of Metal Science at the BAS, commercialising new products developed by the Institute's team). There are also those which do not formally belong to the defence industry,[20] but produce equipment for defence purposes, such as Electron Progress Ltd, which has strong R&D activity in the field of communications and in 2005 became the first Bulgarian enterprise approved as a preferred supplier of goods and services by NATO Consultation, Command and Control Agency. There is also the state-owned Technological Research Institute, which under socialism was one of the largest in the area with over 2,000 staff, but after 1990 it shrank to about 60 people employed in the last decade. It retains a small part of its research activity, reorienting itself mainly to the production of ammunition. If the defence industry is considered as part of a larger sector including the **aerospace industry**, innovative companies such as Endurosat (innovative developer and manufacturer of original microsatellites), Avionams Aircraft Repair Plant, Niki Rotor Aviation (creator and manufacturer of original gyrocopter models (autogyro), which are already sold in several countries around the world) and others which manufacture finished products or components for global aerospace manufacturers should also be mentioned.

Figure 2. FINANCIAL INDICATORS AND NUMBER OF EMPLOYEES IN AEROSPACE AND DEFENCE INDUSTRY IN BULGARIA (2012-2021, THOUSAND EUR)



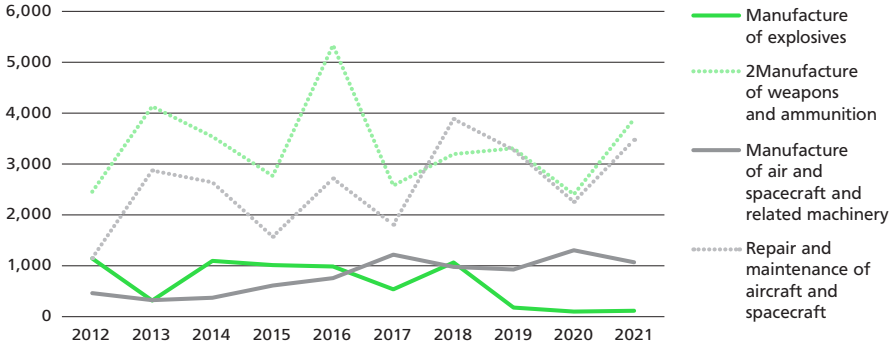
Source: Orbis European Business Database, 2022.

The main **financial indicators** for the aerospace and defence industry in Bulgaria show that over the last decade it has developed extremely unevenly, with significant dips and peaks. The available data end in 2021 and thus do not cover the period after Russia's war of aggression in Ukraine, which prompted the biggest growth in the defence industry in 30 years. Throughout the last decade, the **armaments and ammunition** manufacturing sub-sector has been

[20] According to the classification of the main economic activities (NACE).

leading in terms of annual revenue, total assets and number of employees. It is followed by the **repair and maintenance** of aircraft and spacecraft, which is mainly due to the large civilian companies in the industry.

Figure 3. REVENUES BY SUB-SECTORS (THOUSAND EUR)

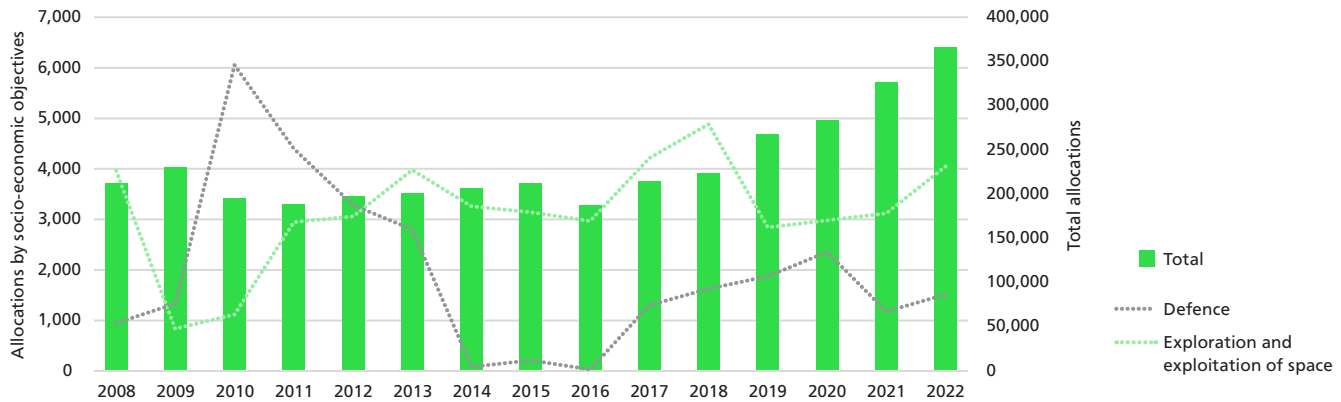


Source: Orbis European Business Database, 2022.

There is a lack of available data on R&D and innovation spending in private business enterprises in the defence industry, and in some cases the occasional data for individual companies cannot be unambiguously attributed to military or civilian production. According to an **expert estimate, about 7-8% of the labour costs in this sector are directed to the work of scientific and research personnel**.[21]

After a period of relative stagnation, in absolute terms the total budget spending for R&D marked a steady upward trend after 2016, being almost double in 2022 compared to the 2008-2016 average. This trend does not hold for defence spending, which after a period of sharp increase for 2008-2010, also saw a sharp decline to near-zero values. It started to increase slowly after 2016, but without reaching the levels for the period 2010-2013. At the same time, budget spending for space research is higher than defence spending and, after a short decline at the beginning of the period under review, is beginning to increase, although the growth is not constant.

Figure 4. GOVERNMENT BUDGET ALLOCATIONS FOR R&D BY SOCIO-ECONOMIC OBJECTIVES (THOUSAND BGN)



Source: NSI, 2023.

[21] Interview with a senior manager in the defence industry, 2023.

Innovation potential of the Bulgarian economy

Gross innovation product

The gross innovation product, or the innovativeness of an economy, is assessed by the new products and services introduced, the new technologies created and the scientific outputs. It involves and results from the interaction of the innovation, technological and scientific products of a country. It is a major benchmark for innovation policy because it allows decision-makers to compare the outcome of the innovation system in temporal and geographical terms, as well as to estimate the need for changes in the organisation and resources of the innovation process.

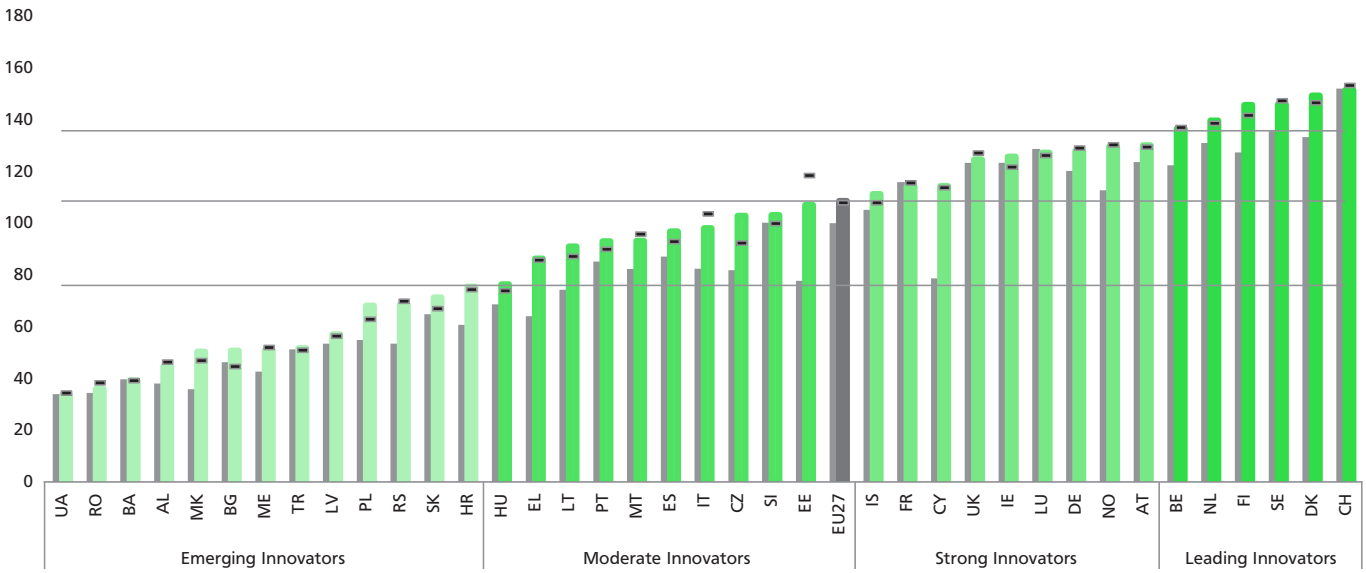
Innovation product

The innovation product results from innovation activity in the form of new and significantly improved processes, products and services based on new and/or adapted existing knowledge and know-how. It is determined by the innovation activity of enterprises in the country and is the most important indicator for assessing the national innovation system. Innovative activity in business and innovation demand by the public, along with the factors which determine these, comprise the innovation potential of the economy – its capacity to develop based on new knowledge.

Bulgaria on the European and international innovation map

The distance of the European Union's economy from the leaders in innovation development – the USA, China and Japan – remains significant and worrying, especially against the background of the series of global and regional crises and challenges. The reasons for this lag are mainly rooted in the inability of the EU to make full use of the scale of its single market, to concentrate public and private resources effectively in research and innovation, and to create companies capable of competing on a global level. However, in 2023 the European economy improved its innovation potential. The growth for the last

Figure 5. EUROPEAN INNOVATION SCOREBOARD*



* The coloured columns show the performance of member states in 2023 based on the most recentdata for the 32 indicators of the European Innovation Scoreboard compared to the EU average in 2016. The positions with black colour on them correspond to the same indicator for 2022. The grey columns show the position of the Member States in 2015 compared to the EU average in 2015. The dashed lines show the 70%, 100% and 125% threshold values between the groups of countries for 2023, adjusted for growth compared to 2016. The threshold values in the EIS methodology, 2023 are adjusted upwards by a factor of 1.085 to reflect the increase in EU efficiency between 2016 and 2023, which explains the higher number of countries in the group of emerging innovators compared to previous years.

Source: European Innovation Scoreboard, 2023.

seven-year period was 8.5%, and for the last year – 0.51%[22]. There are no changes in the composition of the group of innovation leaders. The trend of convergence among the leading innovators continues, whereby Denmark moves forward by two positions at the expense of Sweden and Finland, while Switzerland retains the top spot.

Against this background, Bulgaria had the most serious improvement on a one-year basis within the EU27 – nearly 14%, followed by Czechia (11%) and Poland (8%). The higher values of the country's innovation index in the last year, however, are not enough to catch up with the EU average. Bulgaria remains in the group of emerging innovators in penultimate place (ahead of Romania) at a level of 46.7% compared to the EU27 and below the average performance of the group (54% compared to the EU27). Progress over the past year offsets the lag over the seven-year period and the lowest relative level of the innovation index of the national economy of 41% compared to the EU average reached in 2022.

Data for eight member countries show a year-on-year decline in their performance on innovation potential indicators. The most serious retreat is in Estonia (10%), Romania (over 6%) and Italy (almost 5%).

Bulgaria's comparative advantages are in the field of low-tech intellectual property – trademark and industrial design applications. In terms of patent applications, which meet the requirements for invention and world novelty and are the result of intensive research and development, Bulgaria occupies one of its weakest comparative positions – only 15.5% of the EU average. The country's result is lower only for the indicators "Direct and indirect government support for R&D in the business sector (5.6%) and "Lifelong learning" (14.3%). The "Risk capital" indicator has similar values (15.9).

The worsening geopolitical and geo-economic crises in recent years and the need to respond to their consequences through sharp changes in European and national priorities, as well as the entry into a new program period (related to the preparation of a new set of strategic and program documents) and, most of all, the already substantial political instability in the country further deepened the structural problems of the national innovation system. The lack of sufficient national financial resources for science and innovation (only 22% of the EU27 average levels for the group of funding and support indicators) and the inefficient use of the existing ones, as well as the devaluation of the available human capital (less than a third of the average EU27 levels in the Human Resources group) hold back the qualitative shift to intensive innovation that the country needs. The lack of adequate government support for R&D, the de-skilling and loss of talent, the virtually non-existent mobility of science and technology personnel, and insufficient funding increase the need for bold but unlikely to be implemented innovation policies, and warrant scepticism about the prospects of overcoming the problems and comparative backwardness from the core of the EU.

Compared to 2016 – the base year in the latest report of the European Innovation Scoreboard – Bulgaria **improved most significantly in the following areas**:

- **share of innovative enterprises which interact** with partners within the innovation process (growth of 51.8%), together with an increased number of joint publications of public and private institutions;
- **process innovations** with a growth of 45% and share of innovative enterprises with product innovations (82.2%);
- **employment in innovative enterprises**, which increased by nearly 41%;
- **emissions of fine dust particles from industry** (506% compared to the average for Europe according to the latest available data), as well as the development of technologies reducing the negative footprint on the environment, in which Bulgaria has positions equal to the average for the EU27.

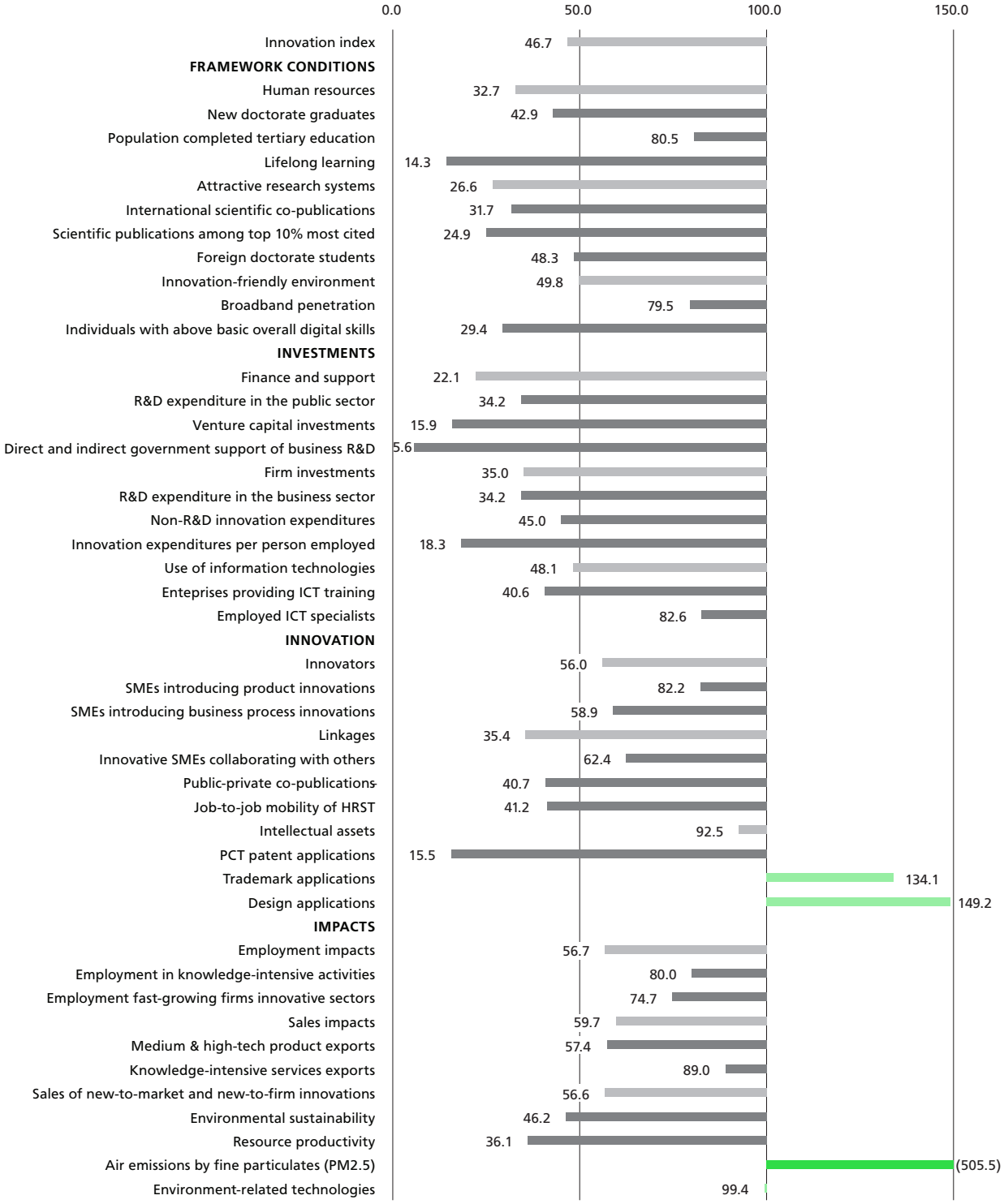
Thanks to a **dynamic ICT sector**, Bulgaria is approaching the average European levels as regards the number of ICT specialists (83%) and the export of knowledge-intensive services (75%).

An even more detailed view of Bulgaria's performance in the field of scientific research and innovation is provided by the Regional Innovation Scoreboard (RIS). It ranks European regions according to indicators of innovation potential. RIS is the regional extension of the European Innovation Scoreboard (EIS), which provides a comparative assessment of the innovation performance at regional level of EU member states and other European countries. RIS uses the EIS indicators for which data are available at the regional level, including regional data from the Community Innovation Survey (CIS). RIS 2023 follows the methodology of EIS 2023 and uses data for 239 regions in Europe for 21 of the 32 indicators.

Both the national economy as a whole and **all individual Bulgarian**

[22] Change in the Innovation Index on average for the EU27.

Figure 6. INNOVATION POTENTIAL OF BULGARIA AS PERCENTAGE OF EU27 AVERAGE LEVELS, 2023



Source: European Innovation Scoreboard, 2023.

regions fall into the last group of emerging innovators. The only indication that the South West Planning Region (SWPR) is doing relatively better than the national average is the positive sign (+) added to the category. There is no change in the categorisation (negative sign (-)) of the North West (NWPR) and South East (SEPR) planning regions, which have innovation indexes that are below 36% of the EU average.

The innovation profiles of the six regions of the country are very specific in terms of comparative advantages and disadvantages. Apart from applications for industrial design and trademarks, in respect

of which Bulgaria has national comparative advantages compared to average European levels, the country's planning regions **do not demonstrate excellence in any of the indicators**.

Moreover, the erratic results of the functioning of the national innovation system at the national and regional level (scientific and innovative product, and resources invested in their creation) indicate that **national policy is rather haphazard with no synergy between the individual impact instruments.** Individual units of the innovation system respond to changes in the national and European strategic framework and global challenges according to their capacity, given the insufficient funding, shrinking talent pool and poorly developed interaction at the intra and inter-sectoral level, and (with few exceptions) without the capacity of implementing proactive actions and an aggressive strategy towards the European and international markets of scientific and innovative products.

Some of the following common factors could account for similar advantages among regions:

- population with higher education in the South West and North Central regions;
- lifelong learning in North Central and South West regions;
- publications with the largest number of citations in the South Central and North Central regions;
- digital skills in the South West, South Central and North East regions;
- costs for innovation activity per employee in the South West and North East regions;
- patent applications in the South West and South Central regions;
- employment in innovative enterprises in the South West and North Central regions;
- sale of new-to-the-market and new-to-the-company products in the South East, South Central and South West regions.

Along with the **South West region**, which leads the country in almost all other indicators, the **North East region demonstrates a better than national and EU average performance** in terms of innovation expenditure other than for R&D.

The North West planning region is the only one in the country that fails to exceed the national average levels in any of the indicators of regional innovation potential. This is also the only region in the country that **registered a decline compared to the base year of 2016.** The growth in the North East region is minimal – less than 1%. The most pronounced **positive change is present in the South West region (8.3%)**, which, however, does not exceed the average dynamics in the EU (8.5%).

The lack of (significant) progress for Bulgaria, demonstrated in the European Innovation Scoreboard and the additional analysis at the regional level, is also confirmed by the data of the Global Innovation Index for 2023. The methodology of the World Intellectual Property Organization (WIPO) covers 81 indicators distributed in seven pillars and two sub-indices – 1) innovation input, which includes data on the business environment, markets, human, financial and intellectual resources invested in R&D and innovation activity; and 2) innovation output represented in the form of new knowledge, technological assets, entrepreneurial activity and market expansion, development of ICT and creative industries.

Bulgaria fell by four positions on an annual basis to 38th place in the world ranking of 132 countries. Measured by the index values, the difference is 0.5 points downward (or an innovation index of 39, which is the lowest for the country in more than 10 years).

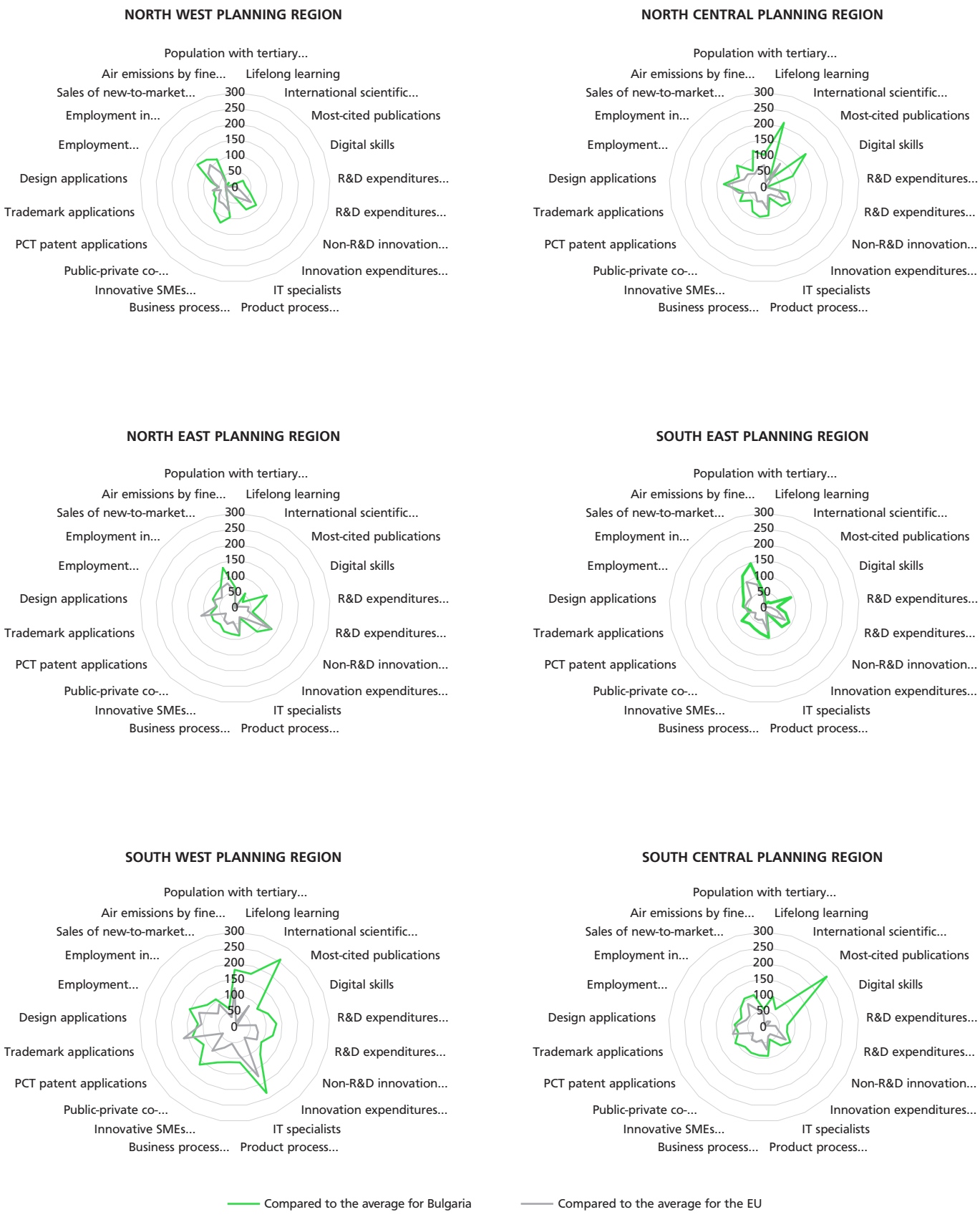
Table 1. POSITIONING OF BULGARIA'S PLANNING REGIONS WITHIN THE FRAMEWORK OF THE REGIONAL INNOVATION SCOREBOARD

NUTS II	Region	RIS	Position	Group	Change*
BG31	**NWPR**	27.2	235	Emerging innovator (-)	-3.7
BG32	**NCPR**	38.8	227	Emerging innovator	4.9
BG33	**NEPR**	36.2	229	Emerging innovator	0.9
BG34	**SEPR**	33.6	233	Emerging innovator (-)	6.9
BG41	**SWPR**	61.6	195	Emerging innovator (+)	8.3
BG42	**SCPR**	40.1	226	Emerging innovator	4.8

* The change indicator reflects the performance of the regions in 2023 compared to the European average in 2016.

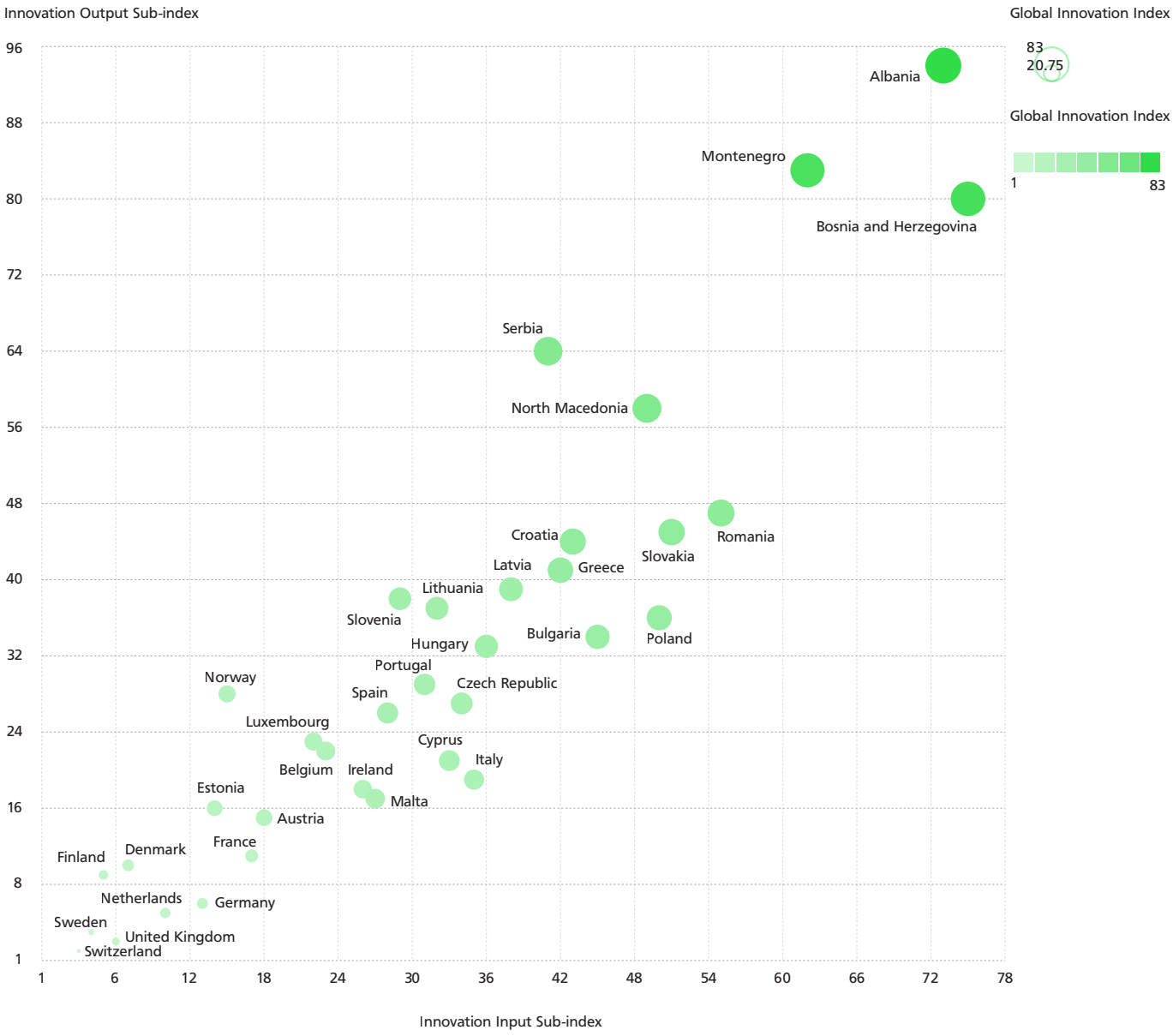
Source: Regional Innovation Scoreboard, 2023.

Figure 7. REGIONAL INNOVATION PROFILES



Source: Regional Innovation Scoreboard, 2023.

Figure 8. GLOBAL INNOVATION INDEX, 2023



Source: Global Innovation Index 2023: Innovation in the face of uncertainty

The difference with the performance of the country in the European Innovation Scoreboard is obvious, and demonstrates, apart from the use of different indicators, the **erratic results of the Bulgarian innovation policy and innovation system**. The country had an improvement in its relative performance on innovation input indicators (45th position), despite data[23] on the decline in R&D spending as a share of the country's gross domestic product (GDP), the number of researchers in full employment equivalent, the number of those employed in knowledge-intensive activities, and graduates in STEM fields of education.

At the same time, there is a decline in terms of innovation score indicators (34th position), primarily related to the country's weaker performance as regards the number of patent applications and the cost of software products, and despite higher values for H-index of cited scientific papers, production and export of high-tech products, and created mobile applications. **Within the EU, Bulgaria ranks 22nd**, ahead of Poland, Greece, Croatia, Slovakia and Romania. In the upper middle-income countries group, Bulgaria ranks third, one position lower than in 2022, after China (which is in 12th place in the general ranking) and Malaysia (36th place in the general ranking).

[23] The R&D funding and human resources data used in the Global Innovation Index 2023 are from 2020 and 2021.

Technological product

The technological product (protected and unprotected new technological knowledge) is the result of creative activities of various participants in the innovation process, it has unique characteristics and economic significance that make it attractive as an object of transfer. The analysis of the application and patent activity, as well as the attitudes of Bulgarian and foreign persons in this field make it possible to assess an essential aspect of the innovation system operation and to seek ways of improving it.

In 2022, the global patent application activity to the European Patent Office (EPO) increased by 2.5% (over 193 thousand applications), the growth being entirely due to companies and organisations outside the territory of the 39 countries EPO members. There was significant increase in patent applications from Chinese companies (15.1%), followed by companies based in South Korea (10%). The growth of patent applications originating in the USA was only 2.5%.

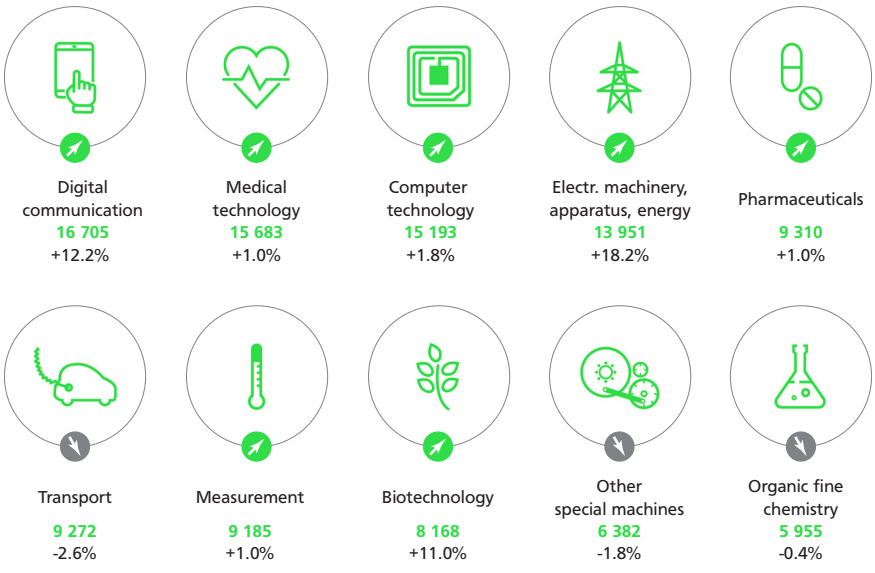
Against this background, the share of requests from the EPO area fell to just over 43% (the lowest level to date).

China's expansion in the field of intellectual property, and above all the unscrupulous practices applied by Chinese companies and the Chinese government, are creating tension between the world's technology leaders. That is why the Five Eyes intelligence-sharing network, with representatives from the US, UK, Canada, Australia and New Zealand, in **a joint appearance in Silicon Valley called for the protection of innovation** from unprecedented Chinese espionage in the high-tech sector.

Bulgaria ranks 24th within the EU27 with 45 patent applications to the EPO (2 more than in 2021), ahead of Cyprus, Croatia and Latvia. Regarding the indicator of the number of patent applications per 1 million people (6.6 patents), Bulgaria is ahead of only Romania (2.4 patents). For comparison, EPO patent applications from Sweden are 481.8 per 1 million people (first among the EU27) and from Slovenia – 58.4 (first in Central and Eastern Europe). **Bulgarian companies and organisations received only 22 patents from the EPO** (one fewer than in 2021), only ahead of Cyprus and Lithuania.

Patent applications to the Patent Office of the Republic of Bulgaria (PORB) in 2022 by Bulgarian nationals and organizations totalled 171. This is the same number as in 2021, but is a 40% drop compared to 2020. Half of the applications come from the business sector (86), followed by applications from individuals (48). The latter may be indicative of the lack of an adequate environment for the commercialisation of inventions in the country, as well as an uncertain legal environment which makes inventors prefer not to institutionalise their knowledge in search of profit. Universities and public research organisations (PRO) come only third with 37 requests for invention protection.

Figure 9. TOP 10 TECHNICAL AREAS OF APPLICANT ACTIVITY AT THE EUROPEAN PATENT OFFICE, 2022



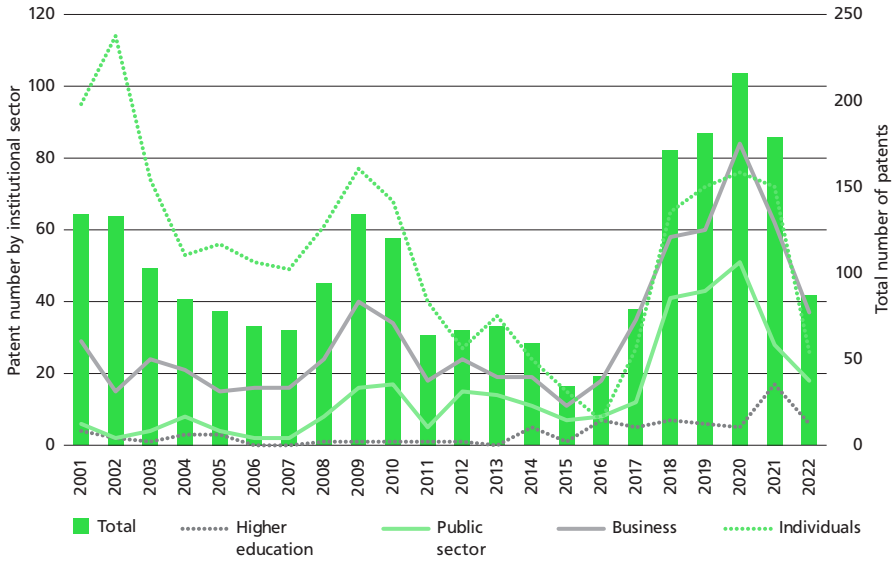
Source: European Patent Office, 2023.

The **applicant activity** in 2022 included the following:

- **utility model** requests – 214 documents (8 requests less than in 2021 and more than twice as low as 2020);
- 95 applications for **industrial design,** where there is also a downward trend for the last three-year period;
- 4,645 **trademark** applications;
- 37 applications for **new varieties of plants and breeds of animals,** which grew in number.

In 2022, 87 **patents were issued by PORB** to Bulgarian patent holders, which is **less than half of their number in the previous year**. A decrease in the number of received patents is present in all institutional sectors, and it is most pronounced in higher education – 6 patents or 35% of

Figure 10. Patent activity of Bulgarian patent holders on the territory of Bulgaria, 2001 – 2022



Source: Own calculations according to data of PORB, 2022.

their number for 2021. This is a return of their typical patent activity of maximum of 7 patents per year. Thus, 2021 seems an isolated peak in patent activity rather than part of a sustainable trend. Nearly 43% of all patents for the year were held by the business sector, followed by the private sector (30%) and the public sector (20%).

Although **universities and public research organisations in Bulgaria are the only beneficiaries of the National Science Fund**, they cannot use this financial source to cover costs for the protection of their inventions and other objects of intellectual property. By definition, money from the Fund are oriented solely to the development of fundamental science, although in practice it is not possible to define a categorical boundary between fundamental and applied scientific research. The hope is that EU **investments in the innovation capacity of Bulgarian universities** through centres of excellence and competence centres, as well as the work of the Sofia Tech Park, will gradually increase the patent activity of these institutions. This is all the more relevant given the dynamics of technological development and the increasingly aggressive competition between research units on the international and European scene. As national funding of scientific units in the country is insufficient, the lack of flexibility on the part of public state instruments creates additional barriers to the protection and commercialisation of new technological knowledge.

For the last five-year period, institutes of the Bulgarian Academy of Sciences (BAS) have received 178 patents from PORB. Almost half of them are owned by the **Institute for System Engineering and Robotics** (86 patents, 48% of all patents for the last five years within the BAS). The institute maintained its leadership position for 2022 as well, with 7 received patents for the territory of the country. The Institute of Solid State Physics (16), the Institute of Electronics (14), the Institute of Metallurgy (11) and the Institute of Information and Communication Technologies (10) remain significantly behind in terms of patent activity.

The higher education sector is dominated by the **Technical University – Sofia** with 3 patents in 2022 (half of the total 6 patents for the sector) and 16 patents for the last five-year period (again almost half for the sector). Two more universities registered successful patent activity in 2022 – Sofia University with 2 patents (total of 5 patents for the five-year period) and Rousse University with 1 patent (also 5 patents for the five-year period).

Of the **Agricultural Academy bodies**, only the **Institute of Animal Breeding Sciences – Kostinbrod** managed to obtain 3 patents in total for the period, one of which in 2022. There was no patent activity by other public research units in the country for the period.

In 2022, **the patent activity of business** on the territory of the country resulted in the 37 patents issued for inventions. Five of the companies have two patents each. Seven of the patents were issued as European patents, and the rest as national patents. Among the patent holders are Aglika Trade Ltd, Veliko Tarnovo[24] and Ted Bed Ltd, Plovdiv,[25] which are among the **winners in the competition for innovative enterprise of the year** of the Applied Research and Communications Fund.

The Bulgarian patent-holding companies for the period 2001-2022 are 414 with a total of 679 patents, 40 of the patents (5.89%) being issued by the EPO. Since 2007, 45 Bulgarian companies have acquired 205 patents. Among them is AMG Technologies Ltd., Botevgrad,[26] a

[24] Winner of the Innovative Enterprise of the Year Award in 2014 in the Innovative Technologies in Traditional Sectors category.

[25] Winner of the Innovative Enterprise of the Year Award in 2022 in the category Quality of Life – honorary diploma.

[26] Winner of the Innovative Enterprise of the Year Award in 2013 in the Sustainable Innovative Behaviour category.

Box 2. PATENT COMMERCIALISATION PRACTICES IN EUROPEAN UNIVERSITIES AND PUBLIC RESEARCH ORGANISATIONS

Universities and public research organisations (PROs) use the opportunities of the patent system to commercialise the inventions they create. This is the best strategy for them to take newly created technologies out of the labs, scale up production and enter the market, thus generating revenue for their organisations. However, there are significant obstacles to the transfer of knowledge and technology from science to industry.

EPO research[27] indicates that research institutions commercialise more than a third (36%) of the inventions for which they have applied for a patent at the EPO, with licensing being the preferred channel for doing so (70% of commercialised inventions). The creation of a separate company (spin-off) stems from 41% of commercialised inventions.

SMEs and large companies play an equally important role (about 40% each) as partners of universities and PROs in implementing new technological knowledge. Most of the successful collaborations (74%) involved partners from the same country and only 27% of the cases were with partners abroad. However, partners from other European countries play a more important role for research organisations in southern and eastern European countries. Channels for seeking partnerships include personal contacts (92%) and previous business and research partners (71%). Patent databases (21%) and e-commerce platforms (15%) are used significantly less often.

Lack of resources is cited as one of the main reasons for not utilising 25% of patented inventions. Above all, this applies to research organizations from southern and eastern Europe. The impossibility of finding a suitable interested partner (38%), as well as the insufficient potential for commercialisation of the created technology (10%), is also a barrier.

Higher education institutions and public research organisations in Bulgaria share the same difficulties in implementing the new technologies they have created. The underfunding of science in the country, the lack of clear mechanisms for evaluating and promoting patent activity (attestation and accreditation procedures include indicators for protected objects of intellectual property, but not for their further commercialisation), the lack of initiative and flexibility in institutionalising the interaction with business by higher education institutions and PRO (with few exceptions), the unclear legal framework regarding the creation and successful management of spin-off and spin-out companies, as well as the lack of experience in this regard, are the problems that for years remain unresolved. An additional obstacle is the shortage of young and high-potential scientists as a result of the negative demographic and migration processes, despite the efforts by the Ministry of Education and Science in recent years to mitigate these.

Source: European Patent office, November 2020.

micro-enterprise working in the field of nanotechnology, with 8 received patents in the last ten years. The company is the winner of the Applied Research and Communications Fund's 2013 innovative enterprise of the year competition.

Patents with Bulgarian holders for the period 2001-2022 (679) are distributed in 57 cities. Sofia, Plovdiv and Stara Zagora are in the top three. In 2022, there were 1,482 patents with foreign holders. Only three of them from two countries were issued nationally by the PORB. The rest are European patents valid also on the territory of Bulgaria.

Research product

New scientific knowledge is an important condition for enhanced innovation activity in the country. The analysis of the dynamics and structure of the process of research creation reveals the potential of Bulgaria to successfully fit in the global scientific networks, its comparative advantages in various fields of knowledge and its ability to compete successfully on the market for intellectual products.

Publication activity

An important prerequisite for increasing the innovation activity of the country is the created new scientific knowledge. The analysis of the dynamics and structure of this process reveals Bulgaria's potential to successfully fit into global scientific networks, the country's comparative advantages in various fields of knowledge and its ability to compete successfully on the market of intellectual products.

In 2022, the scientific community in Bulgaria registered 7,225 documents in the Scopus database, which puts the country 65th in the global ranking for this indicator. On a one-year

[27] Valorisation of scientific results. Patent commercialisation scoreboard: European universities and public research organisations, European Patent office, November 2020.

basis, there is a **5% drop** in the number of documents with Bulgarian participation registered in the database, and a drop of one position in the world ranking. For the five-year period 2018-2022, the number of documents increased by nearly 23%, although **in comparative terms the country fell back by five positions** (5,884 documents and 60th place among 234 countries in 2018). It can be said that after 2016 there has been a **reversal in the downward trend** in the number of publications with Bulgarian authors.

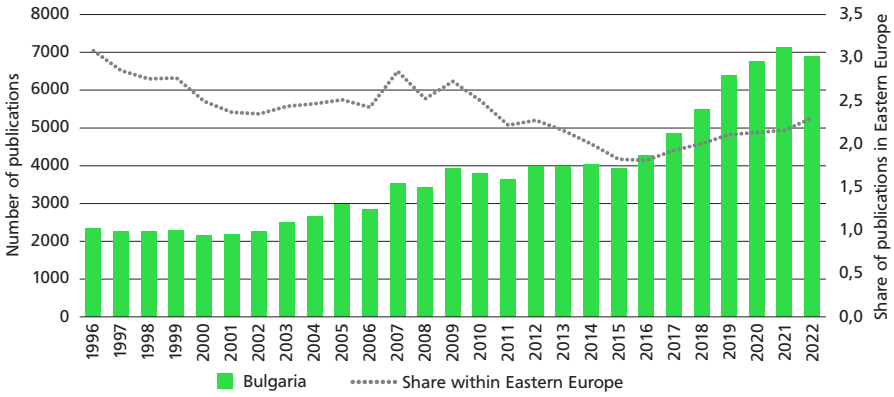
In terms of scientific production included in the Scopus database, **Bulgaria ranks 10th** out of a total of 23 countries in Eastern Europe, followed by three EU member states – Lithuania, Estonia and Latvia.

With leading positions in the EU27 is Germany (5th in the world ranking) with over 18% of the scientific production of the Union, followed by Italy, France and Spain at relatively close positions. The last economy in the top five, the Netherlands, remains far behind, with 6.5%. After some growth in 2018, Bulgaria maintains a stable share of about 0.7% of the publication activity within the EU27, which allowed the country to recover its positions from a quarter of a century ago. **Bulgaria is in 21st place among the other member countries**, ahead of Lithuania, Cyprus, Estonia, Luxembourg, Latvia and Malta.

In terms of the number of scientific publications per science and technology employee, however, Germany lags far behind to 14th place. **The European leader with the most productive scientific system is Italy** – 252.5 scientific publications per person employed in science and technology. Bulgaria climbed two positions to 19th place.

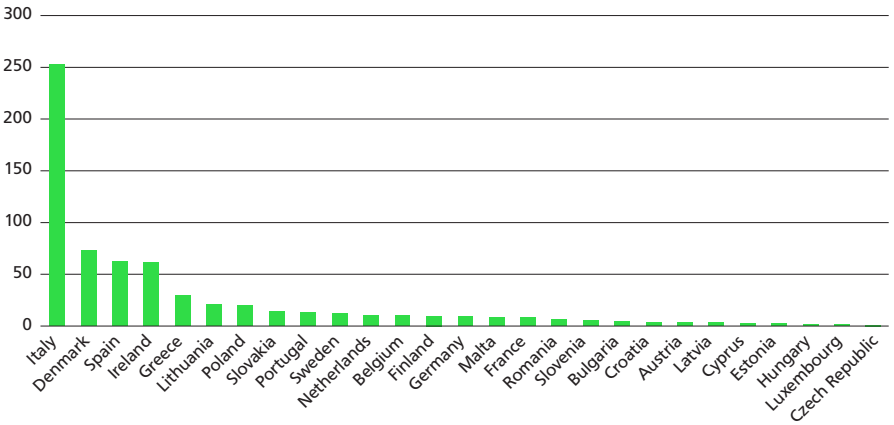
In 2022, the engineering sciences became the leading scientific field in Bulgaria (1,628 documents in the

Figure 11. PUBLICATION ACTIVITY IN SCOPUS, CITED DOCUMENTS, 1996 – 2022



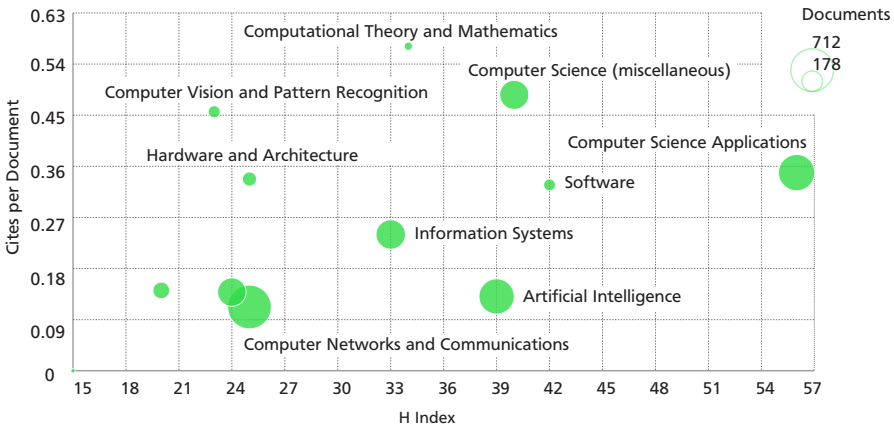
Source: SCImago (2007). SJR — SCImago Journal & Country Rank., http://www.scimagojr.com

Figure 12. SCIENTIFIC OUTPUT PER SCIENCE AND TECHNOLOGY EMPLOYEE, 2022, NUMBER OF CITED PUBLICATIONS IN SCOPUS



Source: Own calculations by SCImago data (2007). SJR — SCImagSCImago (2007). SJR — SCImago Journal & Country Rank., http://www.scimagojr.com and Eurostat, 2023.

Figure 13. PUBLICATION ACTIVITY IN SCOPUS, 2022 – 2023



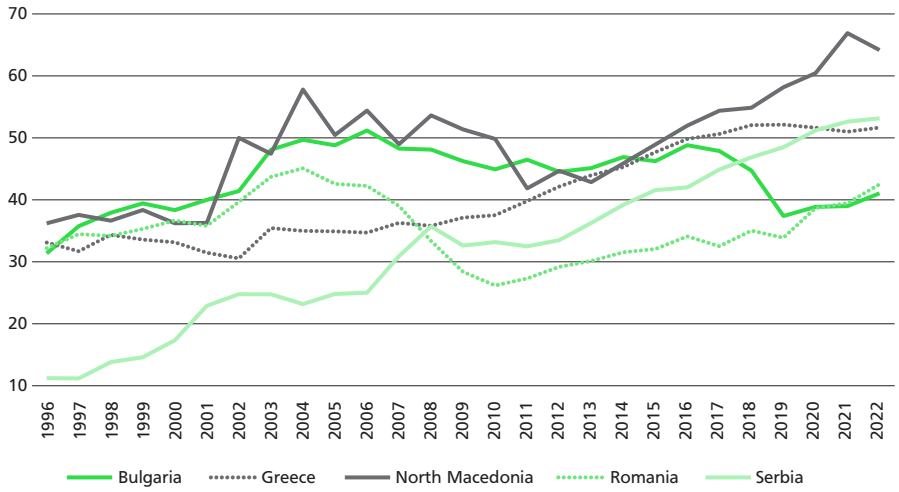
Source: SCImago (2007). SJR — SCImago Journal & Country Rank, 2023.

Scopus database). This is a result of the increased interest of the scientific community in electrical engineering and electronics, security, risk and control, and mechatronics and automotive engineering. Scientific production in the last year ranks the country 60th in the world ranking and 10th in Eastern Europe. After 2015, **the share of publications with Bulgarian participation in the European Union has increased** – from 0.46% to 1.11%, and for the Eastern Europe region – from 1.38% to 2.85%. There has been also an increase in the share of publications with international participation, although the results for 2022 (28.62%) are still far from the best achievements for this indicator registered in the period 2005-2015 (about 50%).

*F*In recent years, including as a result of the Covid crisis, significant additional funding has been allocated to medical research. This also reflected on the growth of scientific publications worldwide. However, in contrast to global trends, **the scientific output in the field of medicine in Bulgaria is rather stagnating** (1,528), including a slight decline on a one-year basis for 2022. The result is 70th place in the world ranking and a declining share of scientific production in the region. There are no indications of a growing interest in any of the sub-categories of medical sciences in our country.

Another change in 2022 was that **the field of physics and astronomy** (1,483) **gives up positions in the top three in favour of computer science** (1,496). A significant growth of scientific production in the field of computer sciences in our country has been observed since 2015, with the increase of publications in the Scopus database having tripled. The share in the regional rankings is also growing – 3.39% in Eastern Europe (1.65% in 2015) and 1.17% in the EU27 (at 0.41% in 2015).

Figure 14. Share of publications with international participation within the total number of publications at the national level in all scientific fields, %.



Source: SCI mago (2007). SJR — SCImago Journal & Country Rank, 2023.

Quality of higher education and the role of research

In 2023, 27 Bulgarian research organisations were listed in the institutional ranking of Scopus. Their distribution by institutional sectors is as follows:

- public sector – 10 organisations, one of which is constituent (BAS) and includes the remaining 9 organisations (BAS institutes);
- higher education – 16 universities, one of which is listed as constituent (Medical University-Sofia), but without including another organisation from the group;
- healthcare – one organisation, first included from 2023.

The private (business) and non-governmental sectors are not present in the ranking.

Box 3. Scopus institutional ranking methodology – SCImago Institutions Rankings (SIR)

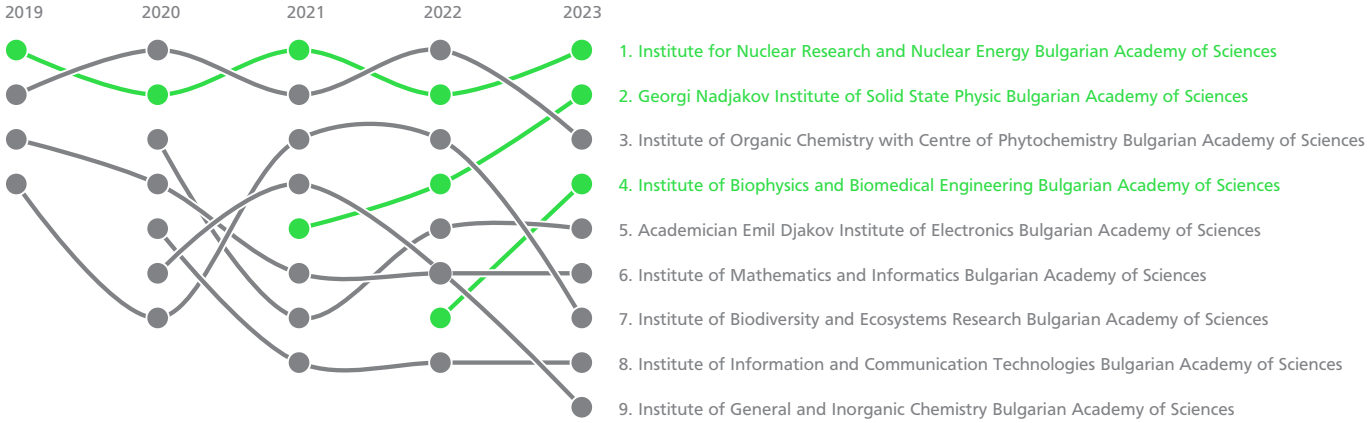
A suitable tool for evaluating the effectiveness of funding and carrying out scientific research, its implementation through innovation and the social impact achieved is **the institutional ranking of Scopus** – **SCImago Institutions Rankings (SIR)**. SIR is a classification of academic and research-related institutions ranked by a composite indicator that combines three different sets of indicators based on research performance, innovation performance and social impact as measured by their web visibility.

The purpose of SIR is to provide a useful metric tool for institutions, policy makers and managers to analyse, evaluate and improve results. Two criteria apply for the inclusion of scientific bodies:

- institutions to have published at least 100 scientific papers included in the Scopus database in the last year of the selected time period.
- cited documents (articles, book chapters, conference reports, reviews and summaries) to represent at least 75% of the total number of documents published by the institution.

Source: SCImago Institutions Rankings (SIR).

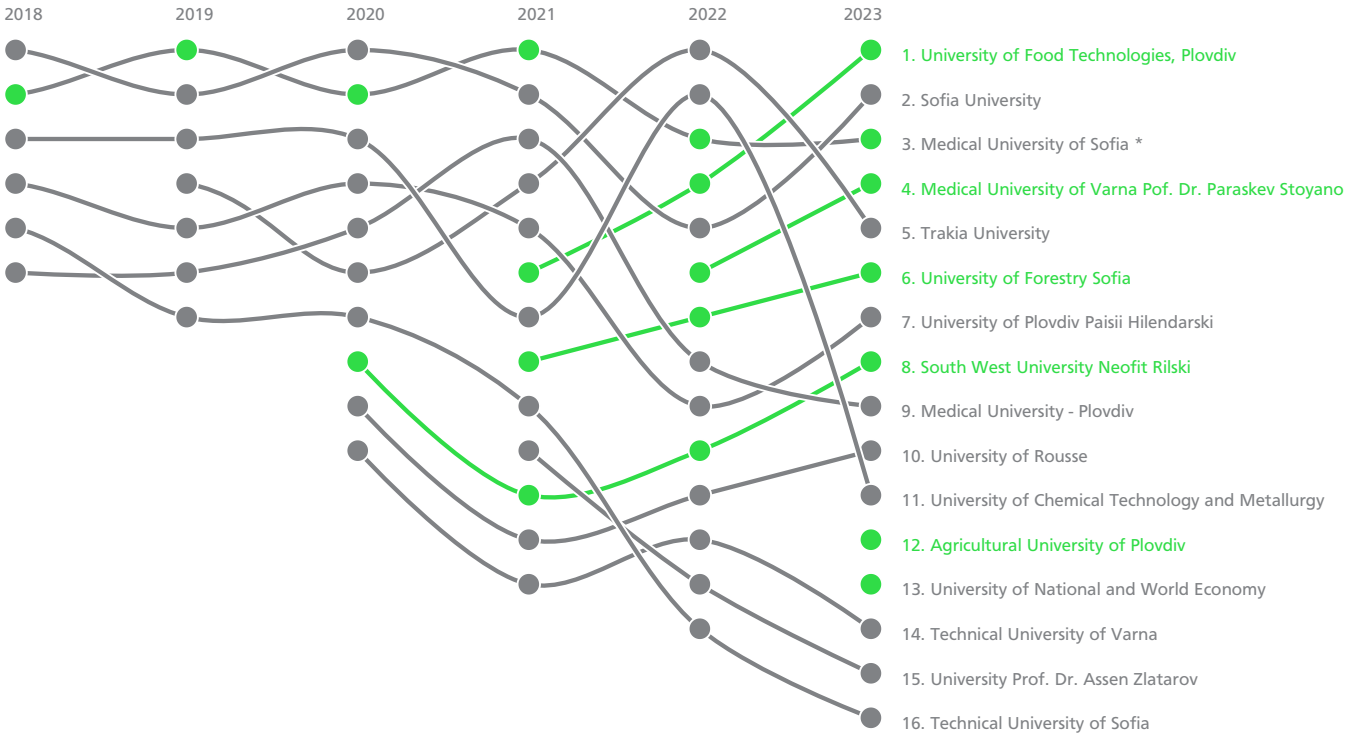
Figure 15. INSTITUTIONAL RANKING, PUBLIC SECTOR, 2018-2023*



* Institutions marked with an asterisk are composite institutions identified by the abbreviated name of the parent institution. Parent institutions show the results of all their constituent institutions.

Source: SCImago Institutions Rankings (SIR).

Figure 16. INSTITUTIONAL RANKING, HIGHER EDUCATION SECTOR, 2018-2023*



* Institutions marked with an asterisk are composite institutions identified by the abbreviated name of the parent institution. Parent institutions show the results of all their constituent institutions.

Source: SCImago Institutions Rankings (SIR).

In 2023, the general ranking according to the three groups of criteria places the **University of Food Technologies – Plovdiv first in the higher education sector** (6182 out of all 8433 institutions included in the world ranking). Runners-up are Sofia University (6552) and Medical University-Sofia (6769).

In the field of scientific research, the leader is the Medical University – Varna (5178), followed by the University of Forestry (5579) and Trakia Uni-

versity (5832). With the highest positions in the application of scientific results is the Medical University – Sofia (4482), followed by the University of Food Technologies – Plovdiv (4786) and the Medical University – Plovdiv (5655), respectively in second and third places. In terms of indicators of **social impact, Sofia University** (1677) **is in first place in the higher education sector** in the country. Among the first three in this sector are also the Medical University – Sofia (4018) and Plovdiv University (4720).

BAS is the leader in Bulgaria in the general ranking of institutional sectors, scientific fields and categories of indicators, except by the indicators for innovative application of scientific results, which can be expected given that its mission is the development of fundamental science.

Another **tool for assessing the performance of universities** by ranking it against specific indicators is the **Times Higher Education** (THE) **series of rankings.** The 2024 ranking includes 1,904 universities from 108 countries and regions. The methodology uses 18 indicators that measure the institution's performance in five areas: teaching, research environment, research quality, industry and international perspective. The 2024 ranking analyses more than 134 million citations in 16.5 million research publications and includes survey responses from 68,402 scientists worldwide.

The University of Oxford topped the ranking for an eighth consecutive year. Stanford University moved up to second place. The Massachusetts Institute of Technology (MIT) climbed two places to third place, while Harvard University remained in fourth place. Stanford University leads the way in teaching, while the universities of Oxford and Cambridge lead the way in research environments. In terms of research quality, the leader is MIT. The University of Sharjah in the United Arab Emirates has the highest score in the category of "international outlook", another 28 institutions receive the highest score (100 points) in the field of industry.

The USA is the most represented country with 169 institutions overall, and also the most represented in the top 200 (56). With 91 institutions, India is the fourth most represented nation, ahead of China (86). The majority of institutions joining the 2024 ranking for the first time are located in Asia. Four countries enter the ranking for the first time – all from Europe (Kosovo, Bosnia and Herzegovina, North Macedonia and Armenia). The previous year, all new entrants were from Africa.

In addition to the 1,904 ranked institutions, a further 769 universities are listed with "reporting" status, meaning they submitted data but did not meet the eligibility criteria to be included in the rankings.

Three higher education institutions from Bulgaria are ranked for 2024. The **Medical University – Sofia**, for which this is the first inclusion in the ranking, ranks in the top positions in the 1201-1500 range of positions. Sofia University and Technical University-Sofia are in the 1500+ range.

This is the **eighth consecutive participation of Sofia University** in the ranking. In each subsequent year, it showed weaker results in the company of a growing number of universities – in the lowest range for 2017 (801+), in the lowest range for each year of the period 2018-2021 (1001+), in the lowest range for 2022 (1201+), in the lowest range for 2024 (1501+). An exception is the positioning of Sofia University in the 1201-1500 range for 2023 (penultimate category), which, however, quickly became history with the latest ranking report. Over the years, its results have improved in the indicators of teaching, research environment and research quality, but this is not enough to bring the university to higher comparative positions.

A significant deterioration in Sofia University's position was registered in the industry indicators, which measure a university's ability to help industry with innovation, invention and consulting. The category seeks to capture knowledge transfer by looking at how much research revenue an institution earns from industry, relative to the number of academic staff it employs. There is also a deterioration in the results for the university on indicators of international outlook, which cover the share of foreign students, the share of foreign professors and participation in international cooperation.

The Technical University – Sofia participates for the third year in a row in the ranking and falls in the last range for the respective year. The university improved its results compared to the previous year in all areas except interaction with industry and knowledge transfer.

Along with the World University Rankings, the Times Higher Education presents the **Higher Education Impact Rankings**, which assesses universities against the United Nations' Sustainable Development Goals (SDGs). Indicators are used in four broad areas:

- Research: the most obvious and traditional way in which a university can help achieve the goals of sustainable development is by conducting scientific research on topics related to sustainable development.
- Stewardship: universities have significant resources; including tangible assets, employees, faculty and students. The way universities manage their resources is one of the key factors in achieving the SDGs.

- Outreach: the environment is key to higher education and the work universities do with their local, regional, national and international communities. Interaction between universities and environmental factors is another tool with which they can influence sustainable development.
- Teaching: teaching plays a critical role, both in ensuring that there are enough skilled professionals to achieve the SDGs, and in
- ensuring that all graduates take the key sustainability lessons into their future careers.

The 2023 Impact Rankings is the fifth edition of the study, which includes 1,705 universities from 115 countries and regions. Any university that provides data for Goal 17 and at least three other goals is included in the overall ranking. The impact on the achievement of each objective is based on a series of indicators that are used to assess the university's performance in the relevant area.[28]

Only two Bulgarian higher education institutions are represented in the 2023 Impact Rankings – **Medical University – Sofia and Sofia University**. Bulgaria is not represented in two of the Times Higher Education rankings (reputation index and young university).

Box 4. NIKI ROTOR AVIATION - WHEN DREAMS FLY

Niki Rotor Aviation Ltd. is a Bulgarian family company headed by Nikolay Nikolov and his daughter Miglena Kopcheva. The headquarters and all production are based in the town of Pravets.

The company is the first and only Bulgarian manufacturer of autogyros, producing three models named Lightning, Kallithea and the latest prototype Cruiser – presented for the first time at AERO Friedrichshafen in April in Germany. Niki Rotor Aviation is expanding in the markets of Europe, North America, Africa, and Australia.

A little background history

Nikolay Nikolov, the founder of the company, has been interested in aviation for a long time. Back in 2000, he developed his first prototype helicopter, which, although it did not reach the market, acted as a springboard for the team to move forward. In 2004, a project was launched for the first autogyro - Niki 2004. Four years later, the autogyro made a successful flight. In 2009, the first Bulgarian autogyro Lightning appeared on the market. Shortly after that, the company began production of the Kallithea model.

2023: the year of the Cruiser

Cruiser is the first company autogyro where the pilot and passenger are side-by-side, and not behind each other (tandem). The model is with a clean and minimalistic interior design inspired by modern aircraft construction, an integrated tablet with special software and a light carbon construction. Unlike the previous two models of the company, the motor frame is made of carbon.

The first test flight of the autogyro and the start of the license acquisition procedure are about to take place. For 2024, the Niki Rotor team plans to produce its own helicopter.

The challenges

"Our business is extremely niche. In Bulgaria, a country with traditions in aviation, there are not many companies that deal operate in this area. Our machines are designed and manufactured entirely by our team, by professionals with high skills and appropriate education, which are not easy to find due to the specifics of the work," says Nikolov. High-tech processes are integrated into the production, such as the use of carbon, produced and processed by the company staff, and allow customers the opportunity to make their autogyro truly "their own" with a specific interior and exterior.

Niki Rotor Aviation is an award winner of the Innovative Enterprise of the Year 2022 in the category Innovations in Creative Industries.

Source: Applied Research and Communications Fund, 2023.

[28] A university's overall score for a given year is calculated by combining its score on Goal 17 with the best three scores on the remaining 16 goals. Goal 17 accounts for 22 percent of the total score, while each of the other objectives has a weight of 26 percent. This means that different universities are evaluated based on a different set of objectives depending on their focus. The overall ranking score is an average of the overall scores for the last two years. The score of each objective is scaled so that the highest score is 100 and the lowest score is 0.

Box 5. SUSTAINABLE INNOVATION

Over the years, the Innovative Enterprise of the Year competition has distinguished sustainable innovators who have shown that this is a phenomenon characteristic not only of the modern startup environment and hi-tech sector. Aglika Trade Ltd, Veliko Tarnovo and Ted Bed Ltd, Plovdiv are examples of constant investments in innovative technologies and products as part of business planning and widening of the development horizon.

Aglika Trade

Aglika Trade has its own departments for innovation development. The company is the owner of two international fabrics patents – for the Doubleface technology (it won an award in the Innovative Enterprise of the Year 2017) and for the so-called membrane fabric which is more elastic, lighter than conventional fabrics and does not allow air or water penetration. Considerable in-house know-how backs the development of all product groups. The products, which do not differ in appearance and quality from other products, are made using new technology, new fabric weave, renovated equipment and an advanced method of production, all of which are a trade secret.

Aglika Trade has all the existing technologies for the production of towels, applying its own innovative technology for dry dyeing of smooth and voluminous fabrics – Watersave. It was created under a BGN 1.7 million project of the Operational Programme Innovations and Competitiveness in 2018-2019. The technology saves 8,000 litres of water when dyeing 300 bath towels. The technology is the result of a long-term partnership with Swiss experts from Textilcolor – a leading company for textiles chemicals and dyes. They create a special dye that provides the same colours as in traditional production.

Ted Bed

Ted Bed is an award winner of the Innovative Enterprise of the Year 2022 competition and has a rich innovation experience both in terms of production technologies and as an approach in human resource management and ESG policies. In 2022, the company was the first in Bulgaria to appoint an expert on sleep and sustainable development to work on ESG projects and educational programmes for children and adults related to sleep and healthy lifestyle. Investments in this area are part of a Sleep Innovation Centre.

Ted Bed has several innovative products created years ago: Nord Star - mattress and top mattress in a hybrid product – an innovation on the European market, protected with a utility model, Materra model – a protected utility model for mattresses with built-in geopathogenic radiation suppressor, Solo model – the world's first 28cm diameter roll-up mattress, FlexFit mattress – a protected utility model for a polyurethane profiled mattress core. The Amber mattress has an international patent for amber foam and is the only one of its kind in the world. It also won an award in the competition as a development startup, later acquired by Ted Bed.

The company is among the first in the furniture industry in Bulgaria to invest in photovoltaic plants. The 2.6 MW photovoltaic plant provides 79% of the company energy consumption during the summer months and about 30% during winter months.

Source: Applied Research and Communications Fund, 2023.

Entrepreneurship and innovation networks

Entrepreneurial activity is often a concomitant indicator of a country's innovativeness. New companies have the potential to offer new products and services to customers in a new way, but also to develop new markets, create new demand. Entrepreneurship within corporations enables already existing firms to develop their innovation capabilities. The viability of the national innovation system is much more dependent on the innovation and entrepreneurship networks than on the specific innovation and entrepreneurship champions. Sustainable mechanisms for technological transfer between the academic community and business, mentoring and investments, partnership in clusters and business associations aimed at forming long-term dialogue and policies are key factors for the success of the national innovation system.

Youth and social entrepreneurship

Entrepreneurship is a **structured risk-taking process** of recombining existing resources, offering or exchanging them in a new way, and is clearly an innovation. The newer the business model of exchange, the more knowledge and research invested in combining resources, the higher the premium for the entrepreneur, accompanied, of course, by a higher risk.

In the paradigm shift from microeconomic capitalism (the profit-maximising independent firm) to that of stakeholders (complex social networks balancing interests and utilities), youth and social entrepreneurship are increasingly important and influential. International development organisations have replaced the consensus of the early 1990s oriented towards privatisation, restitution, liberalisation and development of profitable private firms with a focus on regional development based on youth social entrepreneurship, volunteerism and cooperative forms of production and distribution of products and services[29].

The traditional narrative in Bulgaria is that entrepreneurial activity is low[30], and entrepreneurial policies and culture are underdeveloped, as can be seen from the 63rd position of the country in the Global Innovation Index 2023. However, recent Eurobarometer research[31] contains positive signs for the future of **youth and social entrepreneurship** in the country. These signals are both about activity and, more importantly, about the **attitudes and values of young people.**

Bulgaria is emerging as a **leader in the EU** in terms of attitudes towards entrepreneurship and its implementation among young people (under 30). **The highest share of committed young people** (between 15 and 30 years old) with their own business in Europe is in Bulgaria – 14%, against an average of 9% in the EU, with a minimum level of 5% in Luxembourg. Some of these business ventures are informal, without registering a commercial company: trading on olx.bg and the various meta-channels, Airbnb accommodations, repair crews, etc. This informal entrepreneurship creates experience and acts as a market test.

Another form of **start-up entrepreneurship** among young people (and later also among the self-employed) is work under **a civil contract** for the performance of a certain service. In this way, novice entrepreneurs can assess how much work and for what price they can perform and whether it is worth starting their own business. In this sense, plans to remove eligible costs in civil contracts may lead to the **thwarting of this important channel for entrepreneurial testing**. Civil contracts with legally eligible costs of 25% can be a good (cheaper in terms of transaction costs) alternative to registering a company and hiring an accounting firm.

Right after Bulgaria come young people from Estonia, Latvia, Slovenia and Hungary with 13% and Germany and Denmark with 12% committed to entrepreneurship. The self-assessment of young people about their familiarity with entrepreneurship is again the highest among the Bulgarians – 29% of them believe that they know very well what entrepreneurship is – a share that is more than twice the average in the European Union. The same share is present in Slovakia, and with 1 pp. lower in Portugal. This **high self-esteem** fosters entrepreneurial orientations and attitudes.

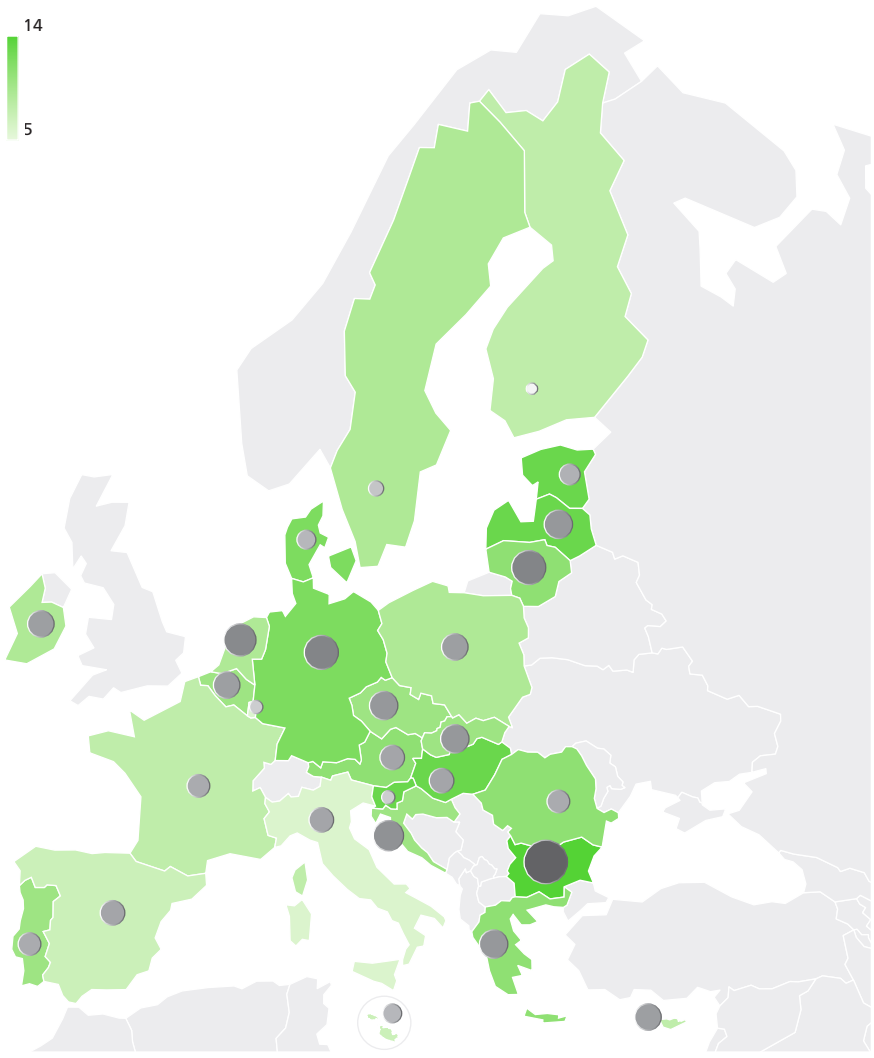
The highest share of young people who **take steps to start their own business** is found in Bulgaria – 23%, with an average share in the EU – 14% and a minimum – 6% in Finland. These steps cover different forms of training (as pupils and students),

[29] UN (2020), World Youth Report: Youth Social Entrepreneurship and the 2030 Agenda.

[30] Please see further in the chapter "Entrepreneurship and innovation networks" of *Innovation.bg* 2020.

[31] Social entrepreneurship and youth – March 2023 – - Eurobarometer survey (europa.eu) The field survey was carried out in October 2022.

Figure 17. ENTREPRENEURSHIP COMMITMENT OF YOUNG PEOPLE (15-30)



Taking steps to start a business: Circle size is between 6% and 23%

Source: Eurobarometer 513, March 2023.

pre-incubation and incubation programmes, entrepreneurial exchanges under the programme Erasmus for Young Entrepreneurs[32], business idea competitions and training companies. The Eurobarometer data is in line with the GUESS survey of student attitudes to entrepreneurship, where 37% report to be trying to start their own business[33]. Annually, about **150 entrepreneurship programmes and trainings** are implemented in the country involving young people who have not yet registered their companies but who have entrepreneurial ambitions. Universities have an important role in the formation of positive entrepreneurial attitudes of students, in stimulating early entrepreneurial activity among young people and reducing the differences between young men and women in terms of development of technological entrepreneurship[34].

The sectors in which young people most often consider starting a business are information and communication technologies (15%), retail and wholesale (11%), marketing (11%), creative industries – art, design and culture (10%). Bulgaria differs from other EU countries in two sectors – **IT and industrial production**. There, Bulgarians have the highest shares of those willing to start a business – 15% against an average of 13% for the EU in the IT sector and 8% against an average of 4% for the EU in the industrial production sector. These attitudes and expectations positively influence the development of the specific market niches that serve them, such as youth companies (often founded by students or even pupils) that provide educational and training services to pupils and students in the field of STEM – programming, robotics, games (Minecraft). Bulgaria also ranks relatively well in the export of services in culture and creative industries (16th position in the Global Innovation Index 2023).

In 2023, a new trend is taking shape in the ecosystem supporting entrepreneurship, namely the **focus on smaller towns**, outside the five large cities (Sofia, Plovdiv, Varna, Burgas and Rousse) and more specifically on places where there are no universities or that have limited outsourced training by established universities. One such place is the city of Kardzhali[35], where several projects in support of entrepreneurship are implemented – an Interreg project with the participation of Industrial Zones, the

[32] European business exchange programme – Erasmus for Young Entrepreneurs (erasmus-entrepreneurs.eu)

[33] Hadjitchoneva, J. (2021). Student Entrepreneurship 2021: Insights from Bulgaria. Retrieved from GUESSS website: https://www.guesssurvey.org

[34] Yordanova, D (2021). Nascent Technology Entrepreneurship among Bulgarian STEM Students. Administrative Sciences, 11(4), 121.; Pergelova, A., F. Angulo-Ruiz, T. S. Manolova, D. Yordanova (2023). Entrepreneurship education and its gendered effects on feasibility, desirability and intentions for technology entrepreneurship among STEM students. International Journal of Gender and Entrepreneurship, 15(2), 191-228.

[35] The Lyuben Karavelov branch of Plovdiv University operates there, which trains students in professional fields 1.2. Pedagogy, 1.3. Pedagogy of training in... and 4.3. Biological Sciences.

Box 6. PRE-INCUBATION AND ACCELERATOR PROGRAMMES

Best youth startup is a national competition organised by the Fund Manager of Financial Instruments in Bulgaria (FMFIB) and the Department of Economics and Business Administration of Sofia University. Conducted since 2022, it includes mentor sessions and trainings of 11th and 12th grade students and young people under 30.

Able Mentor is an annual programme aimed at supporting the career and entrepreneurial development of secondary school students. School year 2023/2024 marked the 20th round of the programme. In addition to business ideas, the programme supports initiatives aimed at social issues and social entrepreneurship.

Teenovator is an annual programme for 10th and 11th grade secondary school students who join startup clubs delivering lectures, seminars and competitions. The programme started in 2018.

The **Accelerator Programme for Agricultural Start-ups** from China and the CEE countries is organised and operated by the Association for the Promotion of Agricultural Cooperation Between China and the Central and Eastern European countries, a secondary budget administration towards the Ministry of Agriculture of Bulgaria and started in 2023.

From Zero to Fintech is a national hackathon for students and entrepreneurs in the fintech industry, which was held by the Bulgarian Fintech Association for the first time in 2022.

SEE Innovation Programme is a supplementary incubation programme by Sofia Tech Park intended for technological transfer and academic entrepreneurship, which starts at the end of 2023.

PARAi Robotics Incubator is a pre-incubation and incubation programme of the Professional Association of Robotics, Automation and Innovations, which has had two rounds so far.

For 25 years, **Junior Achievement** has been organising competitions and training programmes for the development of entrepreneurial skills. Among the most popular are the Company Programme and Innovation Camp.

Innovation Starter Accelerator is an accelerator for entrepreneurs in their pre-seed phase, which collaborates with universities and public institutions.

Source: Applied Research and Communications Fund.

University of National and World Economy, the High-Tech Business Center of Sofia University, Master class for young entrepreneurs of the United Bulgarian Bank and the Department of Economics and Business Administration of Sofia University, as well as the Academy for local entrepreneurs 7.0 of Rinker Center.

The expectations of young people in Bulgaria for the most suitable form of support for starting their business are for **mentorship from experienced entrepreneurs** (30% of young people), the development of a business plan (28%), ensuring access to customers or suppliers (24%) and expanding the social circle, education and training (22%), and less so for the provision of financial support in the form of grants (16%) or easier and cheaper loans (16%). This seemingly surprising result corresponds to the fact that the supporting ecosystem offers precisely such services.

Young people in Bulgaria, like the rest of the European Union, believe that companies should strive to put **people and the planet as the main priority** (44%) over profit maximisation (29%). This is even more pronounced among young people who prefer an entrepreneurial career – 46% to 27%. These data are in line with the dominant trends of sustainable fashion (Patagonia and Zara), zero waste (Blagichka restaurant in the city of Sofia, which employs disadvantaged youth; FoodObox[36]), recycling (including the Caps for the future campaign), etc.

About 9% of young people participated in activities of organisations fighting climate change and environmental protection, and 16% participated as volunteers[37]. In terms of considerations when choosing a company to work for, the levels in Bulgaria are also above European averages – 40% in Bulgaria vs. 26% in the EU for social goals and 32% vs. 28% for goals related to environmental protection.

Despite fierce political propaganda against the **non-profit organisations**, especially against those working in the field of human rights, Bulgarian youth steadily (50-60%) participate in their activities. Even in the narrow area of human rights protection, the level of participation (11%) is above the European average (10%) and close to the maximum 14% in Germany.

For the first time, the ecosystem of **entrepreneurial competitions** in the country includes a global competition for social entrepreneurship – Hult Prize, which will be presented by the American University in Blagoevgrad and Sofia University. Another competition that will be held for the first time in 2024 is the Creative Business Cup with national coordinator the Business Innovation Center Inobridge from the city of Rousse.

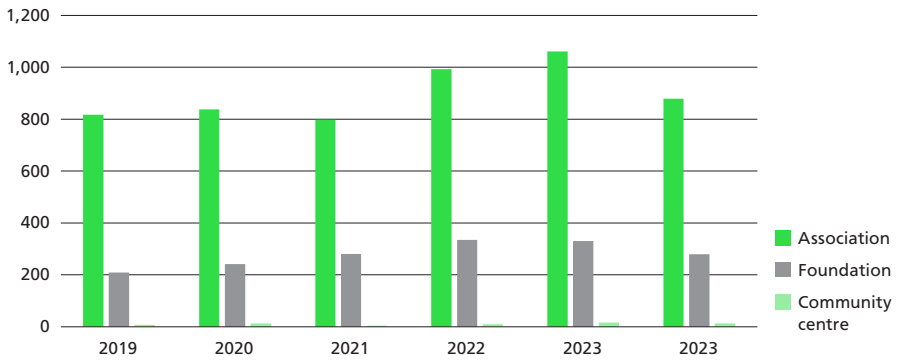
[36] FoodObox has won a number of awards in national startup competitions and attracted investment from the Innovation Capital Fund.

[37] Flash Eurobarometer 502.

Social enterprises are typically thought of as market entities – commercial companies that achieve socially significant goals. In Bulgaria, as in many other European countries, however, the focus is on the activity and the social effect, not on the legal form[38]. Thus, many more associations, foundations, and community centres can be considered as social enterprises. Opening and closing associations and foundations is much easier (and cheaper) than a company. Social platforms like Times Heros match the demand and supply of volunteering with causes.

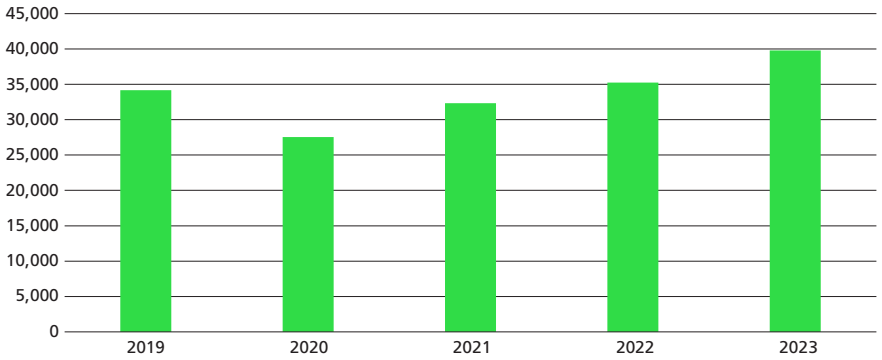
Civic entrepreneurship in new non-profit organisations increased by 36% compared to the pre-Covid year 2019. In the last two years, there have been more than 1,000 new non-profit organisations registered in the country. Cooperation takes place on a civic, not on a capital basis. There are still few new cooperatives and those are traditionally in the field of agriculture.

Figure 18. NEWLY REGISTERED NON-PROFIT ORGANISATIONS



Source: APIS.

Figure 19. NEW COMPANIES' DYNAMICS



Source: APIS. The data for 2023 are extrapolated on the basis of average data for the first 10 months for the period 2019-2023 by type of company.

Establishing new commercial companies

The new companies in 2023 will exceed by more than 16% the newly registered ones in 2019. The recovery of attitudes and the **achievement of entrepreneurial intentions have been very uneven among the regions of the country**. While in Sofia (both the capital and the district) for the first ten months of 2023 there were 30% more new companies than in 2019, in areas such as Kyustendil, Silistra, Stara Zagora, Smolyan, Haskovo, Shumen and Yambol there are still fewer newly registered companies compared to the pre-Covid period.

In addition to Sofia-city and the district, for the first ten months of 2023 the rate of **formation of new companies** (compared to 2019) has been higher than the national average in the districts of Kardzhali (28%), Rousse (24%)), Targovishte (20%), Lovech (20%), Pleven (19%), Veliko Tarnovo (19%), Varna (18%) and Sliven (17%). Growth in different regions is driven by different factors: foreign investments – in Kardzhali from Turkey, in Varna from Ukraine, and in Rousse from Romania; investments of people from the region working abroad – Kardzhali, Sliven and Targovishte; return of young people who graduated in Sofia and abroad, etc.

About 10% of the new companies in Bulgaria are fully owned by foreign citizens, and 2% are new companies – independent or in partnerships with other companies or individuals, a new initiative of existing businesses or the result of restructuring.

Compared to pre-Covid 2019, in 2023 there are changes in the source countries of **partners/investors in the new firms**. For the period January-October 2023, the largest number of companies with partnerships are from **Turkey (426) and Ukraine (415)**, followed by Greece (381), Italy (344) and Germany (323). There is an increased interest from Romanian investors (176), ahead of the French (170). Russians stopped investing in new companies in Bulgaria, which can be explained by the war that Moscow is waging against Ukraine and the retaliatory sanctions imposed by the EU on Russia.

[38] Arabadzhieva, M., & Vutsova, A. (2021). Ecosistema de las empresas sociales: status quo y su desarrollo auspicioso. *Revista de Estudios Cooperativos, 137*.

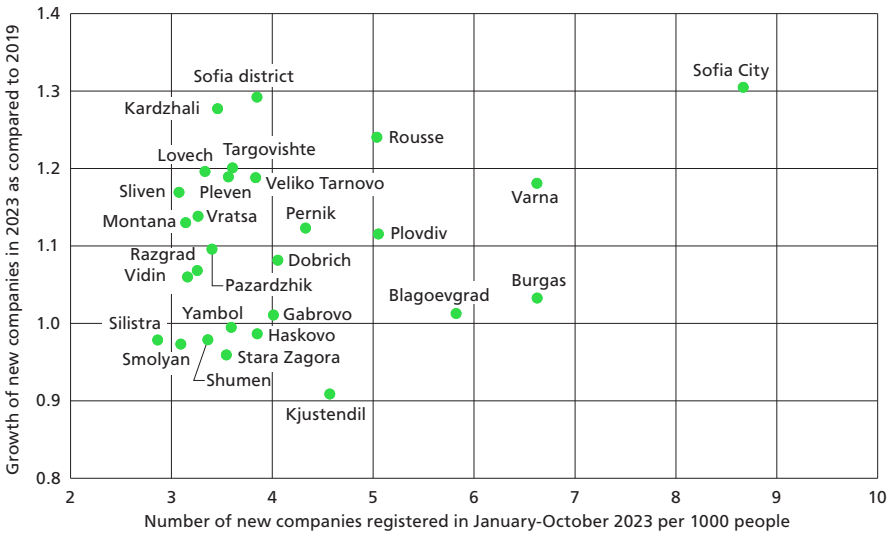
The effect of new firms on employment is complex and delayed by at least a year or so. New firms registered between 2019 and 2022 created **139,000 jobs in 2023.**[39] This number is very small against the background of about 129,000 newly created companies. Between 50% and 60% of new businesses remain without employees because their managers/partners are self-employed and the income, if any, is received through a dividend not a salary. Only 1% of newly created companies have 10 or more employees.

Entrepreneurship manifests itself through the creation of new ones, but also through the **development of the entrepreneurial orientation** of existing companies.[40] The main components of entrepreneurial orientation are: innovation, pro-activity, risk acceptance, competitive aggressiveness and autonomy. The practice of organising internal entrepreneurial hackathons and bottom-up innovation experiments that develop entrepreneurial skills and attitudes of staff has already been adopted, for example in companies such as Scalefocus.[41]

Institutional (regulatory) innovations

In 2023, the **variable capital company** (VCC) was introduced in the Commercial Code.[42] A VCC is a company that allows its capital to be changed in a much easier and cheaper way, compared to the limited liability and joint stock company. Its capital is not registered in the Commercial Register, provides for the issuance of options for the acquisition of shares for the benefit of employees and third parties, as well as convertible loans, much easier transfer of shares and evaluation of contributions. This opportunity is provided only for companies with up to 49 employees and a turnover and/or asset value of up to BGN 4 million. However, it is still not possible to register a VCC, as the Registration Agency cannot provide technical registration of the new type of company. It must change its information system by June 30 2024 and make this possible. The VCC in some countries is called an "entrepreneurial company" (*Unternehmergesellschaft* in Germany and *Sociètè*

Figure 20. DIFFERENCES IN REGIONAL ENTREPRENEURSHIP



Source: APIS.

Table 2. DISTRIBUTION OF NEW ENTERPRISES BY SIZE (EMPLOYEES) IN 2023

	Year of incorporation				
	2019	**2020**	**2021**	**2022**	**2019-2022**
Micro (without employees)	59.50	53.80	49.06	57.30	55.08
Micro (one)	20.07	23.55	28.71	26.82	24.81
Micro (from 2 to 9)	19.13	21.15	21.01	15.03	18.91
Small-sized	1.26	1.46	1.15	0.81	1.15
Medium-sized	0.04	0.05	0.07	0.03	0.05
Large	0.01	0.00	0.00	0.00	0.00

Source: APIS.

[39] The data are based on the number of persons covered by social security from the National Social Security Institution through APIS. These data are only an approximation of employment, since if the manager or others working in a start-up company have other income, above the maximum insurance threshold, they are not present in the statistics of the National Social Security Institution. Unpaid family workers are also not visible in these statistics. The more accurate statistics from NSI, however, are so late that they are practically unusable, except for research.

[40] Davidkov, T., & Yordanova, D. (2015). Entrepreneurial Orientation as a Managerial Innovation: implications for Bulgarian Enterprises. Innovations managèriales: Enjeux et perspectives, 37, 133.

[41] An example of an innovation with a great social effect, generated through a systematic entrepreneurial orientation of the company, is SoundVision, which won the 2023 PMI Bulgaria award in the Project of the Year category.

[42] Variable capital companies are particularly popular in countries with developed capital markets and are used to structure investment funds.

par actions simplifiée in France) and transfers the already established principles of managing collective investment schemes to startups.

The bill to amend the Commercial Code, which introduced the regulation of the VCC, for the first time used the concept of **regtech** in a legal document in Bulgaria (except for the documents of the European Parliament and the European Commission). Regtech, or technologies that facilitate compliance with the increasingly complex and voluminous regulations, is one area where many startups are expected to emerge and grow rapidly.

An example of a Bulgarian company that works in the field of regtech (and fintech) is Iris Solutions[43], which develops technologies for open banking, as a direct consequence of the introduction of the Second Payment Services Directive (PSD2). Omnio is another example of a Bulgarian regtech company that uses artificial intelligence to automatically assess the risk of money laundering and other financial abuses[44]. Currently, regtech in Bulgaria is still developing very narrowly, mainly related to the fintech industry. However, serious developments can be expected in other areas as well, such as the regulation of nuclear power (including small nuclear reactors), architectural and construction regulations (for example, the adoption of requirements for the provision of architectural plans and construction documents in machine format).

The European Green Deal is expected to be the most significant generator of regulatory innovation in the next 3-4 years. The requirements for companies related to environmental, social, and governance (ESG) objectives, the greening of the economy, and carbon neutrality are growing faster than companies would be able to achieve gradually. ESG, like digitisation, is rapidly spreading along value chains and leading to a growth in demand for software products to measure everything related to the environment, social challenges and good governance from the perspective of a wide range of stakeholders. Large financial institutions are already developing tools to help their clients to measure **their carbon footprint,**[45] since they need to assess many environmental risks.

Innovation networks

Innovation networks in Bulgaria are increasing their intensity and linkages. While before the country's membership in the EU and shortly after, the European Innovation Relay Centres (IRC) network and the Enterprise Europe Network (which united IRC and Business Innovation Centres after 2008) dominated in the country, in the last decade more networks have developed, which brought together various private businesses across sectors, geography and other criteria.

Bulgaria performs well on the indicator "innovation links" which places it in the 38th position, which is also the country's overall position in the Global Innovation Index 2023. The research community's links with the outside world are the best developed (10th place), and the weakest is the relationship between universities and business (53rd place).

Box 7. REGULATORY INNOVATIONS, NUCLEAR TECHNOLOGIES AND ADDED VALUE NETWORKS

As a founding member of the International Atomic Energy Agency and member of the Nuclear Energy Agency of the OECD Bulgaria is a part of the process of transformation of nuclear technologies.

In the past few years, the development and legal regulation of small modular nuclear reactors are among the key trends in the nuclear sector and its integration in various value chains. The nuclear ecosystem is part of the global innovation landscape. The areas in which Bulgaria can be competitive and develop competencies, knowledge and technological capacity include:

- Digitisation of the nuclear sector as regards design, construction, exploitation, removal decommissioning and management of radioactive waste and spent nuclear fuel through artificial intelligence and machine learning technologies, digital twins, 3D printing, and prototyping.
- Industrial use of nuclear energy for power generation, production of hydrogen and ammonia with zero emissions.
- Development of hybrid energy systems based on nuclear energy and renewable sources for power generation and hydrogen production, for cooling and heating, transportation, ICT and other critical infrastructure.

The available nuclear capacity is the basis for a future zero emissions nuclear industrial valley and the development of competences and knowledge in the academia and business for zero emissions industries. To this end, R&D and staff training need to be prioritised, together with more competitive choice of technological solutions in the sector, instead of hasty commitment to a specific technological supplier.

Source: Applied Research and Communications Fund based on materials provided by Kozloduy Nuclear Competence Centre.

[43] Award winner of the 2021 Innovative Enterprise of the Year award of the Applied Research and Communications Fund in the category digital transformation.

[44] Award winner of the 2021 Innovative Enterprise of the Year award of the Applied Research and Communications Fund in the category innovative startup.

[45] Such an example is UBB's Agro-calculator of carbon emissions introduced in the autumn of 2022.

Among the innovation networks, first there are the **new business associations,** such as the Bulgarian Entrepreneurship Association (registered at the end of 2017 as the National Representation of the Bulgarian Startup Entrepreneurial Community), AIBEST (formerly the Bulgarian Outsourcing Association, rebranded and expanded in 2019), Bulgarian Employers Association of Innovative Technologies (formerly the Association of Business Clusters, rebranded and expanded in 2020), Artificial Intelligence Cluster Bulgaria (registered at the end of 2019), the network of entrepreneurs POWER of BG, the network of funds of the FMFIB, the events network StartUp Weekend, Night of Entrepreneurs, SERP Conf (the leading conference in the field of SEO) and more.

Next, there are the **international business networks,** such as the Founder Institute, Endeavor and the European Business Network. Their respective representatives in Bulgaria provide a fast track for internationalisation as regards markets and for attracting investors.

Third, there are the **academic networks** (including international ones such as university alliances) and scientific infrastructures of laboratories, parks and centres of excellence and competences. Some of them involve private innovative companies and organisations (such as Clean Tech at the Competence Centre for Clean Technologies for a Sustainable Environment Clean Technologies). In others, companies gain international visibility through partnership in alliances. In research universities, **internal networks for technology transfer and commercialisation** of scientific results are currently being built, and the first results will be visible in 2024.

Innovation networks, or rather **networks of networks**, can and should be strategically created by governments. A similar idea is establishing regional networks of innovation valleys with a pilot trial between Bulgaria and Romania.[46] At the national level, linkages between different sectoral innovation systems are possible, which can have strong positive side effects. For example, **offset agreements** on major strategic purchases (military technology or nuclear reactors) can be used for the development of microelectronics or the production of hydrogen by high-temperature electrolysis, which can then be applied for industrial purposes or as a fuel for transport vehicles. Through the mechanism of **pre-commercial procurement** of smart infrastructure (roads, public buildings), new partnerships can be created between the cement industry, construction, microelectronics and the software industry.

[46] "Bulgaria and Romania to create a network of innovation valleys," *manager.bg*, 04.08.2023.

Investment and financing

Spending on research and innovation is a measure of the investment in the creation, use and dissemination of new knowledge in the public and business sectors. It is considered an indirect indicator of the innovation capacity of the national economies in future periods. A high ratio of R&D financing to GDP is a factor fostering dynamic economic growth and competitiveness.

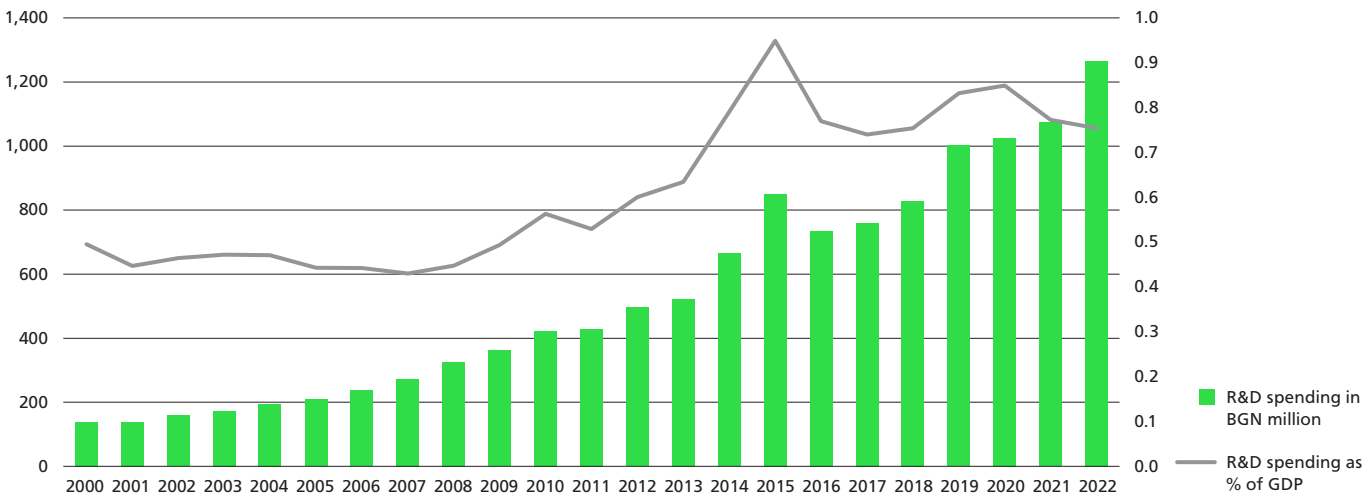
R&D spending

In 2022, R&D spending in Bulgaria reached **BGN 1,266 million**, which represents an **increase of nearly 18% compared to the previous year**. Measured as a share of GDP, however, **R&D spending made up just 0.75% – a decrease of 0.02 pp. on an annual basis**, a significant retreat from the "record" year of 2015.

There is a serious **discrepancy between the achieved results for the level of R&D spending and the target values of the policies** for the development of science and innovation in the country (Table 3). This puts in doubt the appropriateness of the measures for the implementation of the strategic framework and the validity of the planning tools used. The significant difference between the expectations of the Ministry of Innovation and Growth, focused on technology transfer and innovation, and the Ministry of Education and Science, primarily engaged in the development of scientific research, shows a definite **lack of interaction and coordination at the national level** about the vision for the development of science and innovation in the country, the capacity of the innovation system and its units to maintain sustainable growth, as well as about the driving forces and sources of competitiveness of the national economy. Bulgaria remains the only country in the EU that **does not have a definite centre for the development of smart specialisation**, a key tool of the European Commission for directing EU financial resources to regions in member states.

In 2022, **more than two-thirds of R&D spending in the country was made by enterprises (68%).** The total amount of business investments for research and development amounted to BGN 858 million, which is **a growth of 21%** compared to the amount spent in 2021. The increase allows business to keep R&D spending as a share of the GDP at the level of 0.51%, which is significantly below the peak values of 2015. As before, the launch of the programmes for financing innovation and technological transfer of enterprises under the European structural and investment funds (this is already a fact from 2023 for the Programme for Competitiveness and Innovations in Enterprises), as well as under the National Recovery and Resilience Plan, is expected to mobilise significant private resources.

Figure 21. R&D SPENDING IN BULGARIA, 2000 – 2022



Source: NSI, 2023.

Table 3. R&D SPENDING AS PERCENTAGE OF GDP, TARGET VALUES

	2022	2025	2027	2030
National strategy for R&D development in the Republic of Bulgaria 2017-2030	2.4	3.0		3.3
Innovation strategy for smart specialisation			1.5*	

* The Ministry of Innovation and Growth follows the Global Competitiveness Report as data source for R&D spending as a share of GDP.

Source: ARC Fund.

The share of R&D spending of GDP of the higher education sector is also unchanged – 0.05%, which is the result of an **increase of 14%** on a one-year basis **in the sum spent by universities for science and technology transfer**. The exception is the **public sector**, where there is a **drop in the share of R&D spending in GDP by 2 pp. to 0.19%.** The amount spent for R&D by public research organisations is BGN 322 million, with a growth of nearly 11% on a one-year basis.

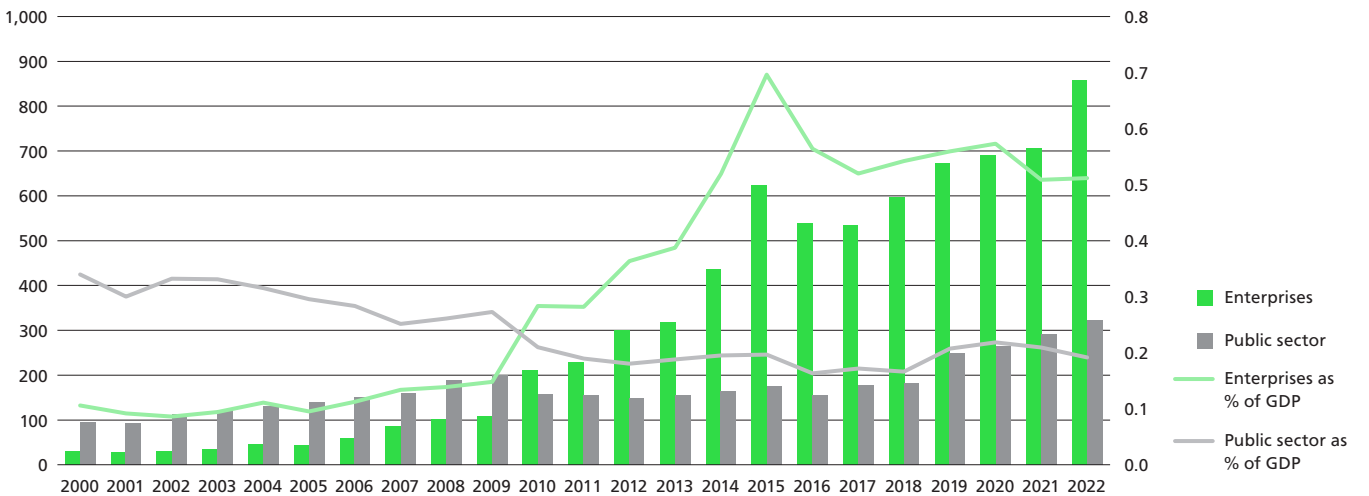
Exactly half of all R&D spending is in the area of technical sciences. The biggest contribution is by enterprises, which generate 90% of the investments made. Only 7% of technical science funding is provided by public sector entities. **Medical and health sciences attracted 21% of R&D spending** (again, nearly 90% of funds in this area were provided by business), **followed by natural sciences with a share of 17%** (led by the public sector, which provided 69% of the funding in this area).

Large enterprises have a predominant share in R&D spending in the sector – nearly 55% in 2022 (down 3 p.p. compared to the previous year). Medium-sized and small enterprises contribute 22% and 17% respectively of business investment in research and development. The group of small enterprises has the highest growth in R&D spending (52%), which brings their share closer to that of medium-sized enterprises (a difference of only 5 p.p.) compared to previous years. Micro-enterprises are in second place in terms of R&D investment growth on a one-year basis (21%).

Enterprises from all economic sectors increased their R&D spending. It is most significant (over twice) in the agriculture, forestry and fisheries and construction sectors. The sectors of professional activities and scientific research, creation and dissemination of information and creative products, and telecommunications are with equal positions of 34% as a share of total business expenses for R&D, followed by manufacturing with 25%.

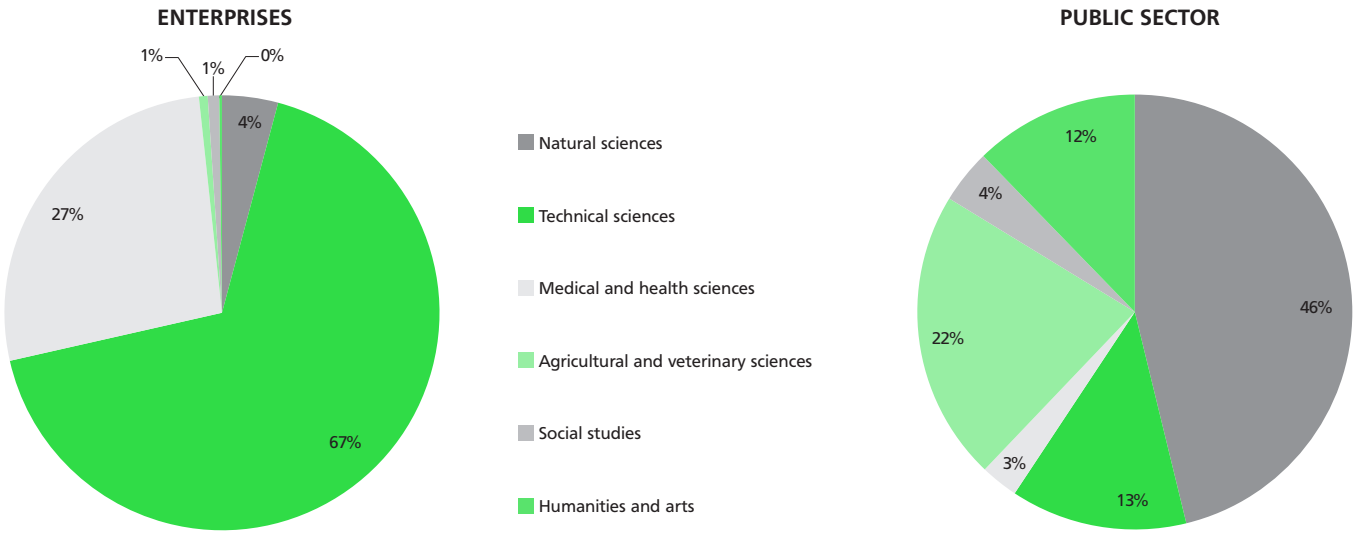
The predominant part (40%) of R&D spending is from abroad – European structural and investment funds, European framework programmes, but also foreign direct investments, international organisations and investors.

Figure 22. R&D SPENDING BY ENTERPRISES AND THE PUBLIC SECTOR, 2000 – 2022



Source: NSI, 2023.

Figure 23. STRUCTURE OF R&D SPENDING, 2022, %



Source: NSI, 2023.

They are **almost entirely allocated to business (88%)**, while the public and higher education sectors attract equal shares of 5.3% on average. **In the second place as a source of R&D funding are enterprises, which invest almost entirely in their own developments (92%)**. Enterprises spend only 6% of their R&D budget on commissions to research units in the public sector and allocate another 2% to higher education institutions. **The public sector provides 25% of all R&D spending in the country, and uses 87% of it**, and another 12% goes to higher education institutions. The higher education sector is almost entirely self-sufficient. Universities have an extremely limited own resource for R&D (0.5% of the country's entire portfolio), over 95% of which is spent by them.

R&D spending from the public budget in 2022 increased by a little over 12% on a one-year basis, reaching **BGN 365.8 million**.[47] It covers R&D financed by the state budget, carried out both on the territory of the country and outside of it. Annual membership fees paid to international scientific organisations, as well as payments for the participation of Bulgaria in bilateral and multilateral R&D programmes, are also treated as budget R&D spending.

According to the nomenclature for analysis and comparison of scientific programmes and budgets (NABS 2007), three areas **lead in terms of the distribution of public funds** and are significantly ahead of others:

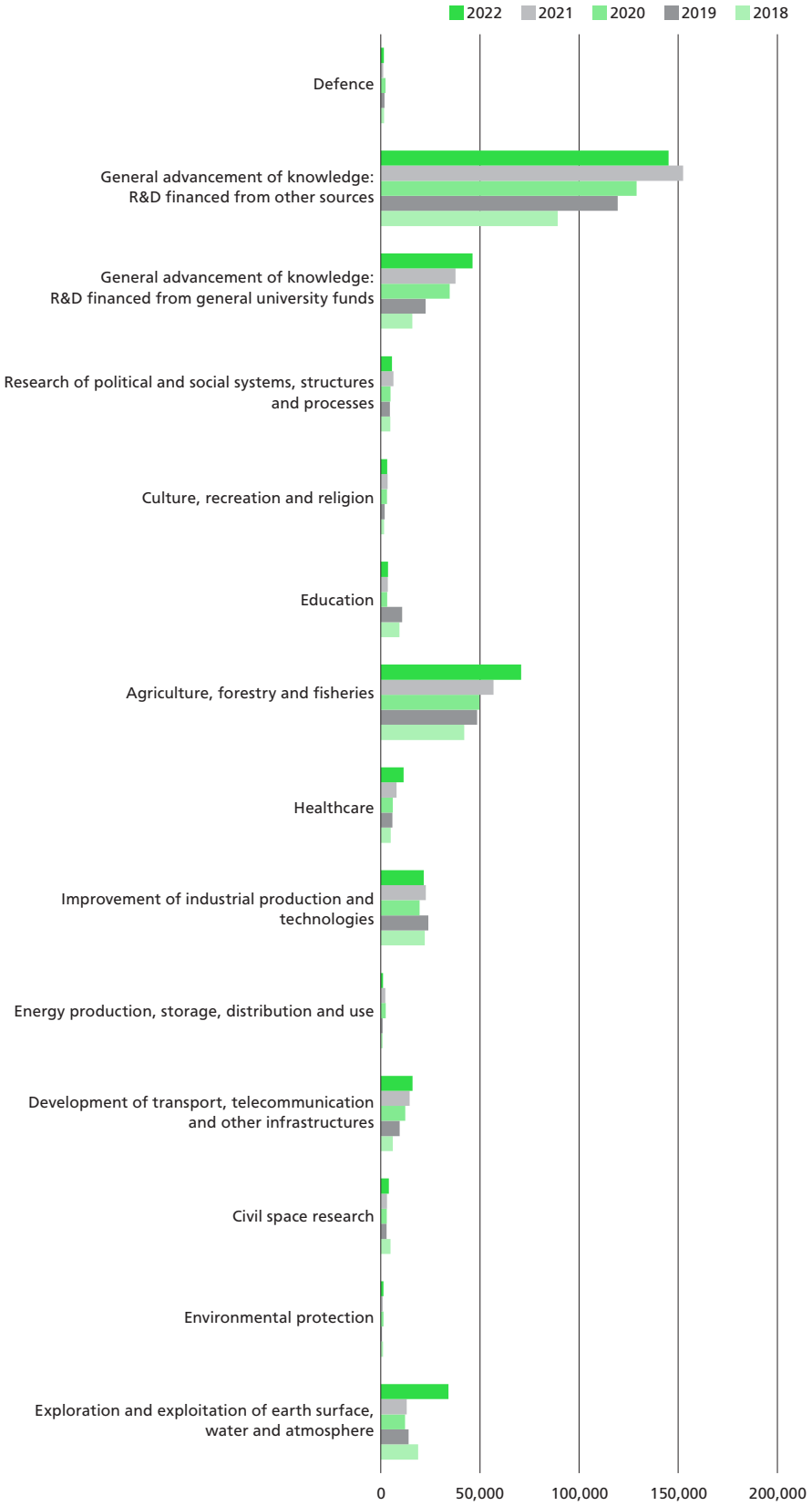
- With a **40%** share (or BGN 145 million) in first place is the field of general development of knowledge: R&D financed from other sources. In 2022, it covered the institutional funding for BAS structures with BGN 141 million (including all increases in public financial transfers to the BAS)[48], along with membership fees and the country's participation in international scientific agreements.
- The development of agriculture, forestry and fishing is with just over **19%** of all R&D budget spending (BGN 71 million), which is mainly allocated to the **units of the Agricultural Academy through the budget of the Ministry of Agriculture and Food.**
- Another **13%** is allocated to the research of **public higher education institutions.**
- In 2022, the budget for the exploration and exploitation of the Earth's surface, waters and atmosphere had the biggest increase – more than 2.6 times compared to the previous year. The health sector is next with an additional 45% compared to the 2021 budget.

In five socio-economic fields, the public funds decreased, the most noticeable of which was in the production, storage, distribution and use of energy – the funding in 2022 failed to reach even half of the funds allocated in the previous year. Within the last five-year period, however, **the "record" holder for the decline in public funding is the education sector** – the budget of BGN 3.6 million in 2022 represented only 39% of the funding provided in 2018.

[47] The study is comprehensive and covers all ministries and departments, primary allocators of budget appropriations for R&D.

[48] According to the Annual Report 2022, Bulgarian Academy of Sciences, BAS Publishing House "Prof. Marin Drinov"1 S., 2023, ISSN 1314-4499.

FIGURE 24. BUDGET R&D SPENDING BY SOCIO-ECONOMIC OBJECTIVES, BGN THOUSAND

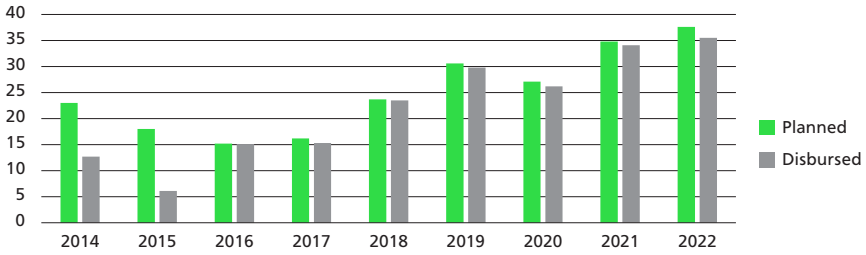


Source: NSI, 2023.

Box 8. SUPPORT BY THE NATIONAL SCIENCE FUND OF FUNDAMENTAL SCIENCE IN BULGARIA

The work of the National Science Fund (NSF) is carried out in accordance with the National Strategy for the Development of Scientific Research, the National Reform Programme, the framework programs of the European Union, the European and national roadmap for R&D infrastructure and other European and international initiatives. According to the National Strategy for the Development of Scientific Research 2017-2030 "Better Science for a Better Bulgaria", **NSF is the main instrument for financing the research of scientific organisations and higher education institutions based on a competitive selection of projects** in the priority areas outlined in the National Strategy.

PLANNED AND DISBURSED NSF FUNDING 2014-2022, BGN THOUSAND



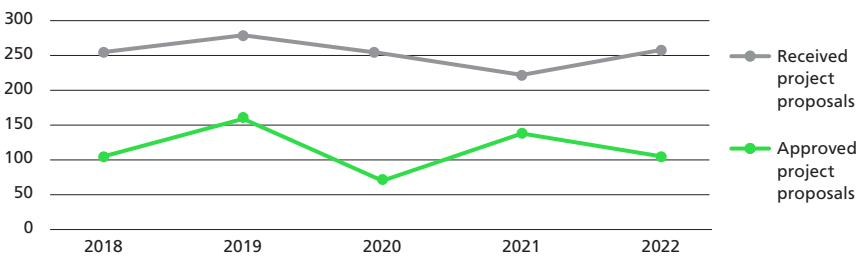
Source: Annual report of the National Science Fund for 2022.

Since the adoption in 2016 of changes to the Research Promotion Act and a new Regulation of the NSF, **the calls for funding projects for fundamental R&D, projects of young scientists and post-doctoral students, and of Bulgarian scientific periodicals have been held annually**. Competitions continue under seven programs for bilateral cooperation with Austria, India, China, Russia and France. The fund is also involved in a number of international science programmes (ERA-NET).

Since 2016, **the Fund's budget has more than doubled** and reached nearly BGN 38 million for 2022, while the allocated funds for new and previously launched fundamental research projects amounted to BGN 35.5 million.

For the five-year period of operation of the first stage of the implementation of the National Strategy for the Development of Scientific Research (2018-2022), the largest number of project proposals were submitted under the procedures for **fundamental R&D** – 1,267 for the entire period. A little over 45% of them were financed by BGN 82 million. A significantly higher success rate was achieved in the calls for fundamental R&D for young scientists and postdoctoral students – 77% for the period for a total of nearly BGN 6 million. After 2018, two more procedures for funding fundamental R&D were carried out – on societal challenges and on societal challenges related to the Covid-19 pandemic, for which a total of just over BGN 8 million was allocated.

RECEIVED AND APPROVED PROJECT PROPOSALS BY THE NSF IN CALLS FOR FUNDAMENTAL R&D, 2018-2022, NUMBER



Source: NSF, 2023

The main part of the funds in 2022 was allocated to:

- Fundamental R&D – 53%, of which 4% for young scientists and postdoctoral students.

The technical sciences receive the largest relative share of the Fund's total budget (17.3%), followed by the biological, medical, social and agricultural sciences with almost equal shares, varying around 11%. The funds allocated to mathematical sciences and informatics, and earth sciences are minimal (about 6%).

With equal positions in the competitive sessions for fundamental R&D are the institutes of BAS – a total of 47 projects received funding of BGN 11.40 million, and the higher education institutions, which received nearly BGN 11 million for 48 projects. The fund also financed seven projects of institutes of the Agricultural Academy with BGN 1.5 million and three projects of other scientific organisations by BGN 710 million.

In terms of funding for young scientists and post-doctoral fellows, BAS institutes have a clear lead with 26 projects and attracted just over BGN 1 million, followed by higher education institutions with BGN 613 million, allocated to 16 projects. Young scientists from the Agricultural Academy implemented seven successful projects (BGN 270 million), while those from other scientific organizations had four (BGN 160 million).

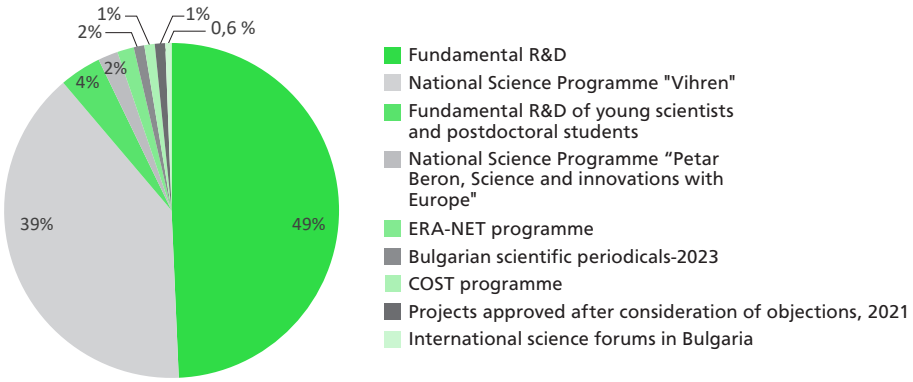
- National R&D programmes Vihren (39%) and Petar Beron (2%).

The two science programmes financed by the NSF are aimed at improving the positions and standing of Bulgarian scientists and scientific research developed in Bulgaria on the international stage. National science programme "Excellence in research and people for the development of European science" (Vihren) supports Bulgarian scientists with high achievements, while the general goal of the National Science Programme "Science and innovations with Europe" (Petar Beron) is to accelerate the reintegration and career development in Bulgarian higher education institutions and scientific organisations of experienced researchers with internationally recognised scientific results.

- International and ERA-NET programmes (a little over 2%).

- Scientific periodicals (1.02%) and international scientific forums in Bulgaria (0.6%).

DISTRIBUTION OF THE 2022 NSF BUDGET BY CALL SESSIONS, %



Source: NSF annual report for 2022.

The main challenges facing the work of the NSF are related to the insufficient budget for the development of fundamental research, as well as the bureaucratic procedures related to its spending; lack of administrative capacity (insufficient number of employees and low level of digitisation of procedures), insufficient number of evaluators. In addition, since 2014, the NSF calls have been held outside the scope of the European State Aid Framework for Research, Development and Innovation, which **excludes applications for patents, utility models and other objects of intellectual property from the scope of eligible costs for funding from NSF**. This complicates the work of scientific bodies, which are forced to look for additional sources of funding to maintain their portfolio of intellectual property objects, including those resulting from the implementation of projects finance by the NSF.

Source: NSF annual report for 2022.

Human capital for innovation

R&D personnel, together with those employed in scientific and technological activity, measure the human resources directly responsible for the creation, application and dissemination of new knowledge in the economy. The indicator of employment in high-tech sectors characterizes the country's specialization in industries with a high level of innovation activity.

The Global Talent Competitiveness Index[49] and the World Talent Index are just some of the international rankings that measure various aspects of the potential of countries and economies to address global challenges. In this case, the focus is on talent – the main driver of innovation, especially in the age of artificial intelligence.

Bulgaria's participation in both indices gives the country the opportunity to measure itself against the best, to position itself within the dynamic competitive environment for **creating, developing and attracting talent** and to outline its vision for a better performance. This is exactly what is need, because:

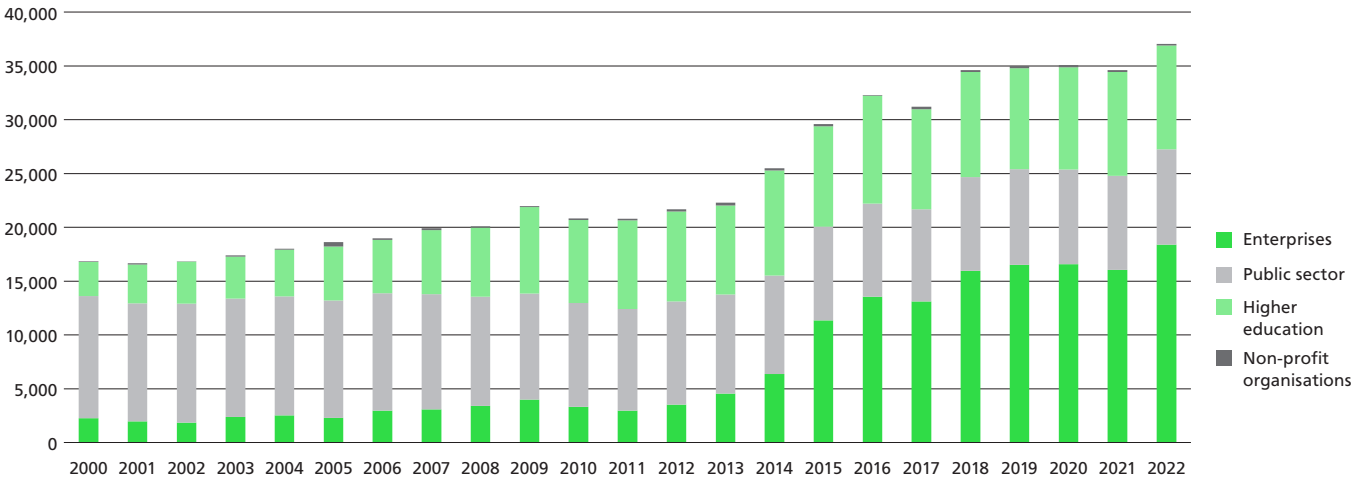
- in the Global Talent Competitiveness Index, the country ranks 49th, just behind Georgia, Costa Rica and Saudi Arabia, and only ahead of Romania within the EU27;
- in the World Talent Index, Bulgaria is in 58th place, in the company of India, Colombia and Mexico, and last among the EU27 member states.

The personnel engaged in R&D in Bulgaria in 2022 numbered **37 thousand people** including a **growth of 7%** over the preceding year. Exactly **half of the research workforce is in enterprises** – the largest share to date after a continuous growth rate since 2013. In the last year alone, the increase in R&D personnel in the business sector has been close to 15%. With almost equal positions are the public and higher education sectors, respectively 24% and 26%. In both groups of public organisations (with small exceptions for higher education institutions), the number of employed researchers has been relative stable, which over time has affected relative weight.

A comparison of R&D staff and spending by scientific field shows **a higher relative remuneration for those engaged in R&D in the technical sciences**, primarily because employment is mainly provided by business research departments (67% of spending for R&D in this area, which mainly covers the remuneration of the employed staff, is done by the enterprises; see further the section *Investments and financing of innovation* above).

Universities have a more balanced age structure of R&D staff compared

Figure 25. Staff engaged in R&D, by institutional sector, number

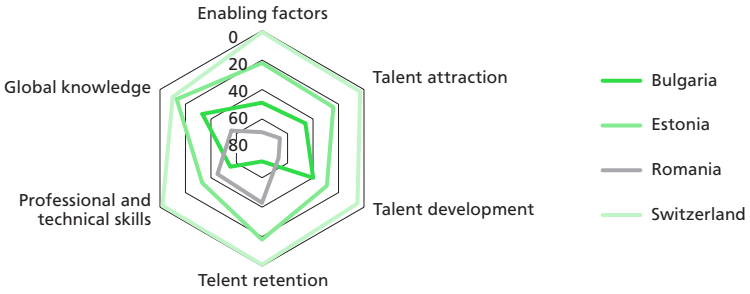


Source: NSI, 2023.

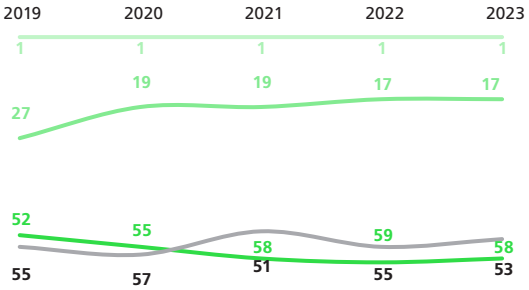
[49] INSEAD (2023): The Global Talent Competitiveness Index 2023: What a Difference Ten Years Make What to Expect for the Next Decade Fontainebleau, France.

Box 9. BULGARIA'S PERFORMANCE AS REGARDS TALENTS

Global Talent Competitiveness Index



World Talent Index



Methodology

Main areas:

- **enabling factors** – legislative and market-related components of the environment that support business and entrepreneurs;
- **talent attraction** – measures the degree of attractiveness of the national business environment from the point of view of attracting foreign investors and highly qualified personnel, as well as the opportunities for realisation of gifted young people;
- **talent development** – covers both the system of formal education and all forms of accumulation and development of knowledge and skills through informal and independent learning;
- **talent retention** – measures the ability to ensure sustainability in the implementation of talent development policies and measures, including through the level of quality of life.

Additional areas:

- **professional and technical skills** – are defined as skills at a medium professional level with an impact on employment and the correspondence between educational/qualification level and workplace requirements;
- **global knowledge** – includes the capacity of highly professional knowledge, creativity and problem-solving skills, with an impact on innovation potential and entrepreneurship and with application in knowledge-intensive sectors.

Methodology

Main areas:

- **investment and development** – takes into account investment and development of local talent, tracks the amount of public investment in education, looks at the quality of education. It includes variables related to apprenticeship implementation and employees' training priorities for companies. It looks at the development of the female workforce. It considers the quality of health infrastructure in terms of meeting the health needs of society.
- **attraction** – examines a country's ability to attract highly skilled foreign labour, assesses how businesses prioritise attracting and retaining talent. Another component of this factor assesses the impact of brain drain on countries' competitiveness, examines the level of motivation of workers. It includes indicators of personal security and the protection of private property rights, which are important for the attractiveness of economies.
- **development** – considers the growth of the workforce and the quality of available skills, experience and competencies of the existing pool of senior managers. It focuses on the ability of the education system to meet the talent needs of businesses. It examines how the education system meets the demands of the talent economy, language skills, student mobility (incoming) and educational results (PISA).

Source: INSEAD (2023). IMD World Talent Ranking 2023.

Figure 26. R&D, structure by fields of science, 2021, %

Source: NSI, 2023.

to publicly funded research units. With a share of 3% of the academic staff under the age of 25 and 18% of those employed in the 25-34 age group (respectively 1.4% and 11% in the public sector), higher education institutions succeed to a greater extent in attracting young people to a scientific career. Moreover, R&D employees under the age of 25 in higher education almost doubled year-on-year, at the expense of public research organisations, where there was a 10% decline by the same indicator.

Given the dynamic development of technologies, the main direction for the development and professional realisation of talent is **digitalisation**, including the development of skills and utilising the potential of information and communication technologies in both professional and personal life. However, EC research in the field of digital transformation indicates that Bulgaria remains an isolated island of ignorance rather than talent, in a number of indicators of the four main areas for tracking progress: 1) digitally literate citizens and professionals, 2) digital transformation of business, 3) digitalisation of public services, and 4) secure, efficient and sustainable digital infrastructures.

According to the **EU's 2030 digitalisation targets**, at least 80% of all adults should have minimum basic digital skills. While almost 90% of the EU population use the internet at least once a week, only 54% had basic or above basic digital skills in 2021. In EU member states, the proportion of people with basic or above basic digital skills in 2021 was highest in Finland and the Netherlands (both 79%), followed by Ireland (70%) and Denmark (69%). **At the bottom of the ranking are Bulgaria and Romania** with respectively 31% and 28% of the population possessing digital skills.

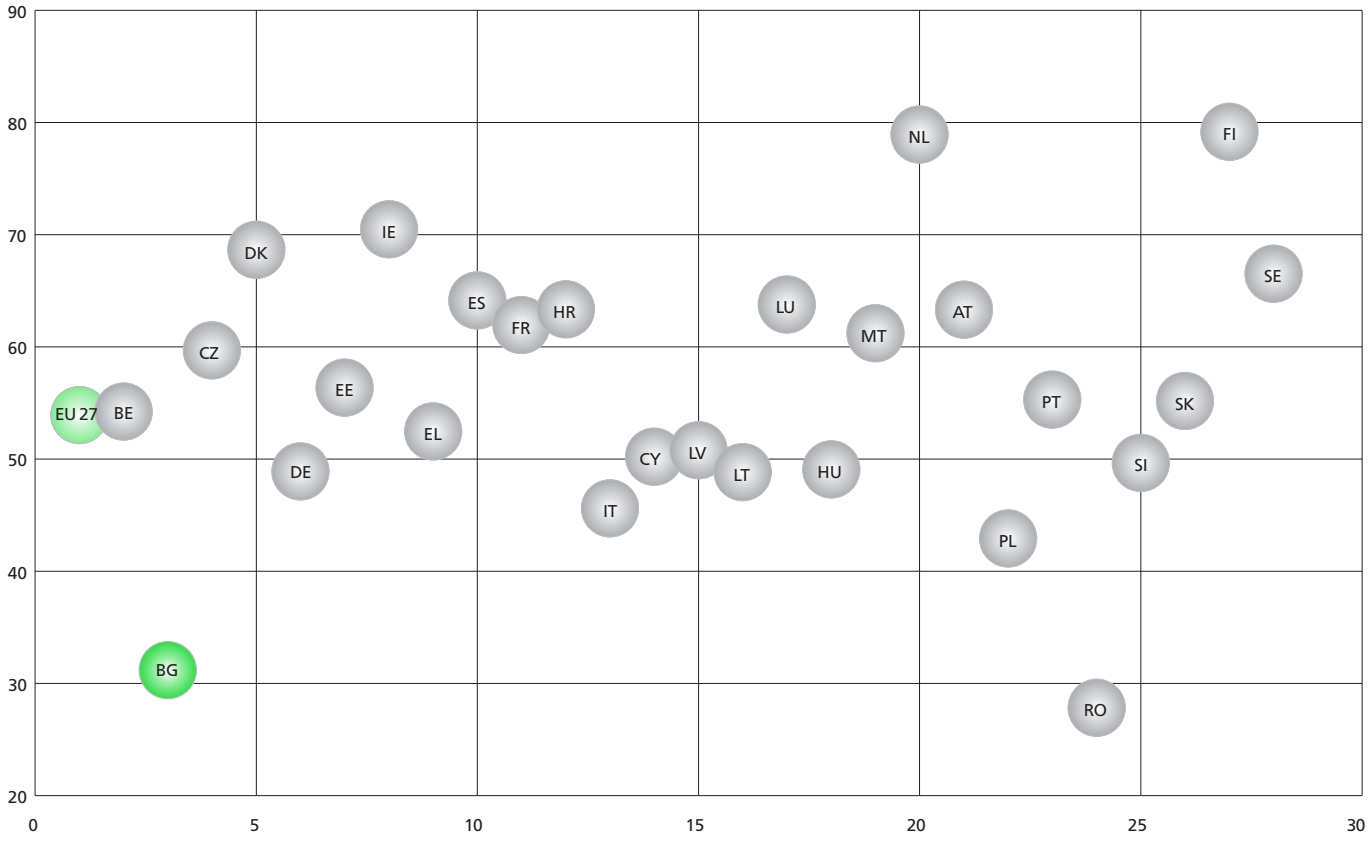
The digitization of business processes affects the increase in the need for **ICT specialists**. In 2021, around 180,000 EU students graduated in ICT, representing 4% of all graduates. The share of ICT graduates is highest in Estonia (10%) and Ireland (8%). Overall, more men than women have an ICT degree. At EU level, men with an ICT degree account for 8% of all male graduates, while only 2% of female graduates have an ICT degree. **The results for Bulgaria are above the EU average** – 4.9% of all graduates are in the field of ICT, with the country ahead of the average European levels and separately for male and female graduates, respectively 8.1% and 2.9%.

The data on employed ICT specialists in 2022, however, show that according to this indicator business in Bulgaria is ahead of only Croatia, Poland, Romania and Greece – 3.8% of all employed in the country are ICT specialists compared to average levels for the EU27 of 4. 6%. Against this background, only 9.1% of enterprises in Bulgaria provide training for their staff in the field of digital technologies, which is **the second lowest result within the Community** after Romania, at 22.4% on average for the EU27 and 39.8% for Finland, which is the leader in the indicator.

The fact that 52% of enterprises in Bulgaria have a very **low level of digitalisation of business processes** (only ahead of Greece with 58%; average of 30% for the EU27) is not surprising. For another 30.3%, the degree of digitalisation is defined as low. Only 18% of businesses in Bulgaria have achieved a high and very high level of digital transformation.

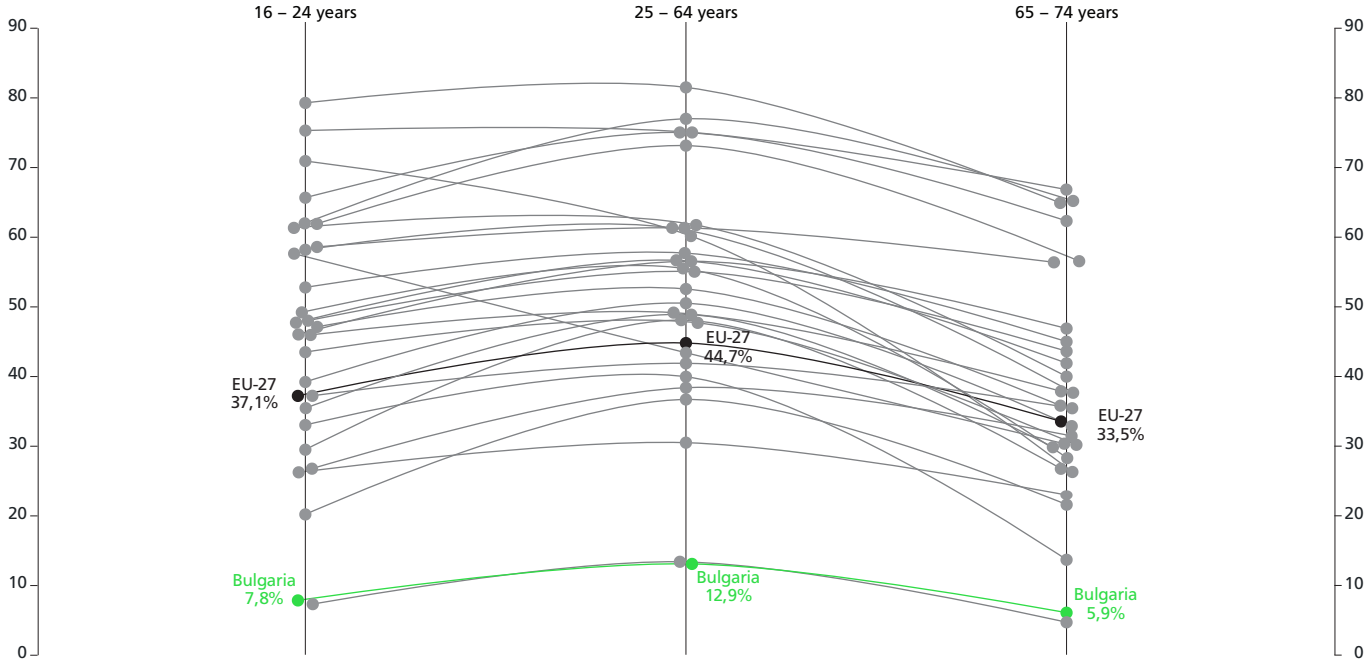
According to the EU's Digital Decade targets, all key public services for businesses and citizens should be fully online by 2030. In 2022, 42% of people in the EU who were active online in the previous 12 months had used it, to receive information about

Figure 27. PEOPLE WITH BASIC OR ABOVE BASIC DIGITAL SKILLS, 2021, % OF POPULATION



Source: Eurostat, 2023.

Figure 28. PEOPLE OBTAINING GOVERNMENT INFORMATION ONLINE, 2022*



* As % of people who used internet in the last year.

Source: Eurostat, 2023.

services of government organizations. This share varies considerably across EU countries. In 13 EU member states, over 50% of people have used such information, with Finland (79%), Denmark (74%) and the Netherlands (73%) leading the group. **In Bulgaria, the share of people who inform themselves about government services online is critically low,** both as a total share (11.6%) and in relation to the individual age categories – between 16-24 years old (7.8%), 25-64 years (13%) and 65-74 years (5.9%). For the EU 27, the proportion is highest among those aged 25 to 64 (45%), followed by 16-24 (37%) and 65-74 (33%).

Some of the indicators in which the negative statistics for the country continue with last positions within the EU 27 include online shopping for all age groups, the use of internet-connected devices and the recycling of end-of-life electronic devices.

Information and communication technologies

Information and communication technologies (ICT) continue to be a significant factor in the innovation of enterprises and the growth of economies. The notion of ICT has significantly changed since the first report Inovation.bg 2004. Automation moved smoothly from machines through production processes and reached the cognitive abilities of the enterprise's personnel or its customers. Artificial intelligence (AI) is transitioning very quickly from a special technology to a general-purpose one#– widely affordable in price and available for use, embedded in a variety of other software provided as a service.

Cognitive technologies benefit companies' competitiveness

Introduced in late 2022, the generative artificial intelligence (AI) ChatGPT is the fastest growing information, communication or cognitive technology to date. In just five days, it reached one million users, and a year later – 100 million. Over 70% of workers worldwide are already using generative AI.[50] The lowest usage rates are in Finland (51%) and the highest in Australia (86%). Most of this use is a simple replacement of (or advance) internet search via ChatGPT. Only 46% of employees receive guidance from their employers on how to use AI for their work needs.

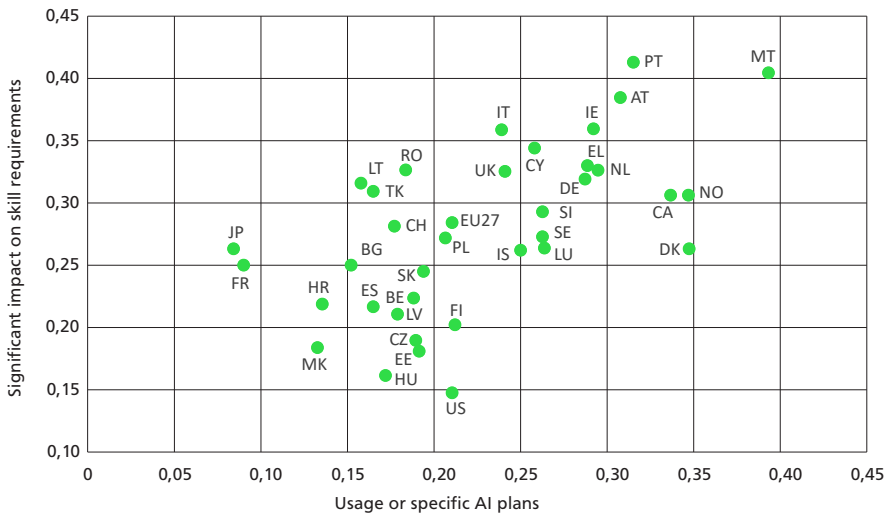
Although there have been generative artificial intelligences for over 50 years (the first being Eliza[51], invented at the Massachusetts Institute of Technology in 1966), only now there is an easy and affordable application programming interface to embed it into other software services. In addition, it works adequately in the Bulgarian language, which is rare for global ICT solutions.

Bulgarian business is no exception to this trend, although at a much slower pace. In a survey of its members in the first half of 2023, the Bulgarian Chamber of Commerce found 26% of businesses already using AI in their business processes, and 28% planning to do so in the next three years. 18% of businesses think they don't need AI and the same number say that it is too expensive; the remaining 10% are not sure what to think about AI.

Usually, members of business associations are larger and more competitive companies than the national average, so the real adoption rates of AI in the Bulgarian economy are probably lower. The closest approximation of the real penetration of AI among Bulgarian businesses is the Flash Eurobarometer 537 survey, which has questions that combine "usage" and "concrete implementation plans with a 5-year horizon". According to it, about 15% of the Bulgarian companies use AI. Although the planning horizon is getting longer, for small businesses even a 3-year period is a long time. These data position Bulgaria as catching up with Switzerland, Lithuania, Spain and ahead of Japan and France.

Population mirror data,[52] however, show that the Bulgarian society is late with the adoption. A significant part of Bulgarians (37%) do not

Figure 29. Companies' expectations in a 5-year horizon about the use and impact of artificial intelligence



Source: Flash Eurobarometer 537, fieldwork: March 2023.

[50] Adecco (2023), *Global Workforce of the Future Report 2023: What's working? Navigating the AI Revolution and the Shifting Future of Work*.

[51] In Bulgaria, Eliza was popular among students in mathematics high schools as early as the 1980s.

[52] Survey by Research Center Trend commissioned by *24 Hours* daily newspaper in the period June 10-16, 2023.

know what artificial intelligence is, and 39.4% have a negative attitude towards it. Only 31% of those surveyed know what artificial intelligence is (self-assessment) and have a positive (and rather positive) attitude. Actual "frequent" usage is just under 10% (daily is 2.4%).

In Bulgaria, statist attitudes towards AI dominate. Over 50% of Bulgarian citizens believe that it is necessary for the government to limit the use of artificial intelligence, and 19% even want it to be banned. Fears of new technologies and the accompanying conspiracy theories persist in Bulgarian society, sometimes leading to absurd political decisions such as the moratoriums on the development of 5G technologies in the municipalities of Balchik and Mezdra in 2020.[53] These attitudes are extremely harmful for the development and implementation of innovations and new technologies in the Bulgarian economy, as they show a fundamental lack of trust even in non-state institutions, such as religion (superstition and the occult are preferred to Christianity or Islam) or science. Studies have found, for example, that 75% of Bulgarians believe in prophetic abilities of Vanga, a Bulgarian attributed mystic and healer, 63% believe in the existence of people with supernatural power, 45% believe in magic, and 25% in the so called chemtrails.[54]

At the same time, Bulgarians follow science and technology news more often (35% of the population) than the European average (28%).[55] Countries that are at the same or higher levels are Romania (35%), Croatia (36%) and Greece (39%). As is well known, the consumption of media content is highly dependent on social networks, which poses a serious risk to the quality and credibility of the information received.

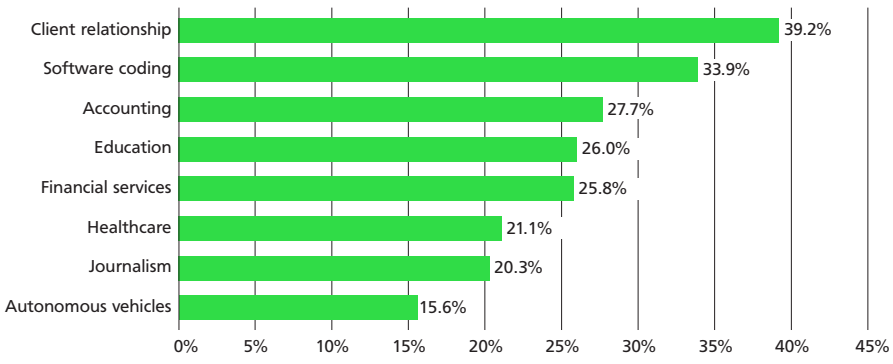
However, there is a sufficiently wide range of applications of artificial intelligence in which Bulgarians have relatively high levels of trust. Most often, this is customer relationship by automated call centres (39%), because there is already enough accumulated user experience – both in outgoing and inbound calls.

There is a relatively high level of trust in programming (34%) and accounting (28%). In the field of software engineering, generative artificial intelligence was tested and used first, while in accounting companies they practically started from scratch and there are no adequate examples of accumulated experience with the use of AI.

Some of the oldest projects in the field of artificial intelligence and machine learning are related to the detection of fake news.[56] In 2023, progress in this regard was demonstrated by the teams of the GATE Institute of Sofia University. However, trust in AI applications in journalism is twice as low as in call centres – 20%. One of the things Bulgarians worry most about are autonomous vehicles, in which they trust less than 16%. This is probably related to the many problems of GPS navigation apps in the country.

About 21% of Bulgarians have the realistic idea that artificial intelligence will transform jobs by simultaneously creating new jobs and closing existing ones. The digitalisation of manufacturing enterprises – from the production of clothes to food and beverages – has already clearly shown these processes, and the previous *Innovation.bg* reports detailed examples in various sectors. Automation is increasingly being planned not so much as a means for achieving higher quality, increasing capacity or reducing costs, but as a strategy to deal with staff shortages. A Bulgarian innovative company offering similar solutions (collaborative robots) is Giga Automata Ltd. In the field of logistics, the leader is Stam Ltd.[57] with solutions for automated warehouses.

Figure 30. TRUST IN THE USE OF ARTIFICIAL INTELLIGENCE BY APPLICATION AREA



Source: Research Center Trend, 2023.

[53] Relatively quickly after that, both municipalities realised their mistake and now have 5G technology.

[54] Why over 70% of the Bulgarians believe in prophesies and superstitions – Bulgarian National Television (bnt.bg).

[55] Media and News Survey, Eurostat, 2023 (fieldwork carried out between 18 and 24 October 2023).

[56] For example, by Ontotext JsC (part of Sirma Holding).

[57] Award winner in the Innovative Enterprise of the competition Year of the Applied Research and Communications Fund in 2020.

Bulgaria has had good traditions in production automation since the 1980s. The severe decline in industrial production in the 1990s led to a shortage of specialists to implement such solutions, despite a recent resurgence in interest in technical occupations related to automation and robotics. As a result, many implementations of process innovation through technology even at leading companies are delayed by months and sometimes by more than a year.

Information and communication technologies – a factor for the innovative development of the country

A strong point of the innovation environment in Bulgaria is access to information and communication technologies. Bulgaria ranks 24th in the Global Innovation Index (GII) 2023[58] and the intensity of use of the BG TLD[59]. Generally speaking, the processes of digitalisation of analogue productions in Bulgaria started earlier and faster than in a number of other European countries, which created a deeper experience. The main reasons were lower labour costs and the lack of opportunities for more complex financing, which required finding quick innovative solutions. Globalisation processes and especially the financial crisis of 2008-2010 led to the relocation abroad of a number of productions from Western Europe, while in Bulgaria, they remained and developed. The war in Ukraine and the intensification of geo-economic risks for large European manufacturers in countries with authoritarian regimes may lead to additional opportunities for the development of ICT-intensive production and services in Bulgaria.

Having a large enough community of developers of new software technologies in leading areas such as fintech, regtech, insurtech, automotive electronics and management, cobots, etc., leads to external positive effects and development of other businesses, including the field of agriculture, such as the companies Agrovar CC Ltd.[60], Tsarina Wine Cellar, etc.

Existing innovative firms in other sectors – for example Prosfit (medical devices) – transformed their business from manufacturing products to providing services (including cloud-based)m which enabled them to grow faster.

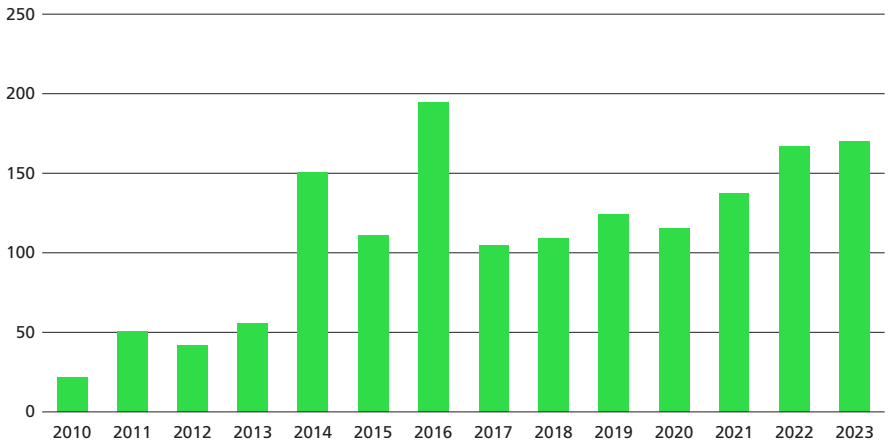
Another strong performance is the 20th place in labour productivity growth (2.9%) in GII2023. Although detailed firm-level data is needed, the qualitative analysis shows that the Bulgarian economy creates more knowledge value and increases the productive capacity of available assets with the help of ICT, as well as business process analysis and redesign.

On the other hand, software costs position Bulgaria low in the GII2023 ranking– 74th place. In practice, however, there is a relatively high intensity of software usage in Bulgarian companies, which can be explained by the purchase of software as a service rather than as an intangible asset.

Bulgaria continues to perform well as an exporter of telecommunications, computer and information services, albeit reaching a plateau in 2023. The explanation for the slowdown in growth is linked to the slowdown of the economies in the European Union in the second half of 2023. There were also several changes in the ownership of businesses in the sector (e.g. Atos), which may have led to optimisation and/or reduction of output and employment in the second half of the year.

Domestic e-commerce continues to grow, passing the 50% online shopper mark, but at a slower pace than the peaks during the Covid pandemic. B2C e-commerce is estimated

Figure 31. Export of telecommunications, computer and information services



Source: Balance of payments, BNB.

[58] Global Innovation Index (GII) (wipo.int).

[59] Domain.bg

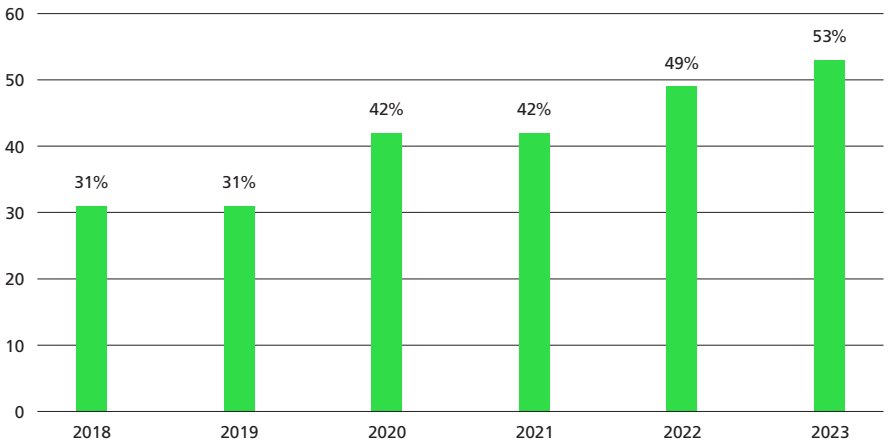
[60] Awarded the "Digital Transformation" Honorary Diploma at the Innovative Enterprise of the Year in 2022.

at around 2% of GDP according to data from the Bulgarian e-commerce association, with average European values of 4%-5%.

Consumers began to recover their behaviour of shopping in person (malls, shops, restaurants, etc.). On the other hand, businesses that can benefit from online commerce have already set up e-stores. About 40% of the available e-stores have integration with couriers operating in the country. A more significant integration along the value-added chain – suppliers, warehouses and couriers – can be expected in 2024.

The largest player in the e-commerce market is eMag, in whose ecosystem there are nearly 10,000 entrepreneurs (companies), who in the first nine months of 2023 sold 13% more products than in 2022.

Figure 32. E-COMMERCE USERS



Source: Bulgarian E-commerce Association, 2023.

A significant problem of e-commerce is the practice of cash on delivery, which increases the proportion of unclaimed shipments between 7% and 20%, in addition to an increased risk of misuse of personal data.[61] Although there was a decrease of 10 pp. in 2022 vs. 2021, cash payments are still very high, in the 50-60% range.

[61] According to data from the Bulgarian E-commerce Association as quoted in the European e-Commerce Report, 2023.

Box 10. "FUTURES THINKING – HOW TO USE IT?" TRAININGS IN BULGARIA

For the first time in Bulgaria, the Bulgarian Chamber of Commerce (BCC) is conducting introductory trainings on the topic "Futures Thinking - how to use it?". The short course is offered in options for corporate training and young people (students at secondary and higher education), with the content adapted to the specific sectors and goals of the learners. The training includes the basics of futures literacy, the five principles of futures thinking, and some basic methods and approaches of futures thinking and ways of using it.

What is futures literacy? The basic literacy of what lies ahead, based on the signs of change, the drivers behind them, trends, people and phenomena "outside the box" and the exploration of different scenarios, is identified by UNESCO as an essential skill for the 21st century. This literacy unlocks people's imagination and ability to prepare and be inventive as changes occur. In futures studies (in the plural because various scenarios are possible) forecasts have a horizon of 10 years and cover signs and trends that appeared at most 2 years before the current moment, so that "today" actually happens "tomorrow". As an example of the applicability of this knowledge, Futureplatform.com cites a 2018 study by René Rohrbeck and Menes Etingue Kum of practices that 83 global companies were implementing in 2008 with a horizon till 2015. It showed that "firms prepared for the future are significantly more likely to be among the best performing firms in the industry. These firms have achieved higher profitability, competitive position and market growth."

The initiator of the creation of the training on "literacy for the future" is Hristina Kasparian, Director of International Economic Cooperation at BCC. She explains what futures thinking is in an interview with the Economy magazine: "Futures thinking skills are a combination of business, leadership, creativity, innovation and strategic thinking skills. Anyone can learn such basic skills and use them in their field of work."

BCC "educates" the market in order to create a demand for the trainings. "We carry out a variety of activities to facilitate the international contacts of Bulgarian companies. To this end, we are tracking the development of established or emerging trends to guide us as to what goods and services are or will be in demand. This is how we can be useful to companies. The largest global companies have departments of more than 300-400 people who deal with this matter only but still use the services of specialised institutes and external experts. These companies are the 'creators' of the future. That is why it is important to create basic literacy on the subject in Bulgaria".

After the introductory training, BCC plans to develop more specialised trainings related to the practical application of specific futures thinking tools in business sectors. "We will work with different scenarios and introduce the different futures thinking methods to see how they work in practice. The training will contain demonstrations and original game elements," says Kasparian.

Source: Applied Research and Communications Fund, 2023.

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