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We Create IDEAS for Poland

INNOVATE OR RUN ADRIFT

POLISH GROWTH MAP 2026-2035

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REPORT
MAY 2026

0.5% the share of the public procurement market that in 2024 was innovative in character

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TABLE OF CONTENTS

POLISH INNOVATION IN NUMBERS

1.56% GDP

- gross domestic expenditure on research and development (GERD) in 2023
- increase from app. 1.0% GDP in 2015

53 BLN PLN

- gross domestic expenditure on research and development (GERD) in 2023
- 3x more than in 2015

65%

- private sector's participation in R&D financing in 2023
- +39% than in 2015

34 BLN PLN

- private sector's participation in R&D financing in 2023
- 5x more than in 2015

OVER 2300

- industrial Ph.D.s in cooperation with businesses (non-existent before 2017)

A FEW HUNDRED PORTFOLIO FUNDS AND COMPANIES

- received public-private capital from PFR Ventures – the largest program of VC market creation in the history of Poland

1.5–2 TIMES MORE

- R&D projects are executed with support of tax breaks than before the reform

BARRIERS AND SYSTEM GAPS

66% OF EU AVERAGE

- Poland's result on the European Innovation Scoreboard in 2025
- +52% compared to 2015, but still below EU average

„RISING INNOVATOR"

- category of the EIS ranking where Poland is still included despide a decade of reforms and increase in expenditure

10–15 PATENT SUBMISSIONS TO EPO PER 1 MLN INHABITANTS

- few times lower than Germany, France or Scandinavian countries

8–9%

- share of highly advanced technology products in the Polish exports
- EU: app. 18–20%

12 MONTHS+

- average duration of R&D evaluation period in the most important public competitions vs 2-3 months in the best European systems

0.5%

- the share of the value of all public procurements in 2024 that was innovative in character, **while the value of all public procurements was app. 600 bln a year**

NO SPECIALIZED AGENCY TO SUPPORT INNOVATION IN DEFENSE

- despite one of the largest defense expenitures in the EU, R&D investments in the defense sector remain mariginal

SIGNIFICANT CAPITAL GAP UPON CLOSURE OF ROUND A

- limited availability of growth capital (B-C) for technology companies **(risk of sales or relocation abroad)**

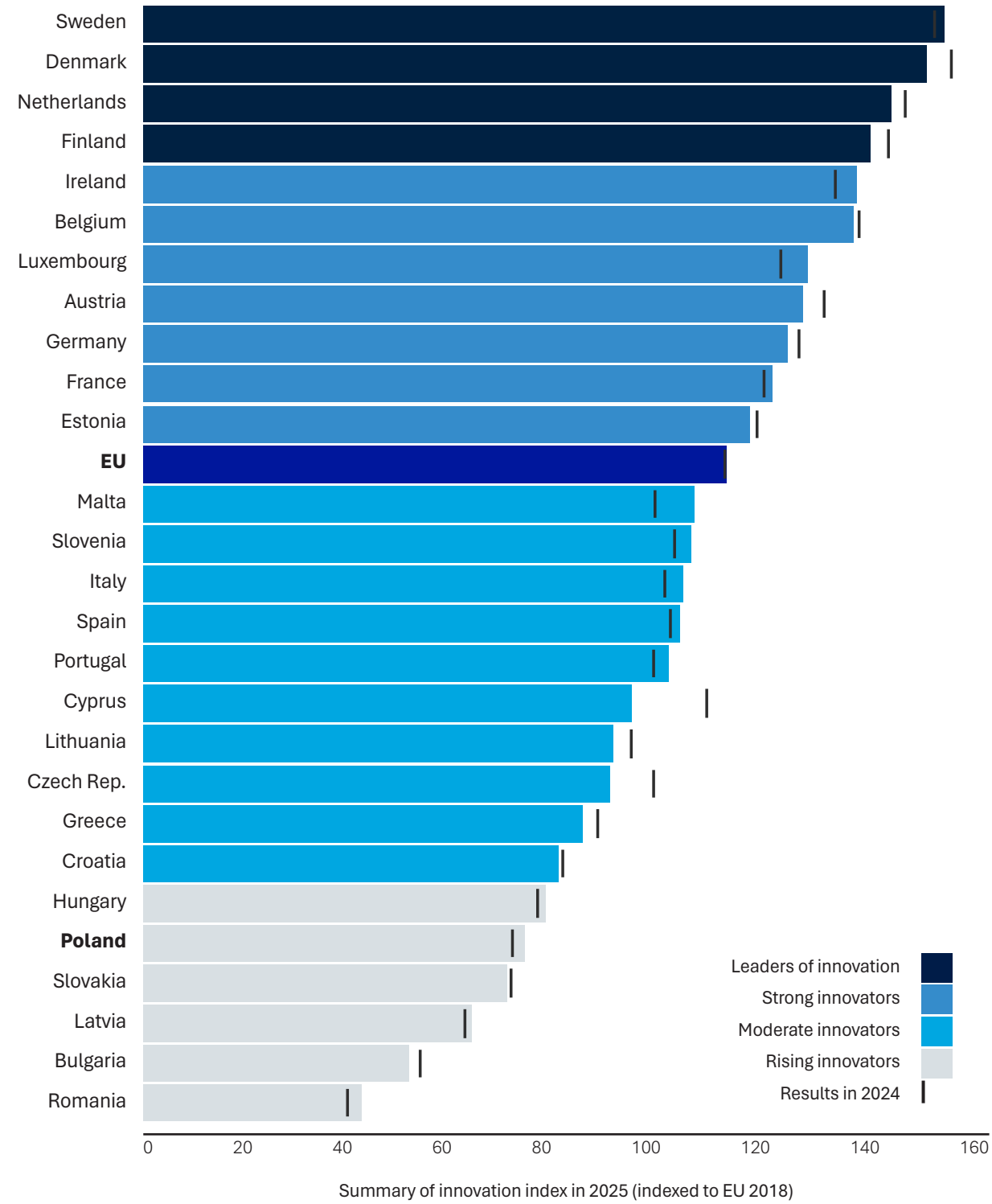
WHERE WE ARE AT

Global Innovation Index – report for 2025

Rank	Country	Score	Income Rank	Region Rank
1	Switzerland	66	1	1
2	Sweden	62.6	2	2
3	United States	61.7	3	1
4	Republic of Korea	60	4	1
5	Singapore	59.9	5	2
6	United Kingdom	59.1	6	3
7	Finland	57.7	7	4
8	Netherlands	57	8	5
9	Denmark	56.9	9	6
10	China	56.6	1	3
11	Germany	55.5	10	7
12	Japan	53.6	11	4
13	France	53.4	12	8
14	Israel	52.3	13	1
15	Hong Kong, China	51.5	14	5
16	Estonia	51.1	15	9
17	Canada	51.1	16	2
18	Ireland	50.4	17	10
19	Austria	50.1	18	11
20	Norway	49.2	19	12
21	Belgium	48.5	20	13
22	Australia	48	21	6
23	Luxembourg	47.3	22	14
24	Iceland	47	23	15
25	Cyprus	45.5	24	2
26	New Zealand	45.5	25	7
27	Malta	45.4	26	16
28	Italy	44.9	27	17
29	Spain	44.6	28	18
30	United Arab Emirates	44.2	29	3
31	Portugal	43.9	30	19
32	Czech Republic	42	31	20
33	Lithuania	40.8	32	21
34	Malaysia	40.6	2	8
35	Slovenia	40.1	33	22
36	Hungary	40	34	23
37	Bulgaria	39.1	35	24
38	India	38.2	1	1
39	Poland	37.7	36	25

Rank	Country	Score	Income Rank	Region Rank
71	Colombia	28.5	18	5
72	Costa Rica	28.4	19	6
73	Kuwait	28.2	49	13
74	Republic of Moldova	27.4	20	37
75	Seychelles	27.2	50	3
76	Tunisia	27	6	14
77	Argentina	26.8	21	7
78	Mongolia	26.7	22	13
79	Uzbekistan	26.5	7	3
80	Peru	26.5	23	8
81	Kazakhstan	26.3	24	4
82	Panama	25.9	51	9
83	Jamaica	25.2	25	10
84	Barbados	25.1	52	11
85	Belarus	25.1	26	38
86	Egypt	24.7	8	15
87	Botswana	24.6	27	4
88	Brunei Darussalam	24.5	53	14
89	Senegal	23.8	9	5
90	Lebanon	23.6	10	16
91	Namibia	23.5	28	6
92	Bosnia and Herzegovina	23.4	29	39
93	Sri Lanka	22.9	11	5
94	Azerbaijan	22.9	30	17
95	Cabo Verde	22.6	12	7
96	Kyrgyzstan	22.6	13	6
97	Dominican Republic	22.6	31	12
98	El Salvador	22.2	32	13
99	Pakistan	22.1	14	7
100	Cambodia	22	15	15
101	Ghana	21.9	16	8
102	Kenya	21.4	17	9
103	Paraguay	21.4	33	14
104	Rwanda	21.1	1	10
105	Nigeria	21.1	18	11
106	Bangladesh	21	19	8
107	Nepal	20.2	20	9
108	Tajikistan	20.2	21	10

European Innovation Scoreboard. 2025



Notice: All results refer to the EU in 2018. The horizontal colorful chart bars show results for 2025 using the latest data from 32 indexes. The vertical bars show results for 2024 based on the subsequent, newest data.

STRATEGIC CONTEXT

INSTYTUT SOBIESKIEGO

The decade of 2015 - 2025, was a real hurdle race for the Polish innovation policy: it went from a stage where the state did not consider innovation as the core of its economic strategy, to a period of real acceleration. Development and application of tools eventually began to result in changes to the values of indicators. The starting point in 2014 – 2015 was difficult, however: R&D spending did not break the "glass ceiling" of approximately 1% of GDP, the funding was not structurally healthy (business accounted for less than one-third of its total value, rather than dominate the pool), and Poland's position in EU innovation rankings reinforced its image as that of an economy playing catch-up, based on cost advantages and adaptation rather than on technological development and advantage.

In Chapter 1 of the report, we describe the most important elements of innovation policy that has been implemented in the course of the past 10 years. In Chapter 2, we present the experiences of selected Asian and European countries that over the last decade have performed a real leap in terms of technology and productivity by combining an active role of the state with the mobilization of private capital. In Chapter 3, we present the main areas on which innovation policy in Poland should focus. We highlight the potential of specific companies and startups that can serve as a lever for further growth. In the final, fourth chapter, we identify specific institutional and tax solutions aimed at permanently improving the quality of the Polish economic growth. Their common denominator lies with consistent priorities, courage in experimenting with the public policy, and long-term thinking that extends beyond the horizon of a single term of office.

In the early period, there came a symbolic breakthrough: the first R&D tax credit in 2015 – an initiative developed under the President Bronisław Komorowski's administration by Minister Olgierd Dziekoński. It did not solve the problem by itself, but it opened the door to the "fine-tuning of instruments" that came later: gradual increase in the real attractiveness of incentives and assuring their complementarity. It was not until 2016 that innovation rose to become part of the state's strategic narrative, including Prime Minister Mateusz Morawiecki's Strategy for Responsible Development. It was only then that things began to be translated into tangible regulatory and institutional reforms.

The experience of this decade show there is no single move or single law that can drive innovation. Effective policy is multi-instrumental in nature: some tools "gain traction" (because they meet market needs), while others fail (because they are poorly anchored institutionally, too bureaucratic, or miscalculate the risks). The most important lesson from 2016 – 2023 is that the results were most visible there where the state consistently simplified the rules of the

game and allowed entrepreneurs to decide the direction of innovation on their own. Conversely, where a grant-based logic, formalism, and a diffusion of responsibility prevailed, the system ended up generating transaction costs rather than technological advantage.

Against the backdrop of this experience, three tools clearly stand out as the most successful and worthy of further development. Firstly, R&D tax credits have become a real, scalable mechanism for increasing companies' innovation activity – precisely because they do not replace the market but reinforce it. Then, building the VC market through PFR Ventures and learning from experience gained with previous instruments allowed for shifting expertise and capital "upward" in the ecosystem. This process succeeded despite the continued lack of a stable funding bridge upon closure of Series A and a mature market for tech companies. Thirdly, the simple joint stock company (JSC) strengthened the legal infrastructure for the growth of tech companies by lowering organizational barriers and facilitating flexible ownership structures.

TOP 3 SUCCESSFUL REFORMS (2015–2023)

1. R&D tax credits (along with their expansion and clarification)

The most scalable mechanism, as it reinforces market activity of companies, instead of replacing it.

2. Development of the VC market by PFR Ventures

It has strengthened the capital ecosystem and innovation financing capabilities (despite a lingering funding gap in later stages).

3. The Łukasiewicz Research Network

A shift in the funding model for ministerial research institutes.

Simulanously, the experience of this decade confirms that the mere existence of instruments is not enough – coordination and the state's capacity to learn are equally important. The most productive period of reforms (2016 – 2018) was the result of both legislative decisions and implementation of the management mechanism: strong political support and efficient, inter-ministerial coordination of details before projects entered the phase of widespread consultation. It was precisely this combination of coherence, work rhythm, and a clear "owner" of the policy that kept things on course – and it is one of the most important lessons for the state's current actions.

INNOVATION BY POLISH COMPANIES

IS MAINLY BASED ON ADAPTATION AND PROCESS IMPROVEMENTS, WITH WEAK LEVELS OF COOPERATION BETWEEN THE SCIENTIFIC AND BUSINESS COMMUNITIES, AS WELL AS WITH LIMITED ACCESS TO PRIVATE CAPITAL.

8-9%
share of new technologies in the Polish exports

1.5%
the small share of the Polish GDP allocated to R&D

75%
of the EU average is the level the labor productivity in Poland remains at

STRENGTH OF THE ECONOMY MUST STEM FROM **THE ABILITY TO COMPETE WITH QUALITY**, NOT WITH LOWER **COSTS.**

POLAND MAY REMAIN THE EUROPEAN TIGER OF ECONOMIC GROWTH

BASED ON MORE THAN JUST HARD WORK AND EXCEPTIONAL ADAPTABILITY OF ITS CITIZENS.

The **transition from resilience to agency, from flexibility to innovation** may become **the foundation for further strengthening the growth and the position of Poland in Europe**

In this report, we adopt a comparative perspective: other countries that have made a real technological leap did not treat innovation as a side issue or solely as a result of EU funds. Effective models combine three elements: (1) consistent sectoral priorities (where competitive advantage is created), (2) capital capable of financing growth at subsequent stages (from seed to scale-up), and (3) state-driven demand for innovation – particularly through public procurement and large-scale modernization programs, including defense initiatives.

Importantly, none of the countries analyzed was a leader in innovation 15 – 20 years ago: Finland was dependent on Nokia, France on large corporations and state-owned industry, Denmark on a few recognizable brands, and Switzerland on its traditional strengths in education and precision engineering. The common denominator in all these cases is a strategic shift and the consistent development of a system that combines stable funding, clear division of roles among institutions, and the rigorous enforcement of collaboration between academia and business.

This set of lessons serves in the report as a reference point for identifying areas where "boosting" the existing tools (tax, capital, and demand – especially public procurement) could bring about a measurable technological leap in the coming decade.

An analysis of the structure of the Polish economy and global megatrends indicates that the state's technology policy for 2026 – 2035 should focus on two complementary pillars: (1) sectors in which Poland already has a strong base of companies and expertise, and (2) technologies that are priorities for security and sovereignty, which will require a more active involvement of the state.

→ **Pillar I.** Technologies based on the potential of companies (unlocking growth). These are the areas where Poland already has a broad base of enterprises (including SMEs), as well as manufacturing and export capabilities. Public policy here should primarily focus on removing barriers and accelerating modernization: stabilization of the regulatory and cost environment, support of automation, R&D, and foreign expansion.

Priorities:

1. Green chemistry

security: high | economy: very high |
PL: high baseline

2. New mobility

security: moderate | economy: very high |
PL: high baseline

3. Agrotech and agri-food processing

security: high | economy: very high |
PL: high baseline level

Pillar II. Technologies of national interest (sovereignty and resilience). These are areas of critical importance for energy, digital, and defense security, where the current base of companies in Poland is still scattered or insufficient, but systemic benefits justify implementation of an active public policy: multi-year programs, institutional coordination, and funding for infrastructure and public demand.

Priorities:

1. Semiconductors

security: very high | economy: very high |
PL: low level

2. Longevity and predictive medicine

security: moderate | economy: high |
PL: developing

3. AI factories and post-quantum cryptography

security: very high | economy: very high |
PL: moderate/developing

4. New energy (nuclear/SMR + energy storage)

security: very high | economy: very high |
PL: low

5. Space and dual-use technologies

security: high | economy: high |
PL: developing

Areas listed above were identified based on three criteria:

1. potential contribution to productivity, added value, and exports;
2. impact on security (energy, digital, food, defense);
3. feasibility of implementation within a 3 – 7-year timeframe (technology readiness, skills base, regulatory conditions).

The European Union currently has a set of instruments for financing innovation and strategic technologies (including Horizon Europe, EIC, InvestEU, EDF, and CEF). Poland should use them not only for research, but above all to move technologies into the implementation and scaling phases, integrating domestic companies into European value chains.

The second step in innovation policy involves building the capabilities of institutions that can work with companies on a one-on-one basis, guiding them from capacity diagnosis to implementation, and then holding the system accountable for results. Without this institutional foundation, even the best regulatory policy will be no more than a lever without a fulcrum.

TOP 3 STRATEGIC RECOMMENDATIONS

1. Program of micro-transformation for companies (1:1)

A permanent, large-scale program to work with medium and large companies: from diagnosing their capacity for change through planning to implementation and measurable market impact. The goal is to build real competencies within companies – in management, research and development, intellectual property, sales, exports, automation, and the use of artificial intelligence. Only work at this micro level can break down barriers that cannot be removed by regulations and tax incentives alone.

2. A single "owner" of the innovation system and effective coordination among institutions

Putting the most important agencies (PFR, PARP, NCBR, PAIH, ABM) and the new defense innovation agency ORION in a single economic division responsible for the state's development policy. The goal is to move away from fragmented responsibilities and duplicated instruments toward coherent management of the intervention portfolio – from supporting companies' capabilities through growth financing to public procurement and technologies of strategic importance. In this framework, ORION would serve as a specialized operator of breakthrough dual-use technologies, operating under the logic of overcoming challenges and driving rapid implementation.

3. Changing the system's logic: from project orientation to market impact

Shifting the focus of evaluation away from projects as such to companies' ability to commercialize – measured by implementations, revenue, exports, and productivity growth – while formally accepting risk as a prerequisite for innovation. In practice, this means strengthening market incentives: introducing a super tax credit (200%) for automation, robotization, and AI implementation; a refundable R&D credit for non-profit organizations and SMEs; and the systematic use of innovative and pre-commercial public procurement as a tool for initial demand. A system

structured in this way rewards implementation rather than "authoring proposals" and shortens the path from technology to market.

This report is a continuation of the Sobieski Institute's earlier work on technological potential and companies capable of scaling up. In previous reports drafted, among others, to meet the needs of public administration, we highlighted both the growing importance of technologies critical to the EU's economic security1 and the opportunities for Polish companies to build competitive advantages in the fields of robotics, the Internet of Things, and artificial intelligence2 – including in the context of their financing and capital development paths (including pre-IPO stages). In this study, we go a step further: we demonstrate what institutional and financial conditions must be met for innovation to become a sustainable pillar of economic growth.

What is at stake in innovation policy is not rankings or the number of programs, but the state's ability to sustainably increase productivity and build competitive advantages in the face of global competition and geopolitical pressure.

! The past decade has proven that **Poland is capable of launching reforms. Their scale, coherence, and consistency remain a challenge.** "The second breakthrough" thus signifies a shift in the role of the state: transitioning from a regulator to operator of development capabilities.

If this transformation succeeds, **innovation will become a real source of growth and economic agency in the coming decade.**

1 Analysis of Poland's technological potential in the area of technologies critical to the EU's economic security, prepared for the Ministry of Foreign Affairs, August 7, 2025, https://sobieski.org.pl/analiza-polskiego-potencjalu-technologicznego-w-obszarze-technologii-krytycznych-dla-bezpieczenstwa-gospodarczego-ue-dla-ministerstwa-spraw-zagranicznych/.

2 Polish companies in the robotics, Internet of Things, and artificial intelligence sectors, and pre-IPO financing, September 6, 2023, https://sobieski.org.pl/polskie-firmy-z-rynku-robotyki-internetu-rzeczy-i-sztucznej-inteligencji-oraz-finansowanie-pre-ipo/.

1.
START-UPS – TAX BREAKS – INSTITUTIONS. “HURDLE RACE” FOR INNOVATION BETWEEN 2015–2025

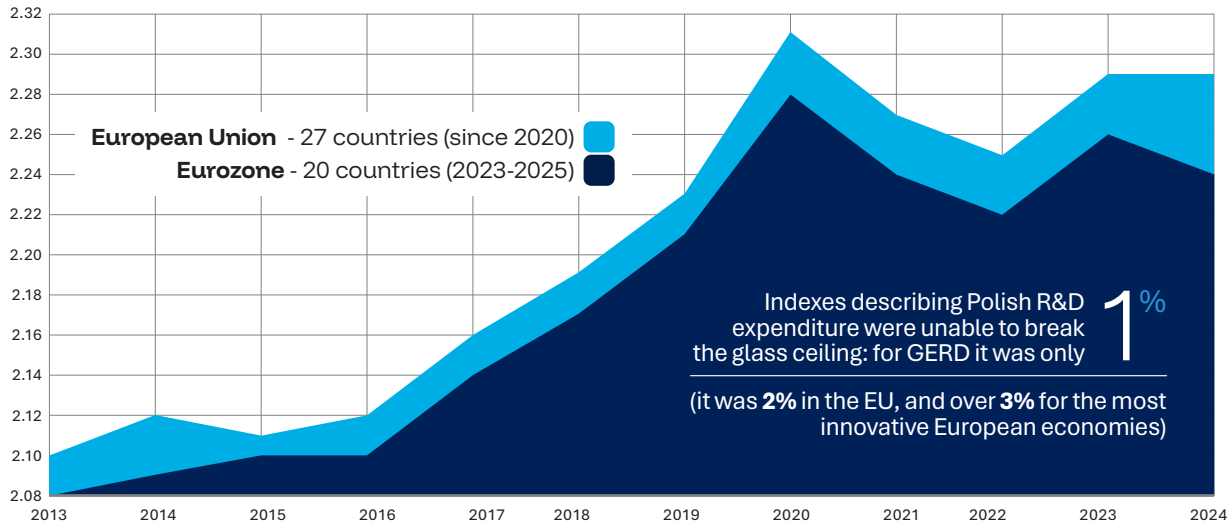
INSTYTUT SOBIESKIEGO

CONTEXT

The years 2016 – 2022 marked a period of significant acceleration in innovation policy in Poland. It was the point where innovation of the economy became one of the main narratives of the new government, and for the first time in the history of the Third Republic of Poland, the topic was raised as a banner of political change. Importantly, things did not stop at the level of political PR alone. Innovation made a bold entrance into the Polish strategic documents, becoming one of the five pillars of the economic section of the National Development Plan (NDP). From the standpoint of political narrative, the link to the central theme of the economic analysis underpinning the entire NDP – the "middle-income trap" – was particularly significant. This accurate diagnosis enhanced the coherence and legitimacy of the new narrative: simple growth reserves have been exhausted; we can no longer rely on low labor costs; we do not want to be merely Europe's cheap assembly plant. The economic development scenarios of Southern European countries served as a clear warning here, and Polish ambitions soared higher: we wanted to catch up with Germany or the Netherlands; we drew inspiration from the example of Finland, as well as from the rapidly growing and innovative Asian economies. Increased innovation among Polish companies was the logical remedy for the dead ends where the countries of Southern Europe got stuck.

Poland's weak position stemmed from both hard data and its ranking. The GERD and BERD indicators, describing R&D expenditure as a percentage of GDP in the economy as a whole and in the business sector, respectively, were unable to break through the glass ceiling: for GERD, it was 1% (compared to 2% in the EU, as set by the Lisbon Strategy, or over 3% in the most innovative European economies). More importantly, the share of business spending in GERD was roughly one-third, whereas the reverse is considered the healthy proportion.

R&D EXPENDITURE ACCORDING TO EFFICIENCY SECTORS [AS % OF GDP]



Source: EUROSTAT, https://ec.europa.eu/eurostat/databrowser/view/tsc00001/default/line?lang=en&category=t_scitech.t_rd

SOBIESKI INSTITUTE — GRAPHICS: NOWEMEDIA24.PL PIOTR PERZYNA

Poland's position in the most frequently cited EU ranking, the European Innovation Scoreboard, has already bumped against not a glass but a steel barrier3 . It is worth noting that the ranking is relative (it refers to the EU average), so the lack of progress in the indicator does not mean absolute stagnation. Nevertheless, for years Poland has been unable to catch up with the EU average.

The outlined playing field got filled quickly with specific reform projects. They shared a common denominator and, in principle, formed a coherent whole. The years 2016 – 2018 were particularly productive, but laws designed to support innovation continued to be adopted until the end of the government by the United Right in 2023.

It is worth noting here the institutional innovation that significantly contributed to maintaining the d coherence and momentum of the reforms. In 2016, the Innovation Council began its work, comprising three deputy prime ministers: Mateusz Morawiecki, Jarosław Gowin, and Piotr Gliński, which ensured strong political support for the proposed solutions. The tasks formulated by the Council were operationally carried out by the Interministerial Innovation Team, which met every Wednesday at 7:30 a.m., coordinating activities on an ongoing basis at the level of deputy ministers and department directors from several ministries, including those of the development (economy and regionAL development/EU funds), science, and finance [4]. In the unanimous opinion of the participants in these meetings, the team served as the institutional

3 Source: 2017 EIS report.

4 The team was led by Jadwiga Emilewicz, then Deputy Minister of Development, and its permanent members included Piotr Dardziński, Deputy Minister of Science and Higher Education, and Piotr Woźny, Deputy Minister of Digital Affairs. Deputy Minister of Finance Paweł Gruza, Deputy Minister of National Defense Bartłomiej Grabski, and Deputy Minister of Health Krzysztof Łanda also regularly participated in the work.

foundation for change, allowing for discussion of the most important aspects of the reforms before the drafts were submitted for regular inter-ministerial consultations. This provided the working-level coordination of details so that the government could speak with one voice during the sessions of government committees or parliamentary commissions. Team spirit also played a significant role, ensuring that everyone knew where the ship was headed.

For the sake of clarity, when summarizing the reforms from 2016 – 2023, it is worth dividing them into two categories: regulatory reforms (covering the legal and tax frameworks) and institutional reforms. This division is justified because while the former were generally successful and welcomed by the market and experts, the outcome of the latter remains mixed, which should serve as an important lesson for every subsequent government and the future of this (and other) public policies in Poland.

INSTITUTIONAL AND TAX REFORMS

TAX INCENTIVES

Even if the first R&D tax credit from 2015 was the "brainchild" of President Bronisław Komorowski's office (with Minister Olgierd Dziekoński as its "godfather"), its actual form and momentum – including the real level of support – were largely the result of measures implemented in 2016 and following years. The most important legislative and implementation work was carried out at that time by the Ministry of Development, led by Mateusz Morawiecki, in cooperation with the Ministry of Science and Higher Education, headed by Jarosław Gowin. The tax credits were introduced gradually: the original 30/50% credit was expanded in 2017 by broadening the list of eligible costs, raised to 100% of costs in 2018, and later to 200% for research and development centers. At the same time, in 2018, innovation was included as one of the criteria in submissions for investment incentives grants as part of the reform of the Polish Investment Network (the successor to special economic zones). Thus the actual accessibility of this tool for companies with Polish capital increased. Subsequently, the IP Box relief was introduced (a preferential 5% CIT rate for income from eligible intellectual property rights – this tool, however, requires refinement, as it is often used, and sometimes abused, mainly by the IT sector), and measures were taken to ensure the elements of the entire system are complementary, i.e., that these tax breaks can be combined with one another (one of the positive changes within the otherwise criticized Polish Deal).

Tax breaks are an attractive support tool in that they leave substantive decisions on the direction of research in the hands of businesses (unlike R&D grants). In 2023, over 2,500 taxpayers took advantage of the R&D tax credits, with the total value of eligible costs amounting to PLN 9.2 billion. There is no doubt that the credit – also thanks to increasingly well-established interpretations by the National Revenue Administration – is currently a proven and effective tool for encouraging companies to engage in innovative activities.

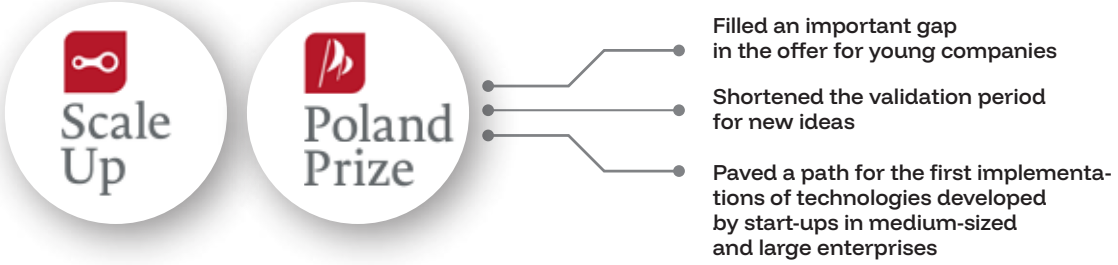
START IN POLAND AND STARTUP POLICY

The United Right governments championed not only innovation as such, but also its specific heroes. The most prominent element of the new narrative was startups, which became its symbol. These – for the most part - tiny companies became stars of economic conferences – not only those associated with the government, such as Impact or Carpathian Startup Fest, but also, riding the wave of the trend, events of a broader nature. Although there was no shortage of good startup conferences before, the novelty was for the startups to leave their bubble (Polish startups had been somewhat stuck in their own little world) and enter the "economic mainstream," particularly to connect with larger companies.

An attempt was made to create a comprehensive "Start in Poland" program – in the government's narrative at the time it was politically endorsed by, among others, Deputy Prime Ministers Mateusz Morawiecki and Jarosław Gowin. The capital investment component was implemented by the Polish Development Fund Group and the Polish Agency for Enterprise Development was in charge of the acceleration component. Particularly worth mentioning are, among others, the ScaleUp accelerators, run by PARP (Minister Jadwiga Emilewicz and PARP President Patrycja Klarecka, among others, played a visible role in the program's recruitment and communication), and the Poland Prize program – also implemented by PARP – whose pilot was announced in 2018 precisely in this institutional and personnel configuration. Perhaps for the first time in history, Poland was not merely a passive recipient of methods and tools "trickling down" from the European Commission through the EU policies (as had previously been the case with clusters and technology parks, among others), but actively co-created new intervention tools, such as Digital Innovation Hubs.

START IN POLAND AND START-UP POLICY

An attempt was made to develop a comprehensive "Start in Poland" program, which was to be an umbrella for the whole set of instruments and support tools, such as **Scale Up** accelarators and **Poland Prize** program.



VC MARKET

Thanks to the establishment of a fund of funds in the form of PFR Ventures and the lessons learned from earlier public tools, such as the National Capital Fund or POIG 3.1, the competencies and resources of Poland's still-fledgling venture capital sector were built up in a more sensible manner. The capital gap got shifted upstream, and the selection of funds and management teams became more quality-driven. Of course, there were exceptions, including those being a result of excessive capital supply in programs managed by the National Center for Research and Development (NCBR): there were simply too many Bridge Alfa funds.

VENTURE CAPITAL MARKET

Thanks to the creation of a specialized fund, namely PFR Ventures, more rational capacity building and asset build-up for the Polish sector of the high risk venture capital became possible.

Selection process of funds and management teams was quality based.

PFR Ventures

SIMPLE JOINT-STOCK COMPANY

In mid-2021, a reform of the Commercial Companies Code came into effect, creating a new type of capital company designed primarily for startups. This solution was developed at the Ministry of Entrepreneurship and Technology by Marek Niedużak, Deputy Minister of Entrepreneurship and Technology, under the political leadership of Jadwiga Emilewicz, the minister of that department. The Simple Joint-Stock Company combines the advantages of a limited liability company (low initial capital, the possibility of quick online registration, and a simple organizational structure) with those of a joint-stock company (flexibility and ease of changes in the shareholding structure). The popularity of the SJSC is growing steadily – currently, nearly 4,000 such entities are registered in the National Court Register – which means that this new form has become a viable alternative to the limited liability company, especially in the technology and innovation sectors.

SIMPLE JOINT-STOCK COMPANY

In mid-2021, a reform which introduced a new model of a capital company created with with start-ups in mind was launched.

The popularity of this form of company is growing – the new formula became the real alternative to a limited liability company.

SCIENCE SECTOR POLICY

Increasing innovation was one of the goals of the reforms of Polish science, with the so-called Constitution for Science (Act 2.0) led by Jarosław Gowin at the forefront. Certain elements of the reforms were intended to bring scientific research closer to the needs and practices of the real economy. A good example of such a tool is the Act on Industrial Doctorates prepared at the Ministry of Science and Higher Education by Minister Piotr Dardziński. It allows students to pursue a doctorate by working at a company and solving a specific technological challenges under the joint supervision of that company and a cooperating university. The program is popular; over 3,000 doctoral students have already taken advantage of this pathway.

The fundamental reform of science - despite its attempt at addressing innovation by, for example, including this criterion in parametric evaluation (both of researchers by the university and of the university by the Ministry) - did not yield the expected benefits in this regard. The strong emphasis on scientific excellence and the decisive weight of this criterion at all levels of evaluation, paradoxically, have drawn researchers even further away from practical application, steering them toward high-impact publications. Even if the transfer of knowledge from academia to business is a fraction of economic innovation worldwide, it has been difficult to observe any kind of progress in this area in recent years in Poland.

As a side note, it is worth mentioning with all honesty that the Ministry of Science, after 2016, has been a key player and advocate for many strictly economic reforms, led by tax breaks, as evidenced by its coordination of the legislative work on the first two “Innovation Acts,” which increased tax breaks.

THE SCIENCE SECTOR POLICY

Some parts of the reform intended to bring the science closer to industrial needs. The **industrial Ph.D.s** which allow the doctoral thesis to be implemented in a given company by working there directly under supervision of an academic mentor are a good example.

Over 3000 Ph.D, students have already taken this path.

PUBLIC PROCUREMENT LAW

The public procurement law reform, which took effect in 2021, was an attempt to move away from the previously dominant criterion of the lowest price in favor of a broader set of quality parameters and benefits, including innovation. It was prepared by the Ministry of Entrepreneurship and Technology in collaboration with Hubert Nowak, President of the Public Procurement Office. The reform expanded the (previously de facto defunct) innovation partnership procedure, used to procure solutions and technologies that do not yet exist, and innovation became one of the recommended criteria for evaluating bids. Supporting innovation was also enshrined as one of the mandatory elements of the State Procurement Policy. Importantly, steps were also taken to ensure the implementation of these tools, which required a shift in deeply ingrained bureaucratic habits – the Public Procurement Office put significant effort into developing materials and training the contracting parties.

In 2024, contracting parties awarded 113 innovative contracts worth PLN 1.8 billion. Outside the scope of the Act (pre-commercial procurement – PCP), 4,430 contracts worth over PLN 132 million were concluded. This is a step in the right direction, though still a drop in the ocean of possibilities. Considering that the public procurement market covered by the Public Procurement Law was worth PLN 330 billion, and another PLN 257 billion was spent outside its scope, contracts with innovative elements accounted for a mere 0.07% of the total number of contracts and 0.54% of their total value.

While the regulatory reforms of that period yielded tangible results, progress in terms of institutional order was limited, and some steps had to be even taken backward.

INSTITUTIONAL REFORMS

POLISH DEVELOPMENT FUND

Supporting innovation is only one of the PFR's objectives; nevertheless, in terms of institutional potential and the ability to act one level "above" from where most interventions in the Polish market happen, it represented a positive institutional revolution. Within the PFR, thematic teams were established, serving as a significant source of state expertise to support specific industries. The PFR Innovation Team has attempted to coordinate the entire innovation support system within the PFR Group.

POLISH INTERNATIONAL DEVELOPMENT FUND (PFR)

PFR Polski Fundusz Rozwoju

Supporting the innovation is just one of the tasks by the Polish International Development Fund (PFR), but it was an institutional revolution nonetheless. Among other things, it was under PFR that special teams constituting a national competence pool to support specific industries were created.

PFR VENTURES

The establishment of PFR Ventures was a milestone in building the VC market in Poland. PFRV quickly became the most important public repository of expertise in the field of venture capital investment. The occasional complaints about this institution can be explained, at least in part, by the fact that funds – eventually – sat in front of a partner who understood what a term sheet, ticket, vesting, lock-up, or drag-along are. A downside – and a serious one at that – was leaving some high-risk funds with the NCBR. It was an inconsistency non conducive to the quality of cooperation and oversight.

STARTUP ACCELERATORS

The creation of the ScaleUp and Poland Prize accelerators was a very wise move. They filled the gap in the market for support institutions and tools. This promising tool, unfortunately, remained largely unused or even squandered: the very next round (still under the United Right government) changed the support parameters (more convenient in terms of tax subsidies, but disastrous for the substantive work of the accelerators), and the selection model itself remained project-based rather than institutional, which does not bode well for the accumulation of expertise and ensuring staff continuity within the accelerators – the most critical indicator of the quality of their work.

PFR Ventures

Scale Up Poland Prize

ŁUKASIEWICZ RESEARCH NETWORK

The ambitious reform of research institutes, led by Piotr Dardziński – the first president of Łukasiewicz – demonstrated the potential of the state's institutional policy. Of fundamental importance to the consolidation, which encompassed 38 institutes, was the decision by Jadwiga Emilewicz, who oversaw 36 institutes under the supervision of the Ministry of Development and Technology. Institutes supervised by the Ministries of Energy and Digital Affairs were also incorporated into Łukasiewicz. By design, the reform did not include institutes supervised by the Ministry of Health and the Ministry of National Defense. Other institutes under the supervision of different ministries, including, for example, the Ministry of Agriculture, planned to establish similar networks of institutes based on the Łukasiewicz model. The establishment of the Łukasiewicz Research Network signaled a change in the management model and an attempt to build synergies between institutes, inspired by solutions used by, among others, the German Fraunhofer Society or the Finnish VTT, which served as a strategic advisor in preparing the draft of the reform. The main goal of the reform was to increase revenue from research and development projects with businesses – which, according to the reform's authors, is the best indicator of responding to market needs. During the first three years of its existence, despite the pandemic and war in Ukraine, structural changes were successfully implemented within and between institutes: institutes were consolidated within their respective locations. An example is the consolidation of five small institutes into a single, multidisciplinary entity – the Poznań Institute of Technology. Similar institutes were established through mergers in Upper Silesia, Kraków, Łódź, and Warsaw. This strengthened their research and commercialization potential while reducing their number from 38 to 22. At the same time, the management of the process related to identifying and responding to the needs of businesses was optimized. Over the first three years, there were more than 1500 calls for the so-called Łukasiewicz Challenges. The institutes' revenues from R&D projects (including international grants) and commissioned work were also increased. The groundwork for further Łukasiewicz reforms was successfully laid, as before the reform many of the institutes involved resembled open air museums of ancient technologies. Due to a lack of funding, the reform was halted halfway, but the experience gained in the meantime can be leveraged in building similar networks of research units.

ŁUKASIEWICZ RESEARCH NETWORK

It was an ambitious reform of the so-called ministerial research institutes led by Jadwiga Emilewicz and Piotr Dardziński. The network was formed mainly of institutes operating under the ministry of economy. Before the reform, many of them resembled open-air museums of ancient technologies.

DIGITAL INNOVATION HUBS

Due to the delay in implementing the new EU framework in Poland, DIHs remain an unknown. The tool itself, however, is well-designed and appropriately targeted, as the vast untapped potential of digitalization concerns both SMEs and larger companies in the Polish economy. Paradoxically, the public sector is ahead of many private enterprises in this regard – at least in certain applications.

POLISH INVESTMENT AND TRADE AGENCY

Although PAIH is not directly an innovation support tool, since 2016 qualitative changes have been introduced to its activities and tools it has at its disposal. First, in the area of foreign direct investment (FDI), innovation and the technological intensity of projects have become key criteria for attracting investors (see: electromobility). Second, in the area of export support, there has been an increased focus on and greater sensitivity to the needs of Polish technology companies and startups. Some of PAIH's foreign trade offices even specialize in this area, which could not be said of the former trade and investment promotion departments (WPHI) of Polish embassies. However, Polish trade offices should still be viewed as an opportunity for development rather than a fully realized success.

NATIONAL CENTER FOR RESEARCH AND DEVELOPMENT

Most of the funds at the NCBR's disposal are directed toward businesses or business-led consortia. Meanwhile, since its inception, this institution has remained under the supervision of the minister in charge of science. The exception was the period from August 2022 to March 2024, when supervision was taken over by the ministry responsible for regional development. The NCBR's return to the supervision of the Ministry of Science was the result of, among other things, serious irregularities that took place in one of the NCBR's competitions. Without downplaying these events, it seems that from the very beginning, the NCBR should not have been subject to either the Ministry of Science or the Ministry of Regional Development (=EU funds), but rather to the Ministry of Economy – in accordance with the purpose of its activities.

To be fair, the effects of the investment reaching 50 billion PLN since the NCBR's inception are very limited. Formally, almost all projects funded by the NCBR are successful, but in reality, few of them lead to effective monetization. There is a lack of systematic analysis and no risk acceptance, business risk (and not just technological risk) in particular. In practice, the scientific or technological perspective, rather than the business perspective, continues to prevail during the evaluation of proposals. A significant portion of the evaluating experts come from the world of science, having no understanding of business realities, including the specifics of a given market. It sometimes happens that during investment committee meetings,

pitching startups are asked about their publications (!). At the peak of the next EU funding period, a massive influx of funds (7.8 billion PLN in 2022) "clogged up" the Center's administrative machinery, and the shockingly low salary levels made it impossible to implement a sensible HR policy, leading to high employee turnover. The scandal involving the transfer of funds to fictitious companies is merely the tip of the iceberg. The real problems of this institution are of a much more systemic nature.

The Center's current management even criticizes the few positive changes from previous years, such as declarations instead of certifications, which at least slightly reduced costs and the bureaucratic burden on companies submitting applications. There is currently neither the will nor a plan to save this executive agency, which is so crucial to innovation policy.

POLISH AGENCY FOR ENTERPRISE DEVELOPMENT

While PARP has not been embroiled in a spectacular corruption scandal on such a scale as the NCBR, it too finds itself in a difficult situation. It is difficult to assess unequivocally whether the serious turmoil at the Agency's management level has already ended, but the publicity surrounding the National Recovery Funds (KPO) for sectoral restructuring certainly did not help anyone. Systemically, PARP faces the same challenges as the NCBR: high employee turnover, problems with recruiting experts to evaluate applications (rates far too low), and above all, high degree of formalization of procedures and avoidance of bureaucratic accountability for potential failures – failures that, in the financing of innovation, are and will remain inevitable.

Like the NCBR, PARP is also a victim of misguided decisions regarding division of roles, responsibilities and competencies, having become an institution responsible for managing R&D projects for SMEs – an area where it simply lacks expertise. All of this has led to a dramatic decline in the quality of work and longer processing times. For example, the SMART competition – a cornerstone program for this institution and the successor to the "fast track" (so named because, at one time, the NCBR took a very reasonable two months to evaluate submissions) – took as long as 13 months to evaluate applications in 2024. If we account for the time required to prepare the submission and sign the contract, for businesses this translates to nearly two years (!!!) of waiting – two years from the initial idea to getting the chance for its implementation. For most industries, given the current market dynamics, such delay defies the very purpose of project submission. When seeking the security of policy from the formal perspective, we have found ourselves in a dead end negating the purpose of support that institutions should provide.

POLISH AGENCY FOR ENTERPRISE DEVELOPMENT (PARP)

PARP Grupa PFR

PARP is faced with a large staff turnover, issues with recruitment of experts who evaluate the applications, officials resorting to formalisms and avoiding responsibility for potential failures (which are imminent in this type of job). SMART competition held in 2024 took 13 months to evaluate all submissions. Given that preparing the application and concluding agreements take time too, it means that the path from formulation of an idea to its implementation is 2 years (!!!). Such delays mean the implementation may no longer make sense.

MEDICAL RESEARCH AGENCY

Established in 2019, the ABM was conceived as the central instrument for state funding of research in medical and health sciences, with a particular emphasis on clinical trials (as well as observational and epidemiological studies). In its first five years of operation (2019 – 2024), the Agency signed 315 grant agreements with a total value of over 4.3 billion PLN (approx. $1.03 billion), which corresponds to an average of approximately PLN 0.86 billion in contracted agreements a year. The average funding was PLN 13.7 million per project. The funded research focused primarily on three areas: cardiovascular diseases, oncology and hematology, as well as neurology and psychiatry. Under the signed agreements, over 51,000 patients are scheduled to be enrolled in the trials, including over 13,000 with rare diseases, which demonstrates the scale of the program in the non-commercial clinical trials segment. The most important test for ABM remains its ability to maintain operational efficiency with limited resources and to select projects with real implementation/commercialization potential – especially within a model deeply rooted in the academic environment.

MEDICAL RESEARCH AGENCY (ABM)

Its role is to fill the gap in terms of financing the research until now commissioned by the Polish companies to be carried out abroad. The challenge here is whether the Agency, given its academic pedigree, will be able to select projects with potential for commercialization.

AGENCJA BADAŃ MEDYCZNYCH

THE NATIONAL AGENCY FOR ACADEMIC EXCHANGE

The National Agency for Academic Exchange (NAWA) was established on the initiative of the then Minister of Science and Higher Education, Jarosław Gowin, as a specialized agency aiming to see the Polish science and higher education go international. It operates formally under the Act of July 7, 2017, on the National Agency for Academic Exchange, and is supervised by the minister responsible for science and higher education (currently the Minister of Science). The Agency finances student and researcher mobility as well as academic exchange programs. In a short time, it has succeeded in creating a modern system of grants and scholarships, which has increased the visibility of Polish universities abroad and made it easier to attract foreign students and researchers. The Agency's budget amounts to approximately PLN 450 million annually (2025), which allows for the implementation of several dozen programs, such as "Poland My First Choice" or "Ster". The scale though remains modest compared to similar European institutions. Limited funds may hinder the implementation of a long-term scholarship policy, especially in the context of rising costs of internationalization and intensifying competition for talent. Another challenge lies in maintaining the balance between support for the outgoing (Poles abroad) and incoming (foreigners in Poland) mobility, so that this does not lead to a brain drain. The coming years will show whether NAWA will succeed in fully translating the scope of academic exchange into a sustainable boost for the quality of science and higher education in Poland.

INSTITUTIONAL GAPS

DEFENSE AND DUAL-USE RESEARCH

Poland lacks a specialized defense research agency, such as the American DARPA, Israel's DDR&D, South Korea's ADD, or France's AID. Currently, research in this area is funded by the National Center for Research and Development (NCBR), but it is done on an absolutely symbolic scale. Poland spends hundreds of billions on armaments, yet only a fraction of that sum goes to R&D in Polish private and public companies, which is a strategic and widely criticized mistake.

A MATURE CAPITAL MARKET FOR TECHNOLOGY COMPANIES (LATER STAGE, HIGHER TICKET)

Despite evident progress with regards to the VC market, it still has a low level of stability. As a rule, high-risk funds generate above-average rates of return by investing in mature projects, and use the profits generated "at the top" to finance capital investments at earlier stages, all the way down to seed and pre-seed rounds, with leveraging public funds being of fundamental importance at this stage. In Poland, the capital gap has shifted upward in recent years, yet there is still no "bridge" as described above, nor are there families of funds investing from the seed phase up to beyond Series A – that is, into Series B or C. This task – which perhaps should be undertaken by PFR – is important since it should effectively mobilize capital from traditional

industries (which, to a large extent, currently invest in real estate, for example) and redirect it toward the technology sector. A good benchmark here is the French Tibi plan (described in another section of this report).

SUMMARY

The period 2016 – 2023 brought a real improvement in the quality and effectiveness of the Polish innovation policy, albeit the progress was uneven and generally more effectively in the areas of regulatory and tax reforms.

Despite setbacks at the institutional policy level, Poland managed to move forward and escape the "death zone," a fact reflected less in innovation rankings and more in hard data. Total national R&D expenditure (GERD) approached 1.6% of GDP in 2023, and more importantly, its structure – measured by the share of corporate R&D expenditure (BERD) – is now essentially sound. However, this is only partially a cause for celebration given that the low overall level of spending and the need for further public funding continue. This makes an analysis of spending by sector all the more important.

If we look at innovation rankings, there is a cautious light at the end of the tunnel. Poland's score on the European Innovation Scoreboard rose from 52% of the EU average in 2015 to 66% in 2025. Poland is (alongside Croatia) the only economy in the bottom tier of the EU ranking to have recorded significant growth since 2016. True, Estonia, the Czech Republic, and Lithuania have improved their scores to a greater extent; however, at least the first two countries are not burdened by a "development debt" from the first 25 years of transition, when innovation policy in Poland remained outside of the mainstream economic policy and was not taken seriously.

In summary, the acceleration from 2016 to 2023 should once and for all put an end to the debate over the justification and purpose of this public policy and shift the horizon of our ambitions. No longer 1.7% or 2% of GDP for R&D, but at least 3% (following the example of Finland, Denmark, or Switzerland), including at least 2% in business spending (BERD). Given the potential lying in two dormant dragons of innovation spending – public procurement and defense policy – this is absolutely within our reach.

A separate, though noteworthy, issue is innovation policy upon the change in government. In a nutshell, its importance has significantly declined; in the new government there clearly is no "owner" of this area, coordination mechanisms are also lacking – although there are also examples of valuable initiatives, discussed below. The current government's efforts appear to be focused on mobilizing EU funds for the 2021 – 2027 programming period, which, combined with the National Recovery Plan (KPO), constitute the largest wave of external funding in history, including funds earmarked for innovation. The problem is that this shift in focus distracts from the essence of this policy and, at the same time, largely amounts to a quiet relinquishment of autonomy (as the disbursement of EU funds once again becomes a substitute for strategy and public policy).

Even such a narrowly defined goal faces difficulties, as the institutions responsible for managing EU funds for innovation - led by the National Center for Research and Development (NCBR) and the Polish Agency for Enterprise Development (PARP) - remain mired in a crisis, which began under the previous government. Moreover, these institutions are also reverting to past bad practices: excessive formalization and bureaucratization, as well as a focus on science-to-business transfer, and even confusing science with innovation.

PERIOD BETWEEN **2016-2023** MEANT → **REAL INCREASE IN THE EFFECTIVENESS OF THE POLISH INNOVATION POLICY**

THE INCREASE WAS, HOWEVER, UNEVEN, AND MOST NOTICEABLE IN TERMS OF REGULATORY FRAMEWORK AND TAXATION.

Despite some setbacks in terms of institutional policies, Poland progressed leaving behind the dead zone, as reflected in the hard data.

GERD is currently reaching 1.6% of GDP, and its structure - in terms of the share of BERD – is already more or less sound (even if it is still too early to celebrate due to low total levels of expenditure and the necessity to resort to boosts from the public funds).

CURRENTLY **GERD** IS REACHING **1.6% OF GDP** WITH A SOUND SHARE OF **BERD**

EFFECTIVENESS OF THE POLISH INNOVATION POLICY

COMPARISON BETWEEN 2015 AND 2023

	2015	2023
Gross domestic expenditure on R&D (GERD)	16 bln	53 bln
Business enterprise expenditures on research and development (BERD)	7 bln	34 bln
GERD (% GDP)	**1%**	**1.56%**
R&D personnel	**39%**	**65%**
Industrial Ph.D.s	158k	326k
doktoraty wdrożeniowe	0	2293

52% OF THE EU AVERAGE IN 2015

A SMALL LIGHT CAN BE SEEN AT THE END OF THE TUNNEL

POLAND'S RESULT ON THE **EUROPEAN INNOVATION SCOREBOARD**

66% OF THE EU AVERAGE IN 2025

Acceleration seen between 2016-2023 should put an end to the discussions on whether such policy is needed and drive ambitions for more.

AT LEAST **3%** LIKE FINLAND, DENMARK, AND SWITZERLAND, INCLUDING **2%** OF BERD

GIVEN THE POTENTIAL SLEEPING WITHIN OUR PUBLIC PROCUREMENTS AND DEFENSE POLICY **IT'S ACHIEVABLE.**

SOBIESKI INSTITUTE

GRAPHICS: NOWEMEDIA24.PL PIOTR PERZYNA

Particular attention should be paid to initiatives with the potential to serve as milestones for financing the innovation ecosystem. In November 2025, Minister of Finance and Economy Andrzej Domański, together with PFR, PFR Ventures, BGK, PZU, and the EIF, announced the launch of the Innovate Poland program, which systematically addresses two fundamental weaknesses of the national ecosystem: a chronic shortage of large, stable long-term capital for venture capital and private equity funds, and the lack of a unified, effective, and transparent system for financing startups by, among others, state-owned companies. According to the program's co-author, prof. Dariusz Adamski, the program's mechanism is based on mobilizing capital from the so-called institutional investors and allocating it to investments into funds that will obtain professional accreditation from PFR Ventures or EFI. The declared scale of these investments is PLN 4 billion in the first phase, with the potential of increase to PLN 8 – 10 billion once new investors join the program. Innovate.pl is referred to as the Polish Tibi Plan because it draws direct inspiration from the French model, which – thanks to the scale of capital raised, consistent approach, and professional fund selection - has accelerated the development of the local technology market on an unprecedented scale. Innovate Poland has the potential to become a long-term instrument of structural change, provided it is implemented as planned and constitutes part of a broader, consistently executed innovation policy, rather than a one-off financial intervention.

2.
INNOVATION: HOW DO OTHERS DO IT? – LESSONS FOR POLAND

INSTYTUT SOBIESKIEGO

ARE EUROPEAN EXAMPLES RELEVANT?

Why does the report refer to European benchmarks, given that – in terms of competitivity - Europe is clearly losing ground compared to the United States and China? Primarily because Poland operates within the same cultural, legal, regulatory, and business environment as the rest of the EU (with the exception of Switzerland). These are the examples closest to the Polish reality, and at the same time defined as successes – which is why they may be more inspiring for Poland than examples coming from places far removed from the realities in which we operate: Silicon Valley, the Israeli model, or the Singaporean model. It is all the more true since such benchmarks prove that even within the European Union – which is constrained by many limitations – or, more broadly, within Europe, it is possible to achieve success in creating and commercializing new technologies.

Importantly, none of the countries cited in this chapter were innovation leaders or had innovation ecosystems fully developed 15 – 20 years ago. France relied on large corporations, Finland – mainly on Nokia, Switzerland on good, business-friendly universities and precision manufacturing, and Denmark – aside from agriculture – on recognized brands such as Ecco, Mersk, and DONG. All of them made a conscious strategic shift toward creating systems conducive to innovation, which became a strong driver of economic growth in these countries.

SWISS LEADERSHIP - SCIENCE CLOSE TO BUSINESS

Since 2011, Switzerland has consistently held the leading position in the European Innovation Scoreboard[5], and has ranked #1 or #2 in the world in the Global Innovation Index[6]. It is a country where innovation is not a one-off political project but has become the core of the domestic economic culture. Their success stems from a combining strategic thinking at the national level, stable public funding, deep collaboration between academia and industry, and an education system that prepares people for practical tasks in new technologies starting in high school. That is why Swiss technical universities are an incredibly strong magnet attracting students, researchers, and innovators from all over Europe and the world.

FIRST, THE STRATEGY: EDUCATION, RESEARCH, AND INNOVATION

The Swiss model for innovation development is called ERI – Education, Research, and Innovation[7]. This is a framework document adopted every four years by the federal government, which does not specify individual programs but rather sets strategic directions, institutional structure, and the financial stability of the entire knowledge system. The current edition (2025 – 2028) provides for a budget of 29.2 billion Swiss francs for the period of four years. This sum represents over 3% of GDP.

ERI focuses on six areas. One of them is education and schooling – here, the key priorities lie with connecting the science with the economy, attracting the best students from abroad, and building digital competencies. The state finances fundamental research and infrastructure, but requires research institutions to collaborate with the business. A university can receive funding for an implementation project only if an industrial partner provides its own contribution – financial or in-kind. This eliminates the "culture of grant digging" prevalent in Poland. Other areas include research focused on health, climate, energy, digitalization, and AI. Innovation is focused not only on startups but also on the SME sector, which faces particular pressure in terms of the technology race and global competition. Strong clusters are one of the main tools here. Human capital and talent policies focus on attracting and retaining the best scientists from abroad, while international cooperation focuses on ensuring participation in the EU and global programs. Transformations and future challenges are seen to be related to the green transition, health and medicine, and preparing the education and innovation systems for digitalization and AI[8] .

5 European Innovation Scoreboard 2025, European Commission, 2025, https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en.

6 Global Innovation Index 2025 Rankings, WIPO, 2025, https://www.wipo.int/edocs/gii-ranking/2025/fi.pdf.

7 Swiss Innovation Ecosystem Monitor, Innosuisse, 2024; https://www.innosuisse.admin.ch; Enhancing Innovation in Rural Regions of Switzerland, OECD, 2023, https://www.oecd.org.

8 Swiss Innovation Ecosystem...; Enhancing Innovation in Rural...

The main recommendations of the current strategy are:

- maintain investment at 3% of GDP in R&D&I;
- strengthen dual education – that is, with a significant amount of business internships – as the foundation of the economy's competitive advantage;
- foster innovation in SMEs through easier access to financing and collaboration with the scientific community.

The war in Ukraine, the pandemic, and tensions with China have led to a revision of the ERI strategy's objectives. Thus, cybersecurity, data sovereignty, supply chain diversification, and dual-use technologies have been included in the strategy.

PILLARS OF THE SYSTEM

The State Secretariat for Education, Research, and Innovation (SERI)[9] is responsible for coordinating science and innovation policy. Reporting directly to the government, SERI sets priorities, monitors the achievement of objectives, and engages in dialogue with the cantons, universities, and the business community.

Fundamental research is funded by the SNSF – Swiss National Science Foundation – which awards grants based on criteria of excellence. The SNSF does not evaluate projects in terms of their profitability, but rather their impact on the advancement of knowledge – it is a counterpart to Poland's National Science Center.

Innosuisse, the Swiss Innovation Agency, focuses on commercialization. It funds projects carried out in university-industry partnerships solely. It does not provide grants to entrepreneurs operating independently. In this way, it bridges the gap between academia and the market, compelling both sides to collaborate. This is how ecosystems are created.

ETH DOMAIN – EXCELLENCE AND TECHNOLOGY TRANSFER

The third pillar is ETH Domain, comprising six institutions: ETH Zurich, EPFL in Lausanne, and the four major federal research institutes. It is a network of world-class centers that not only conduct research but also actively create spin-offs. At ETH Zurich alone, an average of 20 – 25 startups are created each year. ETH Domain collaborates with industry through Industry Partnership Programs; large companies invest in laboratories and gain the right of first refusal on research results. This model allows public funding to be supplemented with private capital and ensures a two-way flow of knowledge between the science and the business.

9 Swiss Innovation Ecosystem...; Enhancing Innovation in Rural...

R&D SPENDING				NUMBER OF START-UPS	IN THE EIS/GII RANKING
GERD	GERD (AS % OF GDP)	BERD	BERD (AS % OF GDP)		
25 BLN CHF	3.2%	16-17 BLN CHF	2.1%	4 500	1 / 1

The Swiss model is based on trust, measurable goals and effectiveness. The government and its agencies focus on concluding objective-based agreements that provide for specific indexes in line with transparent and predictable rules. It's a de-centralized model, with no one ministry to coordinate the activities but they all have a common goal: maximizing the economic value.

OUTCOMES AND METRICS – WHY DOES IT WORK?

Switzerland spends approximately 3.36% of its GDP on R&D, with over 2.5% coming from the private sector – the highest share of BERD in Europe. The number of EPO patents per million inhabitants is the highest on the continent, and the number of startups has grown by an average of 15% annually over the past decade, with 60% of them being deep tech projects.

The Swiss model works because it combines trust, measurable goals, and effective accountability. The government and its agencies do not engage in micromanagement but focus on entering into performance-based agreements with specific metrics according to transparent and stable rules. This allows institutions to plan for the long term. In this system, there is no central ministry of science as understood in Poland – responsibilities are decentralized, but the goal is shared by both the scientific and economic sectors: maximizing the economic value.

THE FINNISH EPÄONNISTUMISEN PÄIVÄ – THE SUCCESS OF NOKIA'S FAILURE

When Nokia lost its leading position in the mobile phone market, Finland was faced with the specter of recession and unemployment in the tech sector. The government then decided to rebuild an innovation ecosystem that would foster the emergence of multiple champions. After more than a decade, the country stands as an example of how a crisis can spur a lasting success and how to set ambitious goals for oneself. Epäonnistumisen päivä – the "National Day for Failure" – is the epitome of this approach. It is an initiative by students at Aalto University. Supported by development agencies and the Finnish media, it also involves startup hubs, incubators, and VCs that publish stories of "failed projects" under the motto that "failure can be an option, not a reason to give up."

THE LEADER'S STRATEGY

In 2020, the government adopted the National Roadmap for Research, Development, and Innovation, a strategy that set a target: 4% of GDP for R&D by 2030 – with two-thirds of that coming from the private sector. For the first time, this target was enshrined in law and safeguarded against political upheavals. The Council for Research and Innovation operating under the Prime Minister monitors the achievement of these goals and publishes annual performance reports to make sure the implementation of the Roadmap is on track.

The Finnish strategy focuses on creating strong and interconnected innovation ecosystems that bring together universities, businesses, and the public sector within regional R&D clusters. The goal is to foster collaboration between academia and business, which drives the growth of start-ups and scale-ups and the development of competitive technology hubs of international significance. The strategy assumes that technological progress and innovation are not the result of actions by individual entities, but rather the outcome of long-term cross-sectoral cooperation.

The so-called flagship programs[10] play a strategic role in this system; these are long-term research and innovation initiatives that focus on breakthrough technologies and national development priorities – such as artificial intelligence, the bioeconomy, quantum technologies, and the circular economy. Since 2022, Finland has emphasised its resilience priorities: cybersecurity, energy sovereignty, and dual-use technologies. The government launched the "Secure Digital Future" program, combining AI with public safety. Additionally, the green transition component has been strengthened – companies developing climate and circular solutions have been supported and - in light of today's threats - considered a factor enhancing national security and stability. Finland's goal is to become a global leader in green technologies.

Finnish flagship programs, managed by the Academy of Finland, serve as a mechanism for building sustainable cooperation networks. Each program is built around a consortium of universities, research institutes, and companies (both large and SMEs) that jointly develop a specific technological area. The goal is to create "centers of excellence" – entities with strong scientific and commercial potential that serve as a foundation for innovation across the entire economy. Flagship programs, known as "innovation locomotives," bring together Finland's top research centers, support researcher mobility and the internationalization of Finnish science, as well as create a space for testing and commercializing new technologies in collaboration with industry. Large companies participate in these programs as industrial partners, implementing or scaling new technologies, while small and medium-sized enterprises can join projects as suppliers, integrators, or innovative users of solutions. In this way, Finland creates an environment where science and business collaborate in a systematic and long-term manner.

10 Shaping the Future of Finnish Innovation, VTT Research Information Portal, 2024; Shaping the Future of Finnish Innovation: The Evolution of Finnish Innovation Policy and the Path Ahead, VTT, 2024, https://cris.vtt.fi/en/publications/shaping-the-future-of-finnish-innovation-the-evolution-of-finnish.

R&D SPENDING				NUMBER OF START-UPS	IN THE EIS/GII RANKING
GERD	GERD (AS % OF GDP)	BERD	BERD (AS % OF GDP)		
8.9 BLN EUR	3.2%	6 BLN EUR	2.2%	3 800	3 / 7

Finland increased its R&D expenditure (BERD) to 2.2% PKB.
There are over 3800 start-ups operating now (2023/2024) in the country (by comparison: app. 3300 in Poland).

The second pillar of Finland's RDI strategy is provision of a comprehensive support for SMEs, mainly via the Business Finland agency[11]. The support includes financial instruments – grants, innovation loans, and accelerator programs – as well as consulting services on exports, internationalization, and commercialization of research results. The goal is to enable small and medium-sized enterprises to participate in research and development projects and to accelerate their digital and green transformation. Support for SMEs is closely linked to cluster policy and investment incentives, which are designed to increase the private sector's share in innovation financing.

SYSTEMIC INSTITUTIONS

The most important role is played by Business Finland, the agency responsible for funding innovation, promoting exports, and internationalization. It combines the functions of Poland's PARP, PFR Ventures, and NCBR, thereby avoiding fragmentation of responsibilities. Such broad competencies under the umbrella of a single organization mean that, for example, startups can count on seamless support on the full length of the path from the initial idea to full-scale operations.

Sitra, on the other hand, as a foundation managing state-owned venture capital, serves as a "laboratory of the future." It does not fund specific industries, but rather systemic projects related to the circular economy, public data, health, and sustainable cities. Thanks to Sitra, Finland has a tool for testing new socio-economic models without risking budget stability.

SCIENCE-BUSINESS PARTNERSHIP

Business Finland implements the "lead company + ecosystem" principle. Grants for large companies are contingent on the creation of a network of startups, SMEs, and universities around them. This gives rise to local R&D clusters (e.g., in Espoo or Tampere). The result is not only product innovation but also a new culture of collaboration.

RESULTS AND DYNAMICS

Between 2013 and 2023, Finland increased its expenditure on research and development (GERD) from approximately 1.8% to 2.2% of GDP, one of the highest increases in the Nordic region. The country is currently home (2023/2024) to over 3,800 startups (for comparison: Poland to approx. 3,300), and companies such as Supercell, Wolt, Oura, and ICEYE have become global brands. ICEYE – a company with Polish-Finnish roots headquartered in Espoo, Finland – was founded in 2014 by Polish entrepreneur Rafał Modrzewski and Finnish entrepreneur Pekka Laurila as a spin-off of Aalto University, with significant participation from Finnish investors and global venture capital funds.

Finland currently ranks (according to data from 2022 – 2023) third in Europe in terms of the number of patents per million inhabitants.

11 An Attractive Innovation Environment, Business Finland, 2024, https://www.businessfinland.fi.

FRANCE – THE OPTIMIZATION BY PROFESSOR TIBI AS A GAME CHANGER

In recent years, France has become home to one of the most dynamically developing startup ecosystems in the world, as evidenced by its rise in international rankings: globally and - following a change in the methodology of the European ranking - also in the European ranking (7th place in the EU in 2025). Its success is the result of a conscious and consistent state policy that has combined public funds, institutional investors, and a culture of entrepreneurship. Two mechanisms played a central role here: the France 2030 strategy[12] and Tibi's plan[13].

FRANCE 2030 – STRATEGIC INVESTMENT ROADMAP

France2030 combines industrial, scientific, and climate policies into a single coherent strategy, managed at the prime minister's level. The €54 billion budget is allocated across 10 priorities: green energy, mobility, health, semiconductors, space, biotechnology, Agriculture 4.0, digitalization, AI, and sustainable industry.

A very "French" aspect of this strategy is the focus on the domestic market, as evidenced by the "environmental footprint" – an indicator of a product's origin and carbon footprint. In line with this approach, for example, subsidies for electric vehicles (EVs) are available only for vehicles that meet European environmental and production standards. In practice, this has eliminated many Chinese models and strengthened domestic manufacturers such as Renault and Peugeot.

Next40/French Tech 120 program is noteworthy here. The program identifies the most promising startups: in the 2024 edition, companies with a combined revenue of €10 billion in 2023 and employing 40,000 people qualified for this group. A significant portion of them (23%) are deep tech startups, aligned with the priorities of France 2030 (AI, quantum, medtech, greentech). Participation in the Next40/120 program provides startups with comprehensive support, including a dedicated government liaison who assists, for example, with interactions with government agencies or international expansion; 88% of the Next40/120-selected startups operate abroad, and French Tech supports their entry into the most significant markets (the U.S., Germany, Asia).

12 Innovation: France's Got Talent – Report on the quality and performance of the French innovation ecosystem, Institut Montaigne 2023, https://www.institutmontaigne.org/ressources/pdfs/publications/innovation-frances-got-talent_report.pdf.

13 Critical and Emerging Technologies Index 2025: France Report, Harvard Kennedy School, Belfer Center 2025, https://www.belfercenter.org/sites/default/files/2025-06/CountryReports_June%202025.pdf.

THE FRENCH MODEL OF INNOVATION

Over the past 15 years, France has transformed its approach to innovation - instead of hundreds of scattered grants and tax breaks, long-term investment programs have been introduced. They fund both research and implementation in strategic sectors. The state does not act as a grantor here, but rather as a partner and investor that helps private companies achieve the scale they need. Bpifrance plays a major role – a development bank that combines lending, equity, and advisory functions. It is Bpifrance that co-finances VC funds, supports technology exports, and funds research programs. In 2023, its portfolio included over €80 billion in assets, a significant portion of which was allocated to innovation and digitalization.

TIBI'S PLAN – A NEW MODEL FOR FINANCING INNOVATION

At the request of President Emmanuel Macron, the Tibi Plan was launched in 2019 by economist Philippe Tibi. Its goal was to address the "glass ceiling" in the French innovation ecosystem and the inefficiency of funds allocated to the startup ecosystem. France had thousands of young companies, but few of them were able to grow to become global players. The reason was lack of capital in the later stages of development – large funding rounds (over 50 million euros) were at the time granted mainly by American or British funds, which led to the "unicorn drain."

Tibi envisioned mobilizing domestic capital – through so-called institutional investors. He did not impose obligations or subsidize funds, but proposed a mechanism of voluntary commitments. The largest French financial institutions – such as AXA, Allianz France, Crédit Agricole, CNP, and BNP Paribas – committed to investing a portion of their assets in VC funds supporting technology companies, selected and identified by Tibi's team. A single transparent model was applied for all major players, thereby reducing investment risk while increasing the effectiveness of funds invested in "certified" VCs.

In the first phase of the plan (2019 – 2022), €6 billion was committed, which, thanks to the multiplier effect, generated a total of approximately €30 billion in investments. In the second phase (2023 – 2026), the plan allocates an additional €15 billion. It is precisely this "snowball effect" that has made Tibi's plan one of the most effective investment instruments in Europe and is now serving as an inspiration for many other countries, including Germany.

THE EFFECTS OF THE FRENCH MODEL

Just a decade ago, the French startup scene was in its infancy compared to, for example, the United Kingdom. Today, considering startups, France is the most dynamic EU country, attracting the largest VC investments in the Union – €8.3 billion in 2023. There are approximately 25,000 startups operating across the country, generating over 1.1 million jobs. A new generation of large-scale tech companies is emerging: as of mid-2025, there were 28 unicorns in France (an increase from 15 in 2023), and this number is growing rapidly with each quarter, granting the country the status of the leader in the EU (including Blablacar and Mistral AI – a new unicorn in the field of language models).

French startups are also attracting record funding rounds. Although 2023 brought a global market slowdown, France recorded over €8 billion in investments (the highest in the EU), and the share of AI startups in these funds increased significantly (27% of capital in 2024 went to AI companies). These results are partly due to the inflow of foreign capital – global VC funds (including SoftBank and General Atlantic) have begun investing heavily in Paris – but also a result of the active role played by Bpifrance, which stabilized the market during more difficult periods. Importantly, at the scale-up stage, fewer and fewer French companies are selling out prematurely – for example, in 2023, startups like Contentsquare and Spendesk opted for additional funding rounds in France rather than go for acquisitions.

France has improved its ranking in the Global Innovation Index from 22nd to 12th, and is classified as a "strong innovator" in the European ranking. In terms of R&D spending, it has reached approximately 2.3% of GDP, which still lags behind Germany (3.1%) and Switzerland, but is growing thanks to the France 2030 initiative. Over the past decade, France has increased its R&D intensity from 1.3% to 1.55%. More important than the numbers, however, is that the culture of cooperation between the public and private sectors has emerged, and the startup ecosystem has become an integral part of the economy.

Improvements are also made evident by the traditional science and technology indicators: France has increased the number of European patent applications and runs second (behind Germany) in terms of the number of patents filed with the EPO (over 10 000 in 2024). Furthermore, the quality of science is a strong asset, which, combined with new commercialization mechanisms (e.g., numerous academic incubators, "pre-seed" funds), results in an increase in the number of university spin-offs.

The French model – centrally driven by capital and initiatives – has led to a dramatic acceleration of innovation in the French economy in recent years. France has transformed from a country playing catch-up into one of Europe's leading startup ecosystems. The greatest success has been the creation of a culture of technological entrepreneurship (the French Tech brand) and successful enticement of the private sector to invest in innovation on an unprecedented scale.

R&D SPENDING				NUMBER OF START-UPS	IN THE EIS/GII RANKING
GERD	GERD (AS % OF GDP)	BERD	BERD (AS % OF GDP)		
60 BLN EUR	2.2%	40 BLN EUR	1.5%	25 000	7 / 12

The French model drove a swift acceleration of innovation in the French economy in recent years. France has gone from playing catch-up to become one of the leading European start-up ecosystems. The greatest success is the development of the culture of technological entrepreneurship (French Tech brand) and encouraging the private sector to invest innovation on a scale unlike anything seen before.

DENMARK – PRAGMATISM AND CONSISTENCY

While Switzerland focuses on universities and top business brands, and France on mobilizing capital, the Danish model is based on the principle of "more innovation for every krone." The point is not to spend more and more money – the 3% of GDP level, i.e., the EU target, is considered optimal – but to achieve the maximum socio-economic impact from every krone invested.

THE BIRTH OF THE DANISH ECOSYSTEM

In 2012, a comprehensive strategy titled "Denmark – a Nation of Solutions" was adopted, encompassing 27 initiatives aimed at transforming the country into a global laboratory for solutions to the challenges of the 21st century – modern education, climate, health, energy, and digitalization. The core premise was the belief that innovation only makes sense when it solves real-world problems.

Over time, Denmark's strategic approach evolved toward sector-specific strategies that address the most critical challenges facing today's economies. They are also more accurate in terms of descriptions of specific needs and proposed solutions. At the same time, "innovation effectiveness" gained increasing importance in Denmark. The government began requiring funded projects to deliver concrete results – new jobs, patents, export revenues, and increased company valuations. The Danish strategy can be summarized as a drive to maximize the commercial impact by building a bridge between a strong scientific base and applications in business and society at large.

Denmark had already achieved the EU target of 3% of GDP for R&D spending before 2020, but this did not always translate into a proportionate increase in new, global technology companies. Therefore, in 2019, the Danish government commissioned an international review of its innovation system, which resulted in the report *Ten Steps and a Leap Forward: Taking Danish Innovation to the Next Level*, indicating that while Denmark is an innovation pioneer, it could further improve synergy among institutions. Consequently, the concept of "mission-oriented innovation" began to be implemented – that is, directing part of the innovation efforts toward solving specific societal challenges. Therefore, particular emphasis is currently placed on climate and environmental innovation. By 2030, Denmark, with such strong brands as Vestas and Orsted, aims to build an image of a promoter and exporter of the best green technologies.

One of the business goals is to develop startups and scale-ups on a larger scale than before. Companies such as Unity and JustEat, among others come from Denmark. It was – in part - the Danish funding that helped the Estonian company Skype to grow. Most of these companies have moved their headquarters abroad, which is why developing the next generation of startups who will not need to relocate has become a key priority now. Denmark promotes itself as a country friendly to international startups and strives to attract foreign entrepreneurs (including through the Startup Denmark Visa program).

INSTITUTIONS AND FUNDING

The core of the system consists of three institutions: UFM (Ministry of Higher Education and Science), which coordinates research and innovation policy; Innovation Fund Denmark (IFD) – which funds university-business partnerships and supports projects from the conceptual stage to product delivery; Export and Investment Fund of Denmark (EIFO) – a public growth fund that invests in equity and provides loan guarantees, ensuring continuous support for technology companies at all stages of their development.

IFD funds several hundred projects connecting universities and companies each year. Every grant is monitored, and success metrics – such as the number of licenses and commercialization – determine whether further funding is freed. EIFO, in turn, invests alongside private VC funds, sharing the risk but not dominating the market.

Denmark has adopted the principle of "economy of effect" – every investment in R&D is evaluated in terms of its impact on productivity, exports, and jobs. As a result, over the course of a decade, GERD rose from 2.5% to 2.9% of GDP, and BERD from 1.7% to 2.1%. This is the highest share of the private sector participation in Scandinavia.

Denmark's innovation policy is not sector-based but cluster-based. The best-known cluster, Medicon Valley, brings together over 300 biotechnology companies from Copenhagen and Malmö. Clusters serve as hubs for collaboration between universities, businesses, and local governments. In addition, the government has introduced the so-called regulatory sandboxes, where companies can test new technologies (e.g., drones, fintech, AI) in a controlled environment.

RESULTS AND ADVANTAGES

Today Denmark is regarded as an innovation-friendly country, with strong universities that serve as efficient vehicles for technology transfer, thematic hubs where the strongest Danish brands locate their R&D centers, and – finally - with startups that accelerate the processes of commercialization. Start-ups from Denmark (Unity, Too Good To Go, Tradeshift) are globally recognized. Denmark is one of the few countries where the number of patents per million inhabitants is steadily increasing despite stable investment levels. About 70% of R&D investment comes from the private sector. Denmark's position in international innovation rankings is among the highest in Europe and the world. In less than two decades, Denmark has built an image that allows the country to attract foreign students, innovators, and investors, who are helping to shape the new economy of this small nation.

R&D SPENDING				NUMBER OF START-UPS	IN THE EIS/GII RANKING
GERD	GERD (AS % OF GDP)	BERD	BERD (AS % OF GDP)		
75 BLN DKK	3.0%	55 BLN DKK	2.2%	2 500	1 / 10

Denmark is considered friendly to innovation, with strong higher education institutions. Danish start-ups are globally recognized and some 70% of R&D investments come from the business side. Danmark holds one of the highest positions in innovation rankings globally and on the European scale. The country has created an image that attracts students, innovators and investors from abroad and together they build the economy of this small country.

LESSONS FROM THE FOUR COUNTRIES – SEVEN PRINCIPLES OF AN EFFECTIVE INNOVATION SYSTEM

STRATEGIC LEADERSHIP AND CENTRAL COORDINATION

In all the countries analyzed, innovation policy is long-term and strategic in nature, most often codified in a single, overarching document (e.g., National RDI Roadmap, ERI Strategy, France 2030). A limited number of institutions with clearly defined roles and responsibilities – most often divided into fundamental research and business implementation – are in charge of its implementation. Coordination is centralized – usually through the Prime Minister's Office or a specialized government agency – which ensures continuity and consistency of actions, regardless of political changes.

A COMPLEMENTARY SYSTEM OF INSTITUTIONS

Effective innovation ecosystems are based on the cooperation of several to a dozen strategic institutions with complementary roles. Some are responsible for fundamental research, others for implementation, venture capital financing, technology export, or SME support. In each of the countries studied, elimination of overlapping institutional responsibilities is deemed crucial – rather than compete, the institutions operate within a single innovation system architecture, guided by shared goals and metrics.

UNIVERSITIES, COLLABORATION, ECOSYSTEMS

Universities and technical universities serve as active participants in the innovation ecosystem, not merely as centers of knowledge and education. Alongside businesses, the government, and local administration, they co-create cohesive economic vehicles within shared technology hubs, science and research parks, and commercialization programs. Their research activities are closely linked to economic outcomes, i.e. to the identification and protection of intellectual property, and commercialization through direct license sales and creation of spin-off companies. As a result, universities become one of the driving forces of local economies.

CONTINUITY OF SUPPORT FOR TECHNOLOGY-BASED ENTREPRENEURSHIP

Systems in Finland, France, Denmark, and Switzerland ensure continuous support for companies from the pre-seed phase all the way to going public. Incubators, accelerators, VC funds, and development institutions form a cohesive financing chain. Start-ups and scale-ups can grow within a single ecosystem, benefiting from mentoring, advisory, and investment programs. Such continuity, predictability, and transparency of support are fundamental to the development of start-ups and prevent their premature migration to other markets.

INNOVATION:

HOW DO OTHERS DO IT?

CONCLUSIONS FOR POLAND

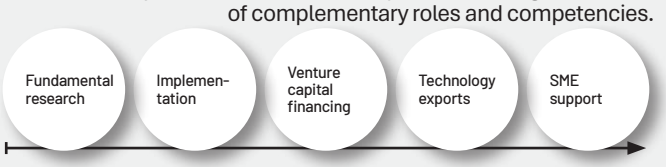
STRATEGIC LEADERSHIP AND CENTRAL COORDINATION

Innovation policy is implemented by institutions of specific, separate competences. Coordination is assured by the office of the Prime Minister or a special government agency.

1. In the Polish system of institutions, **there is no strategic reference point** and no coherent awareness of priorities.

COMPLEMENTARY INSTITUTIONAL SYSTEM

Innovation ecosystems are based on cooperation among institutions of complementary roles and competencies.



Institutions operate within the framework of a single innovation system architecture, focused on achieving common objectives and uniform effectiveness indexes.

2. Cooperation of the institutions in Poland is provided for in the act of law on development institutions, which established the **PFR Group**.

NCBiR and NFOŚiGW should be part of it

UNIVERSITIES, COOPERATION, ECOSYSTEMS

Universities, business, administration and local governments create technology hubs, science and research parks, as well as commercialization programs.

3. Our universities are temples of science and not vehicles of business – transformation is possible by bringing them closer to the world of business and advancing the commercialization of technologies.

CONTINUOUS SUPPORT OF ENTERPRENEURSHIP

These systems provide continuous support going from the pre-seed phase up to IPOs. Such continuity and transparency of support is an important factor in start-up development.

4. In Poland, the support is fragmented and requires integration of activities performed by NCBiR, PFRV, PFR, NFOŚiGW, BGK and ARP.

ACTIVIZATION OF THE PRIVATE CAPITAL

This effect has been achieved through co-financing from public funds and private businesses gradually joining the ecosystem.

5. Polish private capital has minimal involvement in VC and PE funds; financing from institutional investors should serve as a catalyst for change.

CULTURE OF TRUST, COOPERATION AND RISK-TAKING

The Finnish model puts emphasis on the **RISK-TAKING CULTURE** – legal and social tacit agreement that mistakes are part of the learning curve and growth process. Such approach supports experimentation and enterpreneurship.

6. In Poland, a code of good practices for the Business Judgment Rule (BJR) could help foster a culture of risk tolerance.

DURABILITY, EFFECTIVENESS, INSTITUTIONAL INTEGRATION

Redirecting the resources to meet economic objectives, as well as regular evaluation of effectiveness of the programs are of fundamental importance.

7. In the Polish context, reforming and transforming existing institutions appears more effective than creating new ones.

SOBIESKI INSTITUTE
GRAPHICS: NOWEMEDIA24.PL PIOTR PERZYNA

MOBILIZING THE PRIVATE CAPITAL

Access to the sources of financing and the involvement of private capital play an invaluable role in the development, commercialization, and adoption of advanced technologies by the SME sector and large businesses. In all the cases described, this effect was achieved through the co-financing of VC and PE funds as well as startups from public, grant, and commercial funds, and the gradual involvement of business partners – ranging from the largest corporations (institutional investors) to private investors.

A CULTURE OF TRUST, COOPERATION, AND RISK

Innovation thrives in places where the climate of trust and openness between science, business, and government prevails. The Finnish model particularly emphasizes a "culture of risk" – legal and social acceptance of mistakes, viewed as part of the learning process. This attitude fosters experimentation and entrepreneurship, which in turn strengthens the resilience of the innovation system. Joint projects, transparent rules, and stable funding strengthen relationships among ecosystem partners.

SUSTAINABILITY, EFFECTIVENESS, AND INSTITUTIONAL INTEGRATION

Most institutions responsible for innovation development were established in Europe over the past 10 – 15 years and maintain continuity of operations. International examples show that effectiveness does not stem from the number of agencies, but from the integration of activities and the broad scope of their offer, e.g., combining R&D grants with support for startups and VC funds. Instead of creating separate institutions for each field, functions are consolidated into a few strong organizations that collaborate on strategy implementation. It is of fundamental importance to redirect resources toward achieving economic goals and to regularly evaluate the effectiveness of programs in terms of measurable economic outcomes.

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3.
MAP OF THE TECHNOLOGY GROWTH FOR POLAND: INVESTMENT PRIORITIES FOR 2026–2035

INSTYTUT SOBIESKIEGO

Analysis of the structure of the Polish economy and global megatrends points to the conclusion that the country's technological priorities should be built on two complementary pillars:

AREAS BASED ON THE POTENTIAL OF COMPANIES

Sectors with an established, broad base of enterprises (including SMEs) equipped with manufacturing expertise and export capabilities. Public policy should "unlock" growth here: simplify regulations, stabilize the tax and energy environment, finance automation and R&D, and support international expansion. This group includes:

1. Green chemistry

- significance for security: high (access to critical materials and domestic raw materials – e.g., fertilizers – is a prerequisite for food and technological security);
- importance for the economy: very high (chemicals and materials are essential inputs for the industry – from batteries to construction; the modernization of this sector determines the competitiveness of the entire economy);
- current level of development in Poland: high (the Polish chemical industry is a major player in the EU, but we often rely on imported technology for the production of advanced materials).

2. New Mobility

- significance for security: moderate (energy security – making transport independent of oil imports; military mobility);
- significance for the economy: very high (the automotive sector is a pillar of exports and employment; its transformation will determine future competitiveness);

- current level of development in Poland: high (Poland has become a hub for lithium-ion battery production – accounting for approximately 60% of Europe's total – and a leader in the electric bus segment, but it still lacks the ability to produce its own passenger car).

3. **Agrotech and agri-food processing**
   - importance for security: high (food security, supply chain resilience; domestic raw materials – grains, feed, fertilizers – reduce external dependencies);
   - importance to the economy: very high (significant contribution to exports and employment; high potential for value-added growth through modern processing, premium brands, functional foods, and the circular economy);
   - current level of development in Poland: high (Poland is a major food exporter with a rich base of SMEs and cooperatives; areas for acceleration: precision agriculture, automation/robotization, digitalization, and consolidation in processing).

AREAS OF NATIONAL INTEREST

These are areas of critical importance from the perspective of security and technological sovereignty, where the current base of companies is fragmented, but systemic benefits (energy, digital, military) justify introduction of an active public policy: institutional coordination, multi-year programs, and funding for infrastructure and public demand. This group includes:

1. **Semiconductors** (SiC/GaN chips, chip assembly and testing, optoelectronics)
   - significance for security: very high (strategic technology for energy, telecommunications, and military electronics);
   - importance to the economy: very high (foundation of modern industry, from automotive to automation);
   - current level of development in Poland: low (a nascent sector, in the process of rebuilding, with initial investments underway).

2. **Longevity and predictive medicine** (new therapies, medtech devices)
   - Importance for security: moderate (public health indirectly affects the country's stability);
   - importance for the economy: high (huge healthcare market, potential for systemic savings and GDP growth thanks to a healthier workforce);
   - current level of development in Poland: a growing sector (strong pharmaceutical infrastructure, several innovative biotech companies, but still far behind the global leaders).

3. **Artificial intelligence factories** and post-quantum cryptography (industrial-scale AI and digital security)
   - significance for security: very high (AI and PQC determine advantages in cyber defense and intelligence);
   - importance for the economy: very high (automation and data analysis increase productivity across the entire economy);
   - current level of development in Poland: moderate/developing (strong IT workforce, emerging AI centers, but no major investments and native core technologies).

4. **New energy:** small modular reactors (SMRs), large-scale nuclear power, and energy storage
   - importance for security: very high (the country's energy independence, stability of power supply);
   - importance for the economy: very high (affordable energy is the foundation of industrial competitiveness);
   - current level of development in Poland: low (no operational nuclear power plants, only plans; dynamic development of energy storage from a low base).

5. **Space and dual-use technologies** (satellites, GNSS systems, ultralightweight materials)
   - importance for security: high (satellite reconnaissance, communications, dual-use technologies critical for defense);
   - importance for the economy: high (a new sector with a growing share of global GDP, technology transfer to civilian applications);

   - Current level of development in Poland: developing (several companies are already operating in the space sector, but the scale remains small).

Three criteria were used to identify these areas: (1) potential contribution to economic efficiency (productivity, value added, exports); (2) impact on security (energy, digital, food, defense), (3) feasibility of implementation within the next 3 – 7 years (technology readiness, skills base, regulatory flexibility).

The European Union offers powerful financial instruments aimed at advancing research and innovation. In the current budgetary period (2021 – 2027), over €93 billion are allocated for science-industry collaboration under the Horizon Europe program. Separately, the EIC (European Innovation Council) has allocated over €1.4 billion in 2025 to strategic technologies and the scaling of deep tech companies. Meanwhile, the InvestEU program aims to mobilize a total of approx. €372 billion in investments (EU guarantee ~€26 billion) for high-risk projects, including approx. €6.6 billion for research and innovation. These initiatives complement the European moonshots and funds from such sources as the European Defense Fund or the CEF (Connecting Europe facility, connectivity and Energy), enabling the financing of, for example, AI, cybersecurity, zero-emission transport, and semiconductor technologies.

Poland should make the most of this opportunity. Over 25 years of participation in the framework programs, universities and companies have already secured approximately €2 billion, including €667.1 million during the first three years of Horizon Europe (a 130% increase compared to H2020). This is a good result, but still insufficient. Other countries (e.g., Finland, France, and Denmark) are more effective in aligning their national budgets with the EU projects, which accelerates implementation and mitigates commercial risk. Thanks to EU grants and guarantees (EIC, InvestEU, the European Research Council, etc.), technologies of high strategic importance can be developed more quickly, within the next 3 – 7 years, thus, boosting productivity and exports, as well as strengthening resilience to threats (cyber, energy, food). In this context, the use of EU funds can provide a strong growth impetus for companies in the technology sectors described below – enabling them to transition from the research stage to full commercialization, scale up their operations, and integrate into European value chains.

1. ADVANCED MATERIALS AND GREEN CHEMISTRY (HYDROGEN, NANOTECHNOLOGIES, COMPOSITES)

Why it matters. Materials and chemicals form the foundation of every value chain – from steel and concrete in construction, through plastics and chemical intermediates in electronics and the automotive industry, to specialized materials (e.g., pharmaceutical compounds, or nanomaterials for electronics). The level of material advancement in the economy directly translates into its innovation and resilience. Contemporary megatrends – electromobility, renewable energy sources, and digitalization – rely on the development of new materials with improved properties (lighter composites for electric vehicles, more efficient catalysts for hydrogen fuel cells, silicon carbide power semiconductors, etc.). A country that possesses its own capabilities in the production of advanced materials is less vulnerable to supply chain bottlenecks and can derive greater added value from the global economy. The pandemic and the war have highlighted the danger that

comes with dependence on external sources – for example, the lack of domestic microchip production or active pharmaceutical ingredients (APIs) results in production stoppages or high prices. That is why the EU and the US are implementing "resilience" and "friend-shoring" strategies for critical raw materials and components – they want to shorten supply chains and bring them closer to home. Poland, with its significant chemical industry and natural resources (such as copper and silver, as well as its engineering workforce), has the potential to become a pillar of such a European materials ecosystem. The climate policy, in its turn, gave rise to the necessity to develop the "green chemistry". The traditional chemical industry (fertilizers, plastics) is energy-intensive and emits high levels of greenhouse gases. The requirement to reduce CO_2 emissions necessitates changes in processes (e.g., producing hydrogen and ammonia from renewable energy sources instead of natural gas). This is a challenge, but also an opportunity: whoever masters low-emission technologies first (e.g., green hydrogen, chemical recycling of plastics, biomaterials to replace oil) will dominate the new market and dictate the terms. Food security is also important for Poland – domestic fertilizer production (based on domestic raw materials and cheap energy) protects agriculture from price shocks and shortages (as we saw when reliance on Russian gas drove up fertilizer prices in 2022). In summary, this sector is important because: (1) it is a prerequisite for smooth functioning of other sectors (without materials, there are no chips, no vehicles, and no infrastructure), (2) it determines technological sovereignty (access to domestic sources and production capabilities), (3) it allows Poland to enter new global markets (hydrogen as the fuel of the future, biomaterials, closed-loop recycling), while simultaneously (4) addressing pressing environmental issues (plastic waste, heavy industry emissions).

Poland in the global context. Poland ranks among Europe's chemical industry leaders – we are the 7th-largest chemical producer in the EU (3.5% market share) and rank 6th in terms of domestic demand. Importantly, our industry has outperformed the EU average in recent years: chemical production in Poland in 2024 was approximately 3% higher than in 2021, while the EU as a whole saw a 17% decline. This demonstrates our companies posses a certain degree of resilience and competitiveness (thanks to, among other things, lower labor costs and new investments in production capacity, e.g., the new polypropylene plant in Orlen). The production structure remains dominated by bulk products: nitrogen fertilizers, basic plastics (polyolefins, PVC), and construction chemicals. In the area of specialized high-tech materials, we still lag behind – aerospace composites and specialty polymers are mainly imported from the West or from Asia. Poland has a strong scientific base in chemistry (several departments and institutes with world-class achievements), but the commercialization of inventions often falls short. Graphene is a case in point: Polish scientists were among the first in the world to produce graphene on a large scale, yet they failed to develop significant industrial production. Meanwhile, the U.S. and China saw companies that apply graphene, for example, in batteries emerge and succeed.

The EU Context. On the one hand, the EU is tightening regulations (the Fit for 55 package, the Chemicals Strategy – restricting harmful substances), which is putting pressure on the industry to undergo an ecological transformation. Our companies must invest in reducing emissions and switching to alternative raw materials (e.g., biomaterials instead of oil) – which is costly and technically challenging. On the other hand, the EU is creating support programs: IPCEI Hydrogen – major hydrogen projects (Grupa Azoty and Orlen are participants) – and the European Critical Raw Materials Alliance, aimed at developing the extraction and processing of lithium, nickel, and rare earth metals in Europe. Poland can play a significant role here because we do posses natural resources: copper (KGHM), and byproducts of copper mining contain rare earth elements. Research on extracting lithium from feldspar deposits in Lower Silesia (a project near Ząbkowice) is underway. Poland also has hydrogen potential – we are currently one of the largest producers of "gray" hydrogen in the EU (approx. 14% of all EU production), which is mainly a byproduct in refineries and coking plants. Grupa Azoty (Puławy) is the single largest producer of H_2 in the EU (approx. 420,000 tons per year). This is a major asset, as transforming this existing volume into low-emission hydrogen would give Poland a leading position in the "green hydrogen" category. Government policy already takes this into account – the Polish Hydrogen Strategy calls for the construction of 2 GW of electrolysis capacity by 2030. By comparison, the EU's total target for 2030 is 40 GW, so we are aiming for the 5% market share. In the CEE region, countries such as the Czech Republic and Hungary are also focusing on the development of the chemical industry – for example, Hungary has attracted major battery factories (CATL, SK), which will result in the emergence of local chemical suppliers (electrolytes, cathode materials).

Poland, already home to an LG factory in Kobierzyce, should consistently seek to attract further links of the value chain – including the production of cathode components, separators, and electrolytes – as well as aim to develop the battery recycling infrastructure. In this regard, Elemental Holding plant in Zawiercie, launched with support from the IPCEI program is an important step forward. It specializes in lithium-ion battery recycling and the recovery of critical raw materials. This project strengthens Poland's position in the European battery ecosystem and serves as an example of the effective use of public funds to build strategic capabilities.

Against the backdrop of the global chemical market dominated by China (approx. 40% of the global production), Europe must compete through innovation, clean processes, and technological quality. Poland, as a solid producer of basic chemicals, is today on the threshold of transitioning to a higher value segment – to specialty chemicals and advanced materials for the battery, energy, and pharmaceutical industries. It is worth noting that despite geopolitical turmoil and rising energy costs, the sector has maintained its competitiveness: chemical exports from Poland in 2024 were approximately 50% higher than in 2019.

Competing on technology must replace competing on costs.

OPPORTUNITIES AND RISKS

Opportunities: (1) The green transition as a lever for modernization. High energy prices and CO_2 reduction requirements are forcing chemical companies to invest. These investments can be used as a means to modernize and improve efficiency. For example, Grupa Azoty has already been executing a project to use renewable hydrogen for fertilizer production (a 100 MW electrolyzer trial run by 2030). PGE and Orlen are building large renewable energy farms specifically for the purpose of supplying chemical plants with green energy. If Poland carries out its plan to build nuclear power plants and SMRs, our heavy industry will gain a stable, low-cost source of electricity and heat. This could become our advantage over Western countries struggling with high energy costs. (2) Hydrogen – a new sector of the economy. By investing in hydrogen technologies now, Poland can secure a place in the European H_2 supply chain. Planned hydrogen hubs (e.g., Orlen is implementing the Hydrogen Eagle program with a grant of 1.7 billion PLN) will allow for capacity building in the production of electrolyzers, as well as in hydrogen storage and transport. We can become a hydrogen supplier for the region (e.g., via a pipeline to Germany or the Czech Republic) and also develop the domestic production of relevant equipment – such as tankers, compressors, and fuel cells. Each of these elements represents a new industry – for example, Jastrzębska Spółka Węglowa already manufactures its own membrane electrolyzers for its hydrogen projects. (4) Resource utilization and the circular economy. As a country, we have significant reserves of copper and silver, and by developing new copper- and silver-based materials (e.g., high-temperature wires, antibacterial coatings made from silver nanoparticles), we will add value to our mining operations. Furthermore, Poland could become a leader in the recycling of strategic raw materials – for example, the company Elemental is expanding its capacity for electronics recycling (recovering precious and critical metals). In the context of EV batteries, a massive volume of used batteries is expected to become available over the next decade, and whoever masters their recycling first will gain access to valuable raw materials – lithium, nickel, and cobalt. The first permits for lithium-ion battery recycling plants have already been issued in Poland.

Risks: (1) High transition costs and potential loss of competitiveness. The chemical industry is one of the sectors that are most vulnerable to high energy costs and restrictive climate regulations. Gas prices in 2022 forced Grupa Azoty to suspend production, which shows that without access to cheap power, plants may cease to be profitable. If the costs of adapting to green standards (e.g., the EU ETS system, the need to invest in CCS – carbon capture) exceed our companies' financial capacity, we risk to see carbon leakage – the relocation of production outside the EU and closure of domestic factories. Already, approximately 20% of Polish chemical companies are reporting losses, and the industry's debt is rising. The fertilizer sector is under a particularly heavy pressure – the debt ratio there has reached 62%, which analysts describe as alarming. Loss of liquidity by such strategic entities as Grupa Azoty would be a blow to the whole Polish economy and security (dependence on fertilizer imports). (2) Global competition and the technological gap. The world's largest chemical companies (BASF, Dow, China's Sinopec) are investing billions in R&D – new materials, catalysts, and biotechnologies. Polish companies, which have so far focused on increasing capacity and current production volumes, may miss out on technological revolutions. For example, if next-generation

bioplastics come into use within a decade - and we fail to be part of this shift, we will once again become an importer, losing a potential market. (3) Regulatory barriers and public acceptance. New chemical investments in Poland can be difficult due to public protests (environmental concerns) and the complexity of procedures. For example, the construction of a large chemical facility (such as a battery factory or a chemical waste incinerator for recycling) may face resistance from local communities if full transparency and local benefits are not ensured. The process of environmental licensing is lengthy – investors may choose other countries with quicker procedures. The risk of excessive tightening of EU regulations is also present. For example, the planned expansion of the list of substances subject to REACH restrictions can prove to be problematic (compliance costs, withdrawal of certain products). To summarize, the greatest risk of all is the risk of failure to tap into the existing potential. In the worst-case scenario, within a decade we could be importing most of our fertilizers, plastics, and advanced materials from Asia, paying more and losing control over supply chains.

MARKET LEADERS

Chemical giants:

- **Grupa Azoty** (Puławy, Police, Kędzierzyn) – market leader in fertilizers and chemicals, developing green hydrogen and new plastics (e.g., biodegradable plastic composites);
- **PKN Orlen** (formerly Anwil, Basell) – a fuel and chemical conglomerate (Płock Refinery, Anwil Włocławek), investing in biofuels and bioglycol, and planning to enter the lithium mining sector;
- **Synthos** (Oświęcim) – a private chemical company (synthetic rubbers, polystyrene), strongly committed to innovation: developing recycling of plastics, investing in its own small modular reactor (SMR) to decarbonize production;
- **Ciech/Qemetica** (Inowrocław, Nowa Sarzyna) – a manufacturer of soda ash and resins, is diversifying its operations into polyurethane foam, pharmaceuticals, and renewable energy (PV farms on former soda ash fields).

Advanced materials and specialties:

- **Vigo Photonics** (Ożarów Mazowiecki) – manufacturer of unique infrared photodetectors (III – V), and global leader in this niche; supplier to, among others, NASA;
- **Advanced Graphene Products** (AGP, Zgierz) – a manufacturer of high-quality flake and multilayer graphene, collaborates with industry on adding graphene to various materials (e.g., improving composite strength, thermal conductivity);
- **NanoGroup (Warsaw)** – a consortium of biotechnology companies, including NanoVelos, working on nanocarriers for oncology drugs (combining polymer chemistry with medicine).

Hydrogen infrastructure:

- **Grupa Azoty** – plans to build combined-cycle gas turbine power plants with the option of hydrogen combustion (Puławy), and is also designing a hydrogen storage facility in salt caverns;
- **PKN Orlen** – is building H_2 hubs (Trzebinia, Płock) producing renewable hydrogen via electrolysis, powered by renewable energy sources;
- **ZE PAK (Konin)** – a private energy investor, is converting a coal-fired power plant to biomass gasification and hydrogen production facility, and plans to supply H_2 to the railways.

Recycling and the circular economy:

- **Elemental Holding** (Grodzisk Mazowiecki) – an international metal recycler, building a facility in Poland to recover metals from Li-Ion batteries;
- **ML Polyolefins** (Toruń) – is developing chemical plastic recycling technologies (converting polyolefin waste into pyrolytic oil as a feedstock).

These examples highlight that our region – including Poland – has the opportunity to play a central role in the new materials sector, provided we invest appropriately and leverage our strengths. The Polish chemical and advanced materials sector, though facing challenges, is based on strong foundations and qualified workforce, thus has the potential to become one of the pillars of the innovative economy of the future – an economy that is secure in terms of raw materials supply and economic efficiency.

2. NEW MOBILITY AND AUTONOMOUS TRANSPORT SYSTEMS (ELECTRIC, HYDROGEN, AND SELF-DRIVING VEHICLES)

Why it matters. A global revolution - comparable to the transition from horses to automobiles over 100 years ago – is currently taking place. The electrification of vehicles has become inevitable. As early as 2023, electric vehicles (EVs) accounted for nearly 18% of all new cars worldwide, whereas just five years earlier, the figure was a mere 2%. By 2030, this share could exceed 40%, and many countries are announcing a complete phase-out of internal combustion engines. The European Union has adopted regulations stipulating that, starting in 2035, all new passenger cars and vans sold in the EU must be zero-emission. Thus, manufacturers are investing heavily in the development of batteries, power electronics, and EV powertrains. At the same time, the development of autonomous driving systems is progressing – artificial intelligence, sensors, and V2X (vehicle-to-everything)

connectivity are enabling the production of cars and drones capable of operating without a driver. This transformation has implications that extend beyond the automotive industry: it will reshape supply chains (fewer mechanical parts, more software and electronics), change the model of transport usage (the development of Mobility-as-a-Service), and also impact energy security and the environment. Transformation of the rail transport is also accelerating. Rail is already one of the lowest-emission forms of land transport today, but it faces two main challenges: (1) the need to decarbonize operations on lines and sidings without overhead catenary systems (hybrid solutions, "last mile" modules, hydrogen/battery projects) and (2) the digitization and automation of traffic control (ERTMS/ETCS, ATO), which increase the system's capacity, safety, and energy efficiency. For Poland, where the traditional automotive industry accounts for approximately 8% of industrial production and 11 – 12% of exports, the stakes of succeeding to maintain this sector of the economy in the era of new technologies are very hight. New mobility also offers an opportunity to reduce dependence on oil imports – electric and hydrogen vehicles can be powered by energy produced domestically (e.g., from renewable sources or nuclear power), which increases the economy's resilience to geopolitical and price shocks in fuel markets. The social aspect cannot be overlooked either: zero-emission transport will reduce smog in cities, and autonomous vehicles could revolutionize transportation for the elderly and people with disabilities, improving the system's inclusivity.

Poland in a global context. While Poland is not currently a major player in the production of ready-made vehicles, it plays a significant role in the European automotive supply chain. Meanwhile, when it comes to the rail transport sector, well-known rolling stock manufacturers (Pesa, Newag) operate in our country and Poland possesses expertise required for the manufacturing of traction components and power electronics. This presents us with an alternative path to creating added value in "new mobility" – especially where Europe is accelerating railway modernization and phasing out diesel propulsion on non-electrified sections. There are large foreign factories in Poland (VW Poznań, which accounts for ~50% of domestic production, and Stellantis Tychy, which is launching new EV models) as well as hundreds of component suppliers. In the era of electromobility, lithium-ion batteries have become our competitive advantage – thanks to LG Energy Solution's investment near Wrocław, Poland has become their production hub (approximately 60% of EV battery production in Europe is located in Poland, making us the second-largest producer in the world after China). What's more, as much as 20% of the value of Polish automotive exports in 2023 consisted of EV batteries – lithium-ion batteries for electric and hybrid vehicles were the second-largest export item of the Polish automotive industry, demonstrating that we are already profiting from the "new automotive sector." As far as the production of electric vehicles as such goes, our region is only just catching up – Western Europe is a few years ahead of us in terms of bringing EVs to the market (in Poland, the share of electric cars is only

now approaching 10% of new registrations, while in the West this threshold was crossed earlier). Despite this, we've set records in the past year: in 2025, over 3,000 electric cars were registered in Poland per month, and forecasts by the Polish EV Outlook predict the presence of ~700,000 EVs on the Polish roads by 2030.

EU Context: The EU is driving the transition through regulations (such as the aforementioned ban on the sale of new internal combustion engine cars starting in 2035) and funding (the Alternative Fuels Infrastructure Instrument, subsidies for electric buses),. For Poland, this represents both a challenge (the need for rapid expansion of the charging stations network and industrial restructuring) and a chance to capture a huge market – e.g., the replacement of the city bus fleet with electric buses. Poland has already achieved some success in this area: Solaris is the European leader in electric buses with a ~16% share of the EU e-bus market, and holds a ~69% share in the hydrogen bus niche. At the same time, the EU views rail as a key element of transport decarbonization (especially for regional and freight transport), investing in interoperability and automation (ERTMS/ETCS, ATO) as well as in the development of the next-generation of rolling stock and digital technologies through research and implementation initiatives (e.g., Europe's Rail). This opens up the market not only for carriers and infrastructure providers but also for rolling stock manufacturers and technology suppliers from Poland. Another area of potential growth lies in the production of special-purpose and rail vehicles – domestic manufacturers (Pesa, Newag) are developing battery-powered and hydrogen-powered locomotives, which aligns with the European trend toward rail decarbonization. Yet another promising area is the production of rail vehicles – domestic manufacturers (Pesa, Newag) are developing a new generation of locomotives and trainsets, providing for solutions that reduce emissions on the track sections without overhead lines (e.g., "last mile" modules) and alternative propulsion projects. An example of the market's scale is Orlen's 2025 contract for 40 locomotives (20 PESA Gama and 20 NEWAG Dragon 2) with "last mile" modules, valued at over PLN 800 million, with deliveries scheduled for 2027 – 2028. Nevertheless, compared to the industry giants (Germany, France), we still lack a domestic passenger car manufacturer of a global scale. The project of a Polish electric car – Izera - is still in its infancy, while Croatia, for example, has already become a manufacturer of electric supercars thanks to Rimac.

It is clear, then, that Central Europe can create its own brands, but achieving this objective requires determination and capital. Poland, with its large domestic market and industrial base, has the opportunity to play a leading role in new mobility in the region – provided it leverages its strengths (batteries, bus manufacturing know-how, and a skilled engineering workforce) and addresses gaps in areas such as electronics and automotive software.

OPPORTUNITIES AND RISKS

Opportunities: (1) Maintaining and developing the industrial base. The transition to electric vehicles creates opportunities for new investments in Poland – an example is Mercedes' decision to build a an electric vans factory in Jawor (investment of ~1.3 billion euros and 2,500 jobs created) with the support of the Polish government. If we are consistent with our policy of attracting investors (special economic zones, grants), Poland could become one of the centers of EV and battery production in Europe, alongside Germany and Hungary. (2) Poland's specialization in niche markets. Electric and hydrogen buses, special-purpose vehicles (e.g., delivery vans, electric agricultural machinery), and components such as battery management systems – our companies have already succeeded in acquiring expertise in these areas. Increasingly, the rail rolling stock and traction technologies are also included in these niches: locomotive modernization, the development of "last mile" solutions, the hybridization of traction units, as well as integration of control and diagnostic systems (digitalization of maintenance). Pesa and Newag can scale sales up in this segment of the European market, profiting from the acceleration in railway investments and the requirement to replace the diesel fleet. An influx of investments and orders (e.g., the program to replace the current public transport fleet with zero-emission vehicles) could strengthen our competitive edge and translate into increased exports (Solaris already supplies electric buses to over 30 countries). (3) Autonomy as the driver of technological leap. Poland has excellent specialists in AI and robotics; if we create the conditions for testing and implementation (regulatory sandboxes, pilot projects on selected road sections), we can become a testing ground for autonomous transport. The development of autonomous systems in logistics (e.g., cargo drones, autonomous warehouse vehicles) would boost the efficiency of our companies and could give rise to new tech champions. (4) Synergy with energy and climate. The widespread adoption of EVs in Poland will reduce oil imports, improving the trade balance and energy security. It is also a key element in achieving climate goals – cleaner transportation will lower national CO_2 emissions and help avoid costs associated with emissions charges in the transportation sector.

Risks: (1) Job losses and stagnation among existing companies: The transition to electric propulsion involves simplifying vehicle design (e.g., an EV motor has significantly fewer parts than an internal combustion engine). It is estimated that this could reduce the demand for labor in the auto manufacturing industry by several dozen percent. As early as 2024, the Polish automotive sector recorded a decline in employment from 204,000 to 197,000 people, and the transition to EVs with disregard for retraining the suppliers will exacerbate this trend. Plants manufacturing internal combustion engines, exhaust systems, and transmissions are particularly at risk – they must either switch to producing EV components (e.g., battery modules, electronics) or face closure. (2) Being merely an assembly plant for others' technologies. There is a risk that Poland will remain primarily a production base for foreign corporations, without developing its own technical expertise. Value added and profits may then largely flow abroad, while local companies will receive lower margins. To prevent this escape, it is necessary to invest in our own R&D (e.g., Polish innovation in control systems and automotive software) and build Polish brands – otherwise, we will remain on the periphery of the technological shift, dependent on the decisions of corporate

headquarters regarding the location of their production. (3) Infrastructure and legislative delays. The development of new mobility requires infrastructure (chargers, hydrogen stations) and supportive regulatory framework. If we fail to construct the charging network swiftly enough, consumers may be slower in adopting the EVs, and manufacturers will have no one to produce them for. Similarly, lack of legal framework for autonomous vehicles will delay their testing and implementation (e.g., traffic regulations not adapted to the absence of a driver). (4) Competition from outside Europe. There are new giants emerging in the global electric vehicle market – Chinese companies in particular (BYD, Nio, and others) are aggressively entering the European market, competing on price. If the Polish (and – generally - European) industry fails to increase its efficiency, it may be pushed out of its own market. Similarly, the U.S. and Asia are investing billions of dollars (Waymo, Tesla, Baidu) in autonomous technologies, while Europe is lagging behind in terms of regulation. The greatest risk, however, would be failure to act at all – if Poland did not actively participate in this revolution, we would be faced with the gradual decline of one of the economy's most important sectors and dependence on imports of foreign vehicles and transportation technologies.

MARKET LEADERS

Vehicle and battery manufacturers:

- **Solaris Bus & Coach** (Bolechowo) – the leader in electric buses in Europe, also developing hydrogen buses;
- **Volkswagen Poznań** – the largest car factory in Poland (VW Caddy and Crafter models, plans to introduce electric versions);
- **Stellantis (Opel)** Tychy – a plant launching production of electric Jeep and Fiat models;
- **Mercedes-Benz Manufacturing Poland** (Jawor) – an engine and battery factory, with a new e-van plant under construction;
- **ElectroMobility Poland (Izera)** – a Polish electric car project (factory in Jaworzno under construction).

Components and infrastructure:

- **LG Energy Solution** Wrocław – Europe's largest Li-Ion cell factory (near Wrocław);
- **Impact Clean Power Technology** (Warsaw) – manufacturer of battery systems, including for buses and energy storage facilities;
- **Ekoenergetyka** (Zielona Góra) – a leading supplier of HPC charging stations, exporting chargers to the whole Europe;
- **ZPUE (Koroneo)** – a Polish manufacturer of charging stations and energy storage systems;
- **Stempoz/Enekon** – a domestic consortium developing hydrogen refueling and storage technology;
- **Medcom** – a Polish technology company specializing in power electronics, supplying advanced power and drive systems, including for railways, public transport, and electromobility infrastructure.

Rail transport:

- **Pesa** (Bydgoszcz) – a rolling stock manufacturer (trainsets, locomotives, trams); develops solutions to reduce emissions and enable operation without overhead lines, including hydrogen projects (e.g., shunting locomotives) and new locomotives with "last mile" modules;
- **Newag** (Nowy Sącz) – manufacturer of locomotives (including the Dragon) and electric trainsets (Impuls); develops hybrid/"last mile" solutions and participates in large fleet orders (e.g., Orlen – Dragon 2 locomotives with a "last mile" module).

Special-purpose vehicles:

- **Melex** (Mielec) – a manufacturer of small electric vehicles (melexes), with a 50-year tradition, supplied to customers in the EU and the US.

Start-ups:

- **Triggo** (Warsaw) – a project for an electric urban microcar with a variable wheelbase;
- **Husarion** (Kraków) – a company developing autonomous mobile robots (e.g., delivery platforms).

Companies from the CEE region:

- **Rimac** (Croatia) – a manufacturer of electric hypercars (a Porsche partner since 2021, an example of how a startup from the region became a global player);
- **Skoda Auto** (Czech Republic) – a traditional car manufacturer that is successfully introducing electric models (Enyaq) and integrating Czech industry into the electromobility supply chain;
- **InoBat** (Slovakia) – a startup building a lithium-ion battery factory in the region using its own cell technology.

These examples show that Central Europe is beginning to make its mark in new mobility – Poland has all the assets to lead this change.

3. AGROTECH AND AGRI-FOOD PROCESSING

Why it matters. Agriculture and the food sector are pillars of national security – they guarantee provision of food supply to the public supply and reduce dependence on external sources. Poland is largely self-sufficient in terms of food production and has been recording a massive food export surplus for years (gov.pl). In 2023, the value of agri-food exports reached a record 51.8 billion euros, accounting for approximately 15% of total Polish exports. The sector employs hundreds of thousands of people and generates approximately 3 – 4% of GDP, contributing to the development of rural areas. Its significance, however, extends beyond economic indicators – stable food production guarantees the country's resilience to crises (such as the pandemic or the war in Ukraine) and strengthens sovereignty. Furthermore, agrotechnology is becoming a field of intense innovation: new solutions (from precision agriculture to biotechnology) are key to increasing productivity while reducing resource consumption. The modernization of agriculture translates into the competitiveness of the entire economy (e.g., cheaper feed means cheaper food production) and also aligns with global megatrends – smart farming, functional foods, and the circular economy. In short: safe and innovative agriculture is the foundation of both a country's food security and new technological advantages (such as the robotization or digitization of agricultural production).

Poland in the global context. Polish agriculture has made tremendous progress over the past two decades – once considered inefficient, it has become one of Europe's leaders. Poland's share of the EU's agricultural value added has risen to place the country within the top five (we now account for ~8% of the EU's agricultural value added). According to data for 2023, Polish agricultural production was 41% higher than that of the Netherlands and approached that of Germany – a huge leap, given how far behind we were 20 years ago. Today, Poland is among the leading food producers in Europe, ranking 3rd in the EU in terms of farmland area (approx. 14 million hectares), behind France and Spain. We hold top positions in many categories: we are among the EU leaders in the production of grains, milk, poultry, beef, sugar, fruits (including apples), and vegetables. We rank in the top three in the EU in terms of a positive food trade balance, supplying products to markets around the world. Poland's strengths include fertile land in many regions, diverse production (ranging from grains to fruits and meat), and numerous small and medium-sized family farms that can quickly adapt to market niches. Challenges, however, linger: the production structure is fragmented – the average farm size (~11 ha) is still smaller than in the West, and the majority of commercial production comes from some 15 – 20% of farms, the rest being small farms producing to meet their own needs. This hinders the implementation of larger investments and lowers labor productivity (Polish agriculture employs ~8% of the country's workforce compared to ~3 – 4% in the EU), while providing for a relatively low share of GDP. Furthermore, Polish farmers have only recently begun to adopt Agriculture 4.0 technologies widely – the level of digitization, automation, and data utilization is lower than in countries such as the Netherlands or the U.S. Global leaders are investing in agricultural robots, sensor-based field monitoring, and plant genetics – Poland must catch up with these trends, or

we risk remaining a supplier of low-margin raw materials. The dynamic improvement seen in recent years is a positive development: yields are rising (e.g., average wheat yields per hectare have approached the EU average), machinery fleets are being modernized thanks to the EU funds, and exports of "smart food" (e.g., healthy processed foods) are beginning to rise. In summary, Poland is emerging as a regional agrotech leader (the largest food producer in CEE), but a lot needs to be done - primarily in the areas of new technologies, efficiency, and scaling up the production - to close the distance to global leaders in agricultural innovation.

EU Context. The European Union is setting the direction for agricultural transformation, exerting regulatory pressure on the one hand and offering financial and program support on the other. The Green Deal and the "Farm to Fork" strategy set ambitious environmental goals: plans include a 50% reduction in the use of chemical pesticides, a 50% reduction in nutrient losses (which implies a ~20% decrease in fertilizer use), an increase in organic farmland to 25% of all agricultural acreage, and a 50% reduction in the use of antibiotics in livestock farming by 2030. Additionally, the Fit for 55 package requires the agricultural sector to make efforts to reduce emissions – the sector is expected to lower, among other things, methane emissions from livestock farming and CO_2 from landfarming (for example, an emissions cap is being introduced under the non-ETS framework). These regulations pose a huge challenge for the Polish farmers, who – in order to meet the standards - must modernize their production methods (e.g., apply pesticides more precisely, invest in fuel-efficient machinery, and improve animal welfare). In the short term , this translates into costs and the risk of lower yields (e.g., with reduced use of chemicals), which raises concerns among farmers – Poland even called for a review of the expected pace of these changes in light of the war (prioritizing food security). On the other hand, the EU offers significant support instruments to facilitate the green and digital transformation of rural areas. First and foremost, the Common Agricultural Policy (CAP) for 2023 – 2027 allocates billions of euros to Polish agriculture – direct payments are now partially contingent on pro-environmental measures (so-called eco-schemes, e.g., subsidies for precision farming or biological crop protection). RDP funds support farm modernization, investments in digitalization, and green energy in rural areas. Poland has also benefited from the National Recovery Plan – in 2023, the call for grants in Agriculture 4.0 (GPS systems, sensors, drones) was launched, attracting enormous interest from farmers. Furthermore, innovation programs operate at the EU level: Horizon Europe (research on food, climate, and agrobiotechnology), EIP-Agri partnerships (bringing together scientists and farmers in pilot projects), and initiatives such as EIT Food, whose regional center in Warsaw supports agritech startups and projects in Poland. The EU has also launched missions and initiatives related to healthy and sustainable nutrition – e.g., Mission Soil Deal for Europe focuses on soil health (aimed at boosting food quality and improve CO_2 sequestration), while programs like EIT Climate-KIC and Food 2030 promote innovations for sustainable diets and low-carbon agriculture.

This is an opportunity for Poland to benefit from European funding and expertise – provided we can develop appropriate projects and strategies. Though difficult to meet, EU requirements can serve as a catalyst for modernization: whoever adapts first to the new standards (e.g., fertilizer reduction, food carbon footprint) will gain an advantage in the single market.

OPPORTUNITIES AND RISKS

Opportunities: (1) Automation and digitization of agriculture. Poland has the opportunity to leapfrog several stages of development by implementing autonomous machines, drones, IoT sensors, and analytical platforms on a large scale. This will increase labor productivity (which is crucial given an aging workforce) and reduce the consumption of resources (precision fertilizer application, spot spraying). Prototypes of field robots and electric tractors are already being tested; an influx of investment could propel Polish companies to the forefront of global agrobotics. (2) Biotechnology and new products. Innovation in agrobiotechnology is opening up new markets. Polish science circles possess expertise in plant genomics and microbiology; if regulations on gene editing are relaxed, we can breed plants more resistant to drought or new diseases. We also have companies working on biological alternatives to pesticides (e.g., bacteriophages that combat pathogens instead of antibiotics). This is an opportunity to create a highly specialized industry (e.g., production of biofertilizers, insect-based feed, functional foods) that will ensure high margins and technology exports (Polish startups are already selling such innovations globally). (3) Sustainable and low-carbon agriculture. Transition toward green agriculture can become a competitive advantage. Consumers in wealthy countries increasingly value organic food with a low carbon footprint, produced with respect for animal welfare. Poland – with a relatively clean environment in many regions and less intensive use of chemicals than Western Europe – can occupy the niche by becoming the supplier of healthy, certified food. The development of regenerative agriculture (which improves soil health), agro-photovoltaics (combining solar panels with crops), or carbon sequestration in the soil can bring farmers additional income (e.g., through the sale of carbon credits) and make rural areas beneficiaries of the green economy. (4) Value chain integration and innovation in processing. There is enormous potential for increasing added value through the development of modern food processing (e.g., convenience foods, plant-based protein alternatives, dietary supplements). As a major producer of raw materials, Poland can process more domestically (currently, we export a significant portion of our agricultural produce in an unprocessed form). Investments in plant automation, AI for quality control, and biodegradable packaging will allow Polish food companies to compete globally on brand, not just price. By developing premium brands ("Organic from Poland"), we can move up the ladder in the global food supply chains.

Risks: (1) High transformation costs and competitive pressure. Adapting to new environmental and technological standards requires enormous investments, which larger farms can afford. Small family farms, which form the backbone of the Polish agriculture, may struggle to finance precision machinery, IT systems, or the construction of slurry storage facilities and renewable energy installations. There is a risk some producers will drop out of the market if costs (e.g., fuel, low-emission fertilizers) rise faster than productivity. As early as in 2022, the gas price crisis hit the fertilizer industry – production cuts at Grupa Azoty demonstrated how

fragile the supply chain providing the agriculture with basic resources really is. Without support, carbon leakage could also occur in agriculture – food production will shift outside the EU (e.g., to Ukraine or South America), and the Polish countryside will lose income. (2) Fragmentation and the generational gap. In terms of structure, the Polish agriculture is composed of a large number of small farms with an aging owner base. The average Polish farmer is over 50 years old, and many potential successors are seeking work outside of agriculture. If efforts to encourage young people to take over the farms (e.g., through succession mechanisms or tax breaks) fail, and land consolidation is not facilitated, the sector may be unable to compete with large-scale, automated farms operating abroad. Fragmentation also hinders joint investments – for example, purchasing an expensive combine harvester or silo makes no economic sense for a 10-hectare farm. This could lead to the fossilization of a two-speed agricultural sector: a clear split into a small group of specialized, large producers who introduce innovations, and the rest who falls behind, such situation slowing down the sector's overall growth.

MARKET LEADERS

Food producers:

- **Maspex Group** (Wadowice) – Poland's largest private food conglomerate (revenue of approx. PLN 16 billion in 2024), owner of ~70 brands (including Tymbark, Lubella, Kotlin), exporting to 100+ countries;
- **Mlekovita** (Wysokie Mazowieckie) – the largest dairy cooperative in Poland, a leader in dairy exports in the CEE region;
- **Cedrob** (Ciechanów) – one of the largest producers of poultry and pork in Poland.

Machinery and equipment:

- **SaMASZ** (Podlaskie Voivoidship) – a leading European manufacturer of agricultural machinery (mowers, tedders) with branches in Germany, the U.S., and elsewhere, and exporting ~66% of its production;
- **Ursus SA** (Lublin) – a historic tractor brand, currently undergoing restructuring, which has developed a prototype of a Polish electric tractor;
- **Plantalux** (Lublin) – a startup producing smart LED lamps for greenhouse crop lighting (applied in the medical cannabis industry, among others, and exported to Spain, Israel,etc.);
- **Pronar** Sp. z o.o. – a manufacturer of tractors, agricultural trailers, and agricultural machinery based in the Podlaskie Voivoidship.

Startups:

- **SatAgro** (Warsaw) – a precision agriculture platform using satellite data to monitor crops and create variable application maps (allowing for reduced use of fertilizers and chemicals);
- **Proteon Pharmaceuticals** (Łódź) – a biotechnology company developing bacteriophage-based products to combat diseases in farm animals (an alternative to antibiotics); its BAFASAL® dietary supplement against salmonella is the first preparation of its kind approved in the EU;
- **NapiFeryn BioTech** (patented a technology for extracting plant protein from rapeseed waste).

These examples demonstrate that innovative agritech companies are emerging in Poland. By leveraging its existing base of enterprises and agricultural expertise, Poland has the opportunity to build a robust agrotech ecosystem that will not only modernize domestic agriculture but also export solutions to global markets.

4. SEMICONDUCTORS (SIC/GAN CHIPS, CHIP ASSEMBLY AND TESTING, OPTOELECTRONICS)

Why it matters. Microprocessors and semiconductors have already become to the modern economy what oil was in the 20th century – a raw material of strategic importance. The global semiconductor market is projected to reach a value of as much as $1 trillion by 2030. Integrated circuits are essential in all new technologies – from consumer electronics and electric vehicles to artificial intelligence and defense. The importance of these technologies is also growing from a security perspective. The COVID-19 pandemic demonstrated that chip shortages can destabilize entire industries – the semiconductor shortage impacted the global economy by resulting in the necessity to limit production in sectors such as the automotive industry. For this reason, many countries (the U.S., the EU, China) consider the development of their domestic semiconductor sectors a strategic priority. New generations of semiconductors, such as silicon carbide (SiC) and gallium nitride (GaN) components, enable the development of power electronics and energy conversion technologies – which is of fundamental importance for electromobility and the energy transition (e.g., more efficient inverters in electric vehicles). The development of optoelectronics (e.g., lasers, infrared detectors), in turn, drives progress in photonics, fiber-optic communications, and defense systems.

Poland in the global context. Europe as a whole is currently dependent on chip supplies from Asia (over 60% of global chip production comes from Taiwan). To reduce this dependence, the EU implemented the European Chips Act in 2022 with a budget of €43 billion, aiming to double Europe's share of global semiconductor production to 20% by 2030 (from approximately 10% currently). Poland should aspire to play a key role in executing this strategy – drawing on its location, skilled engineering workforce, and relatively lower labor costs, our country can become a hub for the so-called backend of conventional chip production (assembly, testing), and a leader in the production of electronic circuits based on alternative semiconductors. According to a Kearney report, Poland is the "leader among EU countries" in terms of investment attractiveness in the chip assembly and testing segments.

As early as 2023, one of the largest investments in the history of Poland was announced – Intel selected the Wrocław area as the location for a new chip assembly and testing plant worth 4.6 billion euros. The Intel plant was expected to create approximately 2,000 jobs directly and thousands more in the surrounding economy. Until now (since 1990), Poland has not developed advanced semiconductor production (no front-end fabs), but it does have a required scientific infrastructure (e.g., the Łukasiewicz Institutes working on materials and electronics) and companies designing integrated circuits (design centers of global corporations in Gdańsk and Kraków). Relationships with companies from Taiwan and the U.S., combined with the expertise available in Poland, could allow the country to secure a permanent place in the European semiconductor supply chain as a center for assembly, testing, and the manufacturing of specialized components (e.g., infrared detectors).

EU Context. The EU has launched major support programs: the European Chips Act is mobilizing €43 billion to develop the semiconductor ecosystem, with the aim of doubling Europe's share of global chip production to 20% by 2030. As part of this initiative, funding is provided for innovations in SiC/GaN chips and for strengthening chip assembly and testing capabilities in Europe. For example, Polish institutes (Łukasiewicz-IMiF and IWC PAN) have received ~€50 million (half of the sum total coming from EU funds) to build a pilot production line for wide-bandgap semiconductors. Poland intends to capitalize on these projects. We already have some infrastructure in place (optoelectronic companies, R&D centers) and aspire to become a niche leader in new materials (GaN, SiC), optoelectronics, and chip assembly and testing services. However, competition is global – over 70% of chips are produced in Asia today – so Europe is focusing on technological sovereignty, and Poland, to remain competitive, must invest in innovation and participate in European projects, rather than compete solely on labor costs.

OPPORTUNITIES AND RISKS

Opportunity: Establishing the semiconductor sector in Poland will deliver an innovation and export boost. A single integrated circuit factory could increase Poland's GDP by approximately PLN 25 billion over the next decade. If we succeed in attracting more projects (e.g., a silicon wafer factory) or establishing pilot lines for materials such as SiC/GaN, we may be able to create thousands of high-paying jobs for engineers and technicians, which will reduce the brain drain. Developing domestic capabilities in microelectronics manufacturing will also increase the economy's resilience to supply shocks – it will make us partially independent of Asian supplies and secure strategic supply chains (e.g., for the automotive and defense industries).

Risks: Global competition in semiconductors is, however, fierce – other countries (Germany, France, Italy) are also enticing chip investments with subsidies. The high capital expenditures required to build factories (a modern fab costs >10 billion euros) mean that Poland cannot build a complete ecosystem on its own, without resorting to significant public support and partnerships. If technological progress accelerates (e.g., chips below 2 nm or new architectures enter mass production), local facilities risk being reliant on continuous investment to avoid becoming obsolete. Another challenge is the shortage of domestic human capital with the appropriate specialization – resorting to bringing experts from abroad or being forced to train new generations of microelectronics engineers practically from scratch need to be taken into account. Nevertheless, missing out on this opportunity risks leaving the country in the position of a mere consumer of somebody else's technologies, at the time when others build competitive advantages on chips. On a macro scale, lack of domestic semiconductor expertise exposes the country to disruptions in the supply of essential components (which would be critical, for example, in the defense or energy sectors).

MARKET LEADERS

Circuit design:

- **Digital Core Design** (Bytom) – a supplier of cores and digital circuit design services for integrated circuits to customers worldwide;
- **ChipCraft** (Warsaw/Lublin) – designer of integrated navigation receivers (GPS, Galileo) and positioning system components;
- **WiRan** (Gdynia) – a design firm specializing in wireless communications and IoT: from concept through prototyping to electromagnetic compatibility testing;
- **Aerobits** (Szczecin) – manufacturer of miniature transmitters and receivers for aircraft identification signals for use in drones and aviation.

Instruments and materials:

- **VIGO Photonics** (Ożarów Mazowiecki) – manufactures unique, uncooled infrared detectors – solutions used by NASA, among others; develops integrated photonics in the mid-infrared (IPCEI Project: HyperPIC);
- **XTPL** (Wrocław) – technology for the ultra precise dispensing of conductive nano-scale patterns for next-generation displays and electronics; global sales of equipment and materials;

- **Łukasiewicz – IMiF** (Warsaw) – research and development in the field of wide-bandgap semiconductors (GaN/SiC), photonics, and power electronics; building a pilot production line;
- **ENSEMBLE**^{3} (Warsaw) – a center of excellence in nanophotonics and crystal growth for optoelectronic applications;
- **Institute of High Pressure Physics, Polish Academy of Sciences/TopGaN** (Warsaw) – gallium nitride-based laser sources and techniques for growing nitride materials.

Memory components and advanced electronics:

- **Wilk Elektronik** – GOODRAM/IRDM (Łaziska Górne) – Europe's only manufacturer of DRAM modules; developing a factory and expanding its range of memory modules and SSDs;
- **Creotech Instruments** (Piaseczno) – electronics for satellites and controllers for quantum experiments; supplies to scientific institutions and the high-tech industry.

Back-end / integration and process power supply:

- **Łukasiewicz – ITR** (Warsaw) – assembly and testing of electronics, as well as advanced integration of circuits directly onto printed circuit boards;
- **Assel** (Pruszcz Gdański, Gdańsk area) – contract electronics manufacturing and electromechanical integration for high-demand industries;
- **TRUMPF Huettinger** (Zielonka/Kobyłka near Warsaw) – power supplies for vacuum and plasma processes used in the production of thin films in electronics.

These examples demonstrate that a value chain is emerging in Poland and the region, spanning materials production (GaN/SiC) through photonics and nanoprinting to testing and packaging. Support for domestic companies and integration with CEE investments could, within 5 – 10 years, build an economic segment supplying high-value-added systems, thereby strengthening the country's digital sovereignty.

5. LONGEVITY AND PREDICTIVE MEDICINE (NEW THERAPIES, MEDTECH DEVICES)

Why it matters: Societies around the world are aging at an unprecedented rate. Already today, for the first time in history, there are more people over 50 years of age than children under 15. By 2040, the number of people aged 65 and more will increase worldwide by approximately 800 million. It means a massive rise in demand for medical care and solutions that extend healthy life expectancy. The so-called longevity industry – that is, technologies and services that allow to extend human life in good health – is booming. According to forecasts, global market for personalized and predictive medicine (including, among other things, genetic diagnostics, targeted therapies, and health monitoring devices) will grow at a rate of approximately 14% annually, from ~$350 billion in 2023 to ~$690 billion in 2032. Predictive medicine uses big data, AI, and genetics to predict diseases before they develop – which helps to avoid costly treatments. For example, the implementation of preventive genetic testing and precision therapies in oncology could save billions of dollars by eliminating ineffective treatments – estimates suggest over $100 billion in annual potential savings globally thanks to precision medicine in cancer treatment alone. Longevity medicine encompasses not only treatments for age-related diseases (Alzheimer's, heart disease, cancer) but also technologies supporting seniors – from implants to telemedicine devices and care robotics. Investments in healthy aging have an economic dimension: improving the health of people aged 50 and older could add as much as 0.4 percentage points to annual global GDP growth between 2025 and 2050 thanks to longer working lives and higher productivity among older workers. In short, the "silver economy" (the economy related to older adults) will become one of the most powerful forces shaping the markets. As early as 2020, people aged 50 and older generated 34% of global GDP (approx. $45 trillion). Longevity and predictive medicine are therefore both a response to social challenges (population aging) and an opportunity to create new high-value-added sectors of the economy.

Poland in the global context. Poland is also facing rapid demographic aging.

Forecasts indicate that as early as 2030, one in four Poles will be over 65, and by 2050 as many as ~40% of the population will be over 60. This translates into a growing number of people who may require medical care and long-term treatment. At the same time, Poland has a certain foundation in medical sciences and biotechnology, but its commercialization has so far been lacking. Nonetheless, several innovative Polish biopharmaceutical companies have emerged in the last decade: for example, Ryvu Therapeutics and Molecure are developing new oncology drugs, Poltreg is working on cell therapies for type 1 diabetes and multiple sclerosis, and Captor Therapeutics is developing technology for targeted protein degradation in cancer treatment. Poland also has its own large pharmaceutical companies (e.g., Polpharma, Celon Pharma) that invest in research on biological and genetic drugs. However, our biotech sector remains relatively small – according to a Labiotech analysis, we lack capital and systemic support for innovation, resulting in a low level of commercialization of scientific discoveries. Polish

biotechnology has so far ranked poorly in terms of so-called enterprise support – that is, the conditions for startup development (access to financing, legal environment). This indicates that while we have talented scientists and good ideas, the transition from research to marketable products is hindered. Globally, the field of longevity is dominated by the U.S. (Silicon Valley invests in anti-aging startups) and the United Kingdom or Switzerland, where leading biotechnology companies operate. Central and Eastern Europe, however, has some achievements – for example, with the support of significant private capital, the company SOTIO is developing in the Czech Republic innovative oncology therapies (cell-based vaccines), and the Hungarian company Gedeon Richter has become a global player in the field of biosimilars and gynecology (it is also involved in research on drugs for age-related conditions). Poland, although not yet a powerhouse, has its own strengths: well-educated medical doctors and scientists, large medical databases (e.g., National Health Fund data, which could be used for predictive algorithms), as well as drug manufacturing infrastructure (pharmaceutical plants). Our companies are increasingly bold in entering foreign markets – for example, Mabion has secured a partner in the U.S. and produces vaccine components, while Pure Biologics is collaborating on new antibody therapies. In the medtech sector, Polish startups are developing, for example, portable diagnostic devices and telemedicine apps, but we still lack a unicorn on par with the Swiss Longevity Tech Fund. In summary, Poland lags significantly behind global leaders in the race to extend healthy human life, but it also has the potential (talent, experience in pharmaceutical manufacturing) to close that gap, provided adequate support is made available.

EU Context. The European Union is introducing some of the world's strictest regulations for the healthcare sector. An example is the new MDR regulation for medical devices, which, starting in 2027, requires rigorous certification of medtech devices – extensive documentation, additional clinical trials, and compliance with stringent standards. This ensures patient safety but significantly prolongs and increases the cost of introducing innovations. Small and medium-sized medical companies often cannot bear the burden – the cost of certifying an advanced device can reach €1 – 4 million (up to €28 million for centralized procedures), which consumes up to ~15% of an average company's annual revenue. As a result, some innovative therapies and devices may disappear from the European market before patients can fully benefit from them. On the other hand, the EU is launching support programs and funding research to stimulate medical advancement. Among others, the EU4Health program (with a budget of ~€4.4 billion for 2021 – 2027) aims to strengthen healthcare systems and access to medicinal products. At the same time, Horizon Europe is investing billions of euros in R&D projects related to new gene therapies, treatments for chronic diseases, and medtech solutions for an aging population. Public-private partnerships (e.g., the Innovative Health Initiative) are being formed to support breakthrough technologies that extend life and improve predictive diagnostics. Poland must seize these opportunities – domestic medical startups and research centers are increasingly applying for EU grants to work on personalized medicines or telemedicine devices. Nevertheless, our companies face the challenge of meeting EU quality standards and bearing certification costs. By comparison, procedures in the U.S. are simpler – registration of

a specialized catheter, for example, costs ~$3,000 there, while in Europe it costs as much as €140,000. Thus, American and Asian companies have an easier path to market. If the EU does not ease these burdens or support SMEs in the medtech sector, we risk Asian competitors taking over the market by offering cheaper alternatives and pushing out local manufacturers.

! Poland – like the entire EU – must therefore strike a balance between patient safety and innovation, simplifying procedures (fast-track processes, funds for SMEs) while simultaneously investing in new technologies that extend citizens' healthy lives.

OPPORTUNITIES AND RISKS

Opportunities: The development of longevity technologies in Poland is primarily of a social and fiscal benefit – healthier seniors mean less strain on the healthcare and social welfare systems. If innovations in predictive medicine allow, for example, to delay the average age of onset of Alzheimer's disease by 5 years, the billions of zlotys saved on long-term care could be invested elsewhere. From an economic standpoint, extending the working lives of Poles by a few years could increase GDP by over a dozen percent over the course of a decade – people aged 60 and more who remain in good health can continue to work and contribute to creating value (imf.org). Additionally, the biotech/medtech industry could become one of the drivers of exports: already today, Polish companies (e.g., Selvita as a large CRO) provide research services to global corporations, and by developing their own products, they can enter global markets with high-margin drugs or medical devices. If successful on the market, innovative Polish drugs (such as Ryvu's oncology molecules) could generate licensing revenues in the hundreds of millions of dollars annually. The development of the longevity sector will also create highly specialized jobs (molecular biologists, bioinformaticians, biomedical engineers) and attract back our compatriots working abroad in Big Pharma.

Risks: The greatest risk is the long return horizon and the uncertainty related to scientific research. Work on a new drug or medical technology takes many years and consumes vast resources, and comes with the risk that investments will not translate into tangible results (many therapeutic compounds fail to pass clinical trials). For policymakers – who expect results within their term of office - this may be unattractive, hence the temptation to cut funding for research if quick successes are lacking. Another risk is regulation and public acceptance. Innovative therapies (e.g., those based on gene modification or cell therapy) may raise ethical concerns and require careful regulation – while legislative delays could slow down implementation. In addition, if Poland fails to invest in this sector, we risk a "drain" on our finances due to the import of expensive therapies developed abroad. We are already spending billions on innovative drugs from foreign companies – without participating in any way whatsoever in the profits from their sales. Our failure to act in this area would also fossilize the model in which talented Polish scientists leave the country to pursue careers in laboratories in the U.S. or Germany, rather than develop the knowledge economy in Poland. The risk of global competition is also worth noting – the largest corporations are investing in anti-aging projects (e.g., Google established Calico for longevity research). The greatest risk, however, would be to ignore this wave of change – healthcare costs, rising alongside an aging population, could overwhelm public finances if we do nothing to make the population healthier and more independent in their old age.

MARKET LEADERS

- **Ryvu Therapeutics** (Kraków) – develops innovative oncology drugs in clinical phases;
- **Captor Therapeutics** (Wrocław) – a pioneer in protein degradation technology, collaborating with Japan's Ono Pharma;
- **Molecure** (Warsaw) – the company has discovered several drug candidates, including treatments for pulmonary fibrosis, and is conducting clinical trials;
- **Poltreg** (Gdańsk) – a cell therapy based on regulatory T cells, already being tested in patients with type 1 diabetes;
- **NanoGroup** (Warsaw) – a group of companies developing nanotechnologies for drug delivery (e.g., NanoVelos is developing nanocarriers for targeted cancer treatment);
- **Celon Pharma** – in addition to generic drugs, conducts research on innovative therapies (e.g., an esketamine-based antidepressant spray, RNA drugs);
- **Polpharma** – Poland's largest pharmaceutical manufacturer, investing in its subsidiary Polpharma Biologics, which develops biological drugs (e.g., biosimilar antibodies);
- **Adamed** – a family-owned company that has developed its own original oncology drug (neratinib) and conducts R&D projects in metabolic diseases;
- **Medicalgorithmics** – a developer of remote cardiac monitoring systems exported to the U.S.;
- **StethoMe** – a home AI device for auscultating children's lungs;
- **PelviFly** – AR-enabled pelvic floor muscle trainers for urogynecological rehabilitation;
- **ExploRNA Therapeutics** – a University of Warsaw spin-off working on an mRNA modification platform (its groundbreaking discoveries were supported by a grant from the Gates Foundation);
- **IQ Biozoom** – a startup developing non-invasive diagnostic techniques using saliva, particularly in the areas of longevity and well-being;
- **Capturing Calcium** – a spin-off from Jagiellonian University developing new imaging markers for osteoporosis.

These companies and institutions form the nucleus of an ecosystem that – supported by the right policies – could make Poland a hub for health innovation in our region within the next 5 – 10 years.

6. ARTIFICIAL INTELLIGENCE FACTORIES AND POST-QUANTUM CRYPTOGRAPHY (INDUSTRIAL-SCALE AI AND DIGITAL SECURITY)

Why it matters. Artificial intelligence (AI) has become the main driver of the digital revolution, transforming business models across every sector – from manufacturing through financial services to public administration. It is estimated that AI could increase global GDP by as much as 14% by 2030, corresponding to $15.7 trillion in additional value. Process automation, big data analysis, and intelligent machine learning systems boost productivity and create entirely new products. Countries that build a competitive edge in AI will profit massively – for example, China, by investing heavily in AI, expects a 26% increase in productivity by 2030. "AI factories" are initiatives aimed at facilitating the creation and implementation of artificial intelligence solutions on an industrial scale. Equipped with supercomputers and filled with teams of experts, such R&D centers can accelerate AI research and the transfer of results to the wider economy. The European Union plans to launch six such AI factories, investing approximately €485 million to make Europe into a leader in the development of artificial intelligence. One of them – PIAST AI in Poznań – has received €50 million to leverage the computing power of PCSS supercomputers to implement AI in fields such as medicine, biology, cybersecurity, and robotics. The second component of this category – post-quantum cryptography (PQC) – is becoming critical considering that quantum computers capable of breaking current encryption standards are already on the horizon. If efficient quantum computers are developed within the next 5 – 10 years, the RSA and ECC algorithms used today could become useless, exposing the entire digital infrastructure to attacks. That is why the race to develop and implement new cryptographic algorithms resistant to quantum breaking is already underway – NIST in the U.S. approved the first PQC standards in 2022. For an economy increasingly dependent on data and digital services (banking, commerce, online administration), ensuring information security in the post-quantum era is critical. It is worth noting that AI and digital security are intertwined – on the one hand, artificial intelligence helps detect threats and respond to cyberattacks; on the other hand, the emergence of powerful computing capabilities (e.g., quantum computing) could threaten the integrity of systems. Thus, mass-scale investments in AI and PQC should therefore be considered as more than investments in innovation and productivity growth only; they are investments in the foundation of a nation's digital security as well.

Poland in the global context. In the field of AI, Poland has a strong foundation in the form of talented programmers and mathematicians, but so far there have been no major investments in infrastructure. Compared to the countries leading the race (the U.S., China), our spending on AI R&D is modest, but the situation is beginning to change. Poland participates in European initiatives – the aforementioned AI factory in Poznań (PIAST) will be one of six European centers collaborating with the EuroHPC supercomputer network. Polish AI startups (e.g., in computer vision and natural language processing) are gaining global clients. Nonetheless, we lack flagship projects, such as our own language model comparable to ChatGPT – these are being developed in the US and China. According to an EU report, among EU countries Poland has an average level of AI readiness; we have a skilled workforce but low corporate investment in artificial intelligence. Many Polish companies are just beginning to automate processes using machine learning algorithms. There are successes, however: for example, Allegro uses AI for personalized recommendations; banks (PKO BP, PeKaO S.A.) have introduced chatbots and credit big data analysis. The first implementations are emerging in the public sector (chatbots at ZUS, medical image analysis systems financed from the EU funds). The Polish government adopted an AI strategy in 2019, but its rollout has been limited. As for infrastructure, only PCSS will gain the status of an AI hub – until now, Polish researchers have relied on foreign computing power. When it comes to PQC, Poland is not a leading center for work on quantum computers. We do, however, posses a long mathematical tradition in cryptography (e.g., at the Military University of Technology or the University of Warsaw). Importantly, Polish companies are beginning to participate in European projects related to quantum networks and PQC: for example, AROBS Polska (part of an international IT group) was selected by the European Space Agency as the developer of a satellite security system based on post-quantum algorithms. In 2021, Polish scientists also demonstrated the country's first quantum key distribution (QKD) connection – which shows that certain capabilities are being developed. Overall, compared to the rest of the world, Poland is more of a user of others' AI solutions than their active creator – our companies implement, for example, cloud computing bought from global giants, and startups often get acquired by foreign investors. In PQC, we must rely on standards developed mainly in the U.S. (NIST), but we do have a chance to make our mark in niche implementations (e.g., encryption for the satellite sector, as in the ESA project). Nevertheless, falling behind could lead to "digital dependency." Hence the will to participate in programs such as Digital Europe or the plan to build the Central HPC Hub. Poland also has the advantage of being home to a large number of computer science graduates – the challenge is to have them stay in the country so they can build local AI solutions instead of working exclusively for big techs abroad.

The EU Context. On the one hand, the EU is imposing new regulations that tighten requirements regarding artificial intelligence and cybersecurity. The AI Act proposes categorizing AI systems based on risk and imposes numerous obligations on providers – ranging from algorithm transparency through training data disclosure to ethical audits and copyright protection. AI companies must comply with these requirements as early as 2025, which engenders significant compliance costs and potentially slows the pace of implementing new solutions. Penalties are in place for non-compliance (amounting to up to 30+ million euros or 6 – 7% of global turnover), underscoring the EU's serious approach to AI ethics and security. Meanwhile, in the field of cryptography, the European Union plans a radical shift in standards due to the threat posed by

quantum computers: it has recommended that member states transition to post-quantum algorithms (PQC) by the end of 2026 at the latest, and that they apply PQC in protection of critical infrastructure by 2030 at most. This forces the IT sector to modernize current encryption systems so that in a few years – when quantum computers capable of breaking classical ciphers emerge – European data remains secure. The European Union is investing heavily in the development of AI and cybersecurity, aiming to close the gap with global leaders. It is building infrastructure and funding projects: European supercomputers (such as LUMI and Leonardo) are being developed to provide the computing power needed to train AI models on an industrial scale. Programs such as Horizon Europe and Digital Europe are allocating billions of euros to networks of AI centers of excellence, regulatory sandboxes, and AI implementations in business. The EU is also building a Cybersecurity Competence Center (ECCC) and supporting the development of encryption technologies – from classical to quantum. Under the European Defense Fund, groundbreaking projects in the fields of post-quantum cryptography and AI for security – recognized as priorities for Europe's technological autonomy – are being funded. Poland, with its large pool of IT and mathematical talent, is participating in these efforts (our research teams are involved, for example, in work on PQC algorithms, and domestic companies are developing their own AI solutions). However, if we want to avoid remaining merely a consumer of foreign technologies, we must increase investment in our own AI centers and computing infrastructure, as well as proceed more swiftly with adopting the EU standards (e.g., train specialists in post-quantum cryptography). Globally, it is the U.S. and China who dominate in terms of investment and the scale of AI deployments, so Europe – seeking to balance innovation with the protection of values – is focusing on collaborative efforts.

For Poland, this translates into the requirement to join forces with European partners (research consortia, EDF projects), and aim at building competitive advantages in niche areas (e.g., AI in cybersecurity, specialized encryption algorithms) to secure a place in the digital economy of the future.

OPPORTUNITIES AND RISKS

Opportunities (AI): Rapid adoption of artificial intelligence in the Polish economy could boost labor productivity and offset negative effects of labor shortages resulting from an aging population. Estimates suggest that automation and AI could boost productivity growth in Poland by an additional 1 – 2 percentage points annually over the coming decade. AI on an industrial scale will enable the creation of new products and services – for example, training large language models in Polish will pave the way for intelligent assistants for businesses and citizens. Poland can also export AI-based services (e.g., software for Industry 4.0) – our IT companies are already developing image recognition systems that

compete on global markets (e.g., in surveillance and medicine). AI factories, such as PIAST, will allow for the concentration of talent and infrastructure, which will increase the chances of groundbreaking research projects and deep tech startups.

Opportunities (PQC): Early engagement with post-quantum cryptography gives Poland the opportunity to secure its critical infrastructure before the "quantum breakthrough" materializes. If PQC algorithms are ready by 2030 and effectively implemented in government, banking, and the energy sector, we will avoid a situation where the sudden emergence of a quantum computer – e.g., in China – threatens our data. Moreover, companies that acquire PQC know-how can provide consulting and implementation services globally, as nearly every institution in the world will need to migrate its cryptographic systems within the next 5 – 15 years. Polish companies are already participating in such projects (e.g., AROBS at ESA) – this builds brand recognition and expertise.

Risks (AI): If Poland does not accelerate its investment in AI, we risk remaining on the digital periphery – we will import technologies and pay for licenses to foreign suppliers instead of developing our own. The "AI gap" will also widen – advanced nations will reap most of the benefits, while countries lagging behind technologically will receive only a fraction. Furthermore, AI carries social risks; for example, automation may be a threat to certain professions – without appropriate retraining programs, Poland may face the problem of a growing skills gap, where people with lower qualifications are pushed out of the market. Another risk comes with overly strict regulations (e.g., the planned EU AI Act classifying AI systems by risk) could slow down the industry's development in Europe, putting it at a disadvantage compared to less heavily regulated competitors from the US or China.

Risks (PQC): The main risk lies with downplaying the problem – since quantum computers capable of breaking ciphers have not yet been available on the market, it is easy to delay acting on this potential threat. The danger is that once they do appear, it will already be too late to react. Another risk is the fragmentation of standards – if, for example, different countries adopt different PQC algorithms, a problem with system interoperability (e.g., our communication systems with allies) might arise. Poland should rather adhere to NIST/EU standards here and actively participate in testing their implementation. In summary, the greatest risk is to remain passive – from the AI perspective, this threatens resulting in a developmental lag; in cryptography, it entails becoming vulnerable to threats that could undermine trust in the digital economy (e.g., leaks of sensitive data, financial destabilization should cryptocurrency blockchains or banking transaction blockchains be compromised).

MARKET LEADERS

- **Infermedica** – a Wrocław-based medtech startup using AI for initial patient triage, has gained clients worldwide;
- **BLIK** (Polish Payment Standard) – a nationwide mobile payment system operating on a massive scale; a natural leader in AI implementations for fraud detection and transaction risk management, and a key stakeholder in the context of cryptographic resilience (including future migration to post-quantum solutions in critical components of the payment infrastructure);
- **Nomagic** – a Warsaw-based company developing warehouse picking robots using computer vision and machine learning; its solutions are used, among other places, in e-commerce logistics centers;
- **Brainscan** – a startup developing algorithms for analyzing brain MRI scans to detect early changes (e.g., multiple sclerosis);
- **MX Labs** – developed an app that uses a smartphone camera to monitor health metrics (heart rate, stress) with the help of AI.
- **Allegro** – an e-commerce leader, investing in AI for search and recommendations (has its own data science teams);
- **PKO BP** and **PeKaO S.A.** – the largest banks, implementing NLP-based chatbots in customer service and many specialized AI solutions;
- **KGHM** – a copper mining giant, is testing AI systems to optimize mining operations and predict machine failures.

Global R&D centers operating in Poland are also worth mentioning: Google has a team in Warsaw working on the development of the Assistant (Polish language), NVIDIA recently opened an AI competence center in Gdańsk, and Intel is working on AI tools in Gdańsk (including OpenVINO);

- **ElevenLabs** – a startup founded by Polish engineers, developing advanced AI algorithms for voice synthesis and cloning, used in media, gaming, education, and online services worldwide;
- **Voicepin** – an AGH spin-off specializing in voice biometrics (voice-based identity recognition) with AI elements, used in call centers;
- **Quantum Flytrap** – a startup from the University of Warsaw using VR/AR and AI to visualize quantum states (education and research);
- **Synerise** – a Polish startup developing an AI platform for behavioral data analysis and marketing automation, helping companies to personalize their offers, increase customer loyalty, and optimize sales across multiple channels;
- **ResQuant** (Poland) – a young company focused on the hardware implementation of post-quantum algorithms, a partner in the aforementioned ESA project;

- **Poznań Supercomputing and Networking Center** (PCSS) – operator of the PIAST AI factory, home to one of the most powerful supercomputers in Central Europe;
- **NASK** – a state-run institute active in cybersecurity, also conducting research on cryptography (coordinating the Polish part of the EuroQCI project).

Over the next 5 – 10 years, we can expect the emergence of additional companies that will become pillars of this sector – it is important that they receive support during the critical growth phase and do not relocate their operations abroad.

7. NEW ENERGY: SMALL MODULAR REACTORS (SMRS), LARGE-SCALE NUCLEAR POWER, AND ENERGY STORAGE

Why it matters. The energy transition is the foundation of sustainable development – cheap, clean, and stable energy is essential for the economy's competitiveness and the country's security. Poland faces the challenge of decarbonizing its energy sector while maintaining security of supply. Small modular reactors (SMRs) and modern nuclear power can play a groundbreaking role here. SMRs are reactors with a capacity of several dozen to several hundred MW that can be factory-made and installed faster and more cheaply than massive nuclear power plants. Global race is underway for the first commercial SMRs – over 70 projects are in the development phase. Proponents see them as the key to the future of nuclear energy: flexible, safer (thanks to passive cooling systems), and easier to locate closer to energy consumers (e.g., near factories that require stable power). Market forecasts predict dynamic growth in the SMR sector between 2030 and 2040 – according to various analyses, the global SMR market could reach a value of several to over a dozen billion dollars by 2035, and investments in SMRs will exceed $900 billion in total by 2050. For Poland, SMRs represent an opportunity for a technological leap in the energy sector. We can commission the first units of this type relatively quickly (by 2030), filling the gap left by the decommissioned coal-fired power plants and stabilizing the grid as the share of renewables grows. At the same time, the construction of large nuclear power plants is planned (the first unit ~1 – 1.6 GW to be brought online around 2033), which will provide for the necessary scale. The third key element is energy storage – the development of batteries, pumped-storage hydropower plants, and, in the future, hydrogen storage – which will enable the storage of surplus energy from renewables and its use during peak demand periods. Without effective storage, the energy transition will stall, as it is impossible to replace 70% of generation with wind and solar without a method to buffer their variability. The International Energy

Agency indicates that in order to achieve climate goals, global energy storage capacity must increase 35-fold by 2030, to approximately 970 GW. This represents a massive new market and a field for innovation. In summary, clean and stable energy is the foundation of economic development – new nuclear and storage technologies can guarantee both energy security and industrial advantages for Poland (e.g., the development of domestic industries around SMRs and battery production).

Poland in a global context. Until now, Poland has not developed a nuclear power sector, but thisas been changing in recent years. In 2022, a decision was made to select the American Westinghouse as technology provider for the construction of the first power plant (a large PWR of approx. 1.1 GW) in Pomerania. If plans come to fruition, the first large reactor will go online around 2033 – 2035. SMR: Poland is a pioneer in the region in this field – Orlen Synthos Green Energy (a joint venture between PKN Orlen and Synthos) is already collaborating with GE Hitachi on the implementation of the BWRX-300 (a 300 MW SMR). The ambition is to build as many as 10 such units – the first could come online between 2028 and 2030, ahead of many Western countries where procedures are longer. Polish companies (Orlen, KGHM, Ciech) have also signed letters of intent with other technology suppliers for the construction of SMRs (NuScale from the U.S., Rolls-Royce from the U.K.). We might not have our own nuclear technology in Poland, but we can become one of the first users of SMRs globally – which will give the industry an incentive to participate in the supply chain (e.g., Rafako or Energomontaż could supply components). Energy storage: Here, Poland is swiftly catching up – in 2023, PGE began construction of one of Europe's largest battery energy storage systems (262 MW/980 MWh in Żarnowiec, integrating it with the existing pumped-storage power plant). More and more solar farms are being turned into hybrid storage systems, and the grid operator – PSE - is planning for large-scale storage facilities to stabilize the grid. Importantly, Poland has become a European hub for lithium-ion battery production – thanks to the LG Energy Solution gigafactory near Wrocław, we have hold a 60% share in EV battery production in Europe. This means we have the know-how and infrastructure for further development of storage systems (which use similar cells to those in the automotive industry). In the CEE region, other countries are also focusing on these areas: Romania and the Czech Republic are planning their own SMRs (e.g., Romania with NuScale, the Czech Republic with Rolls-Royce), while Hungary and Slovakia are developing traditional nuclear power (expansion of Paks NPP in Hungary, Mochovce NPP in Slovakia). However, Poland, with its larger economy, could take the lead in this part of Europe – for example, by building a maintenance service center for SMRs operating in the region. Countries like Germany, the U.S., and China lead the way in energy storage, but Poland is already a top producer and exporter of batteries – an asset worth leveraging.

EU Context. On the one hand, the EU is tightening CO_2 emission standards and setting ambitious reduction targets (the Fit for 55 package) as part of its climate policy. This is pushing the energy sector to undergo a rapid transformation – moving away from coal and gas toward zero-emission sources. EU countries must meet increasingly stringent criteria. In the Polish case it entails enormous pressure to invest in clean energy: large nuclear power plants, a fleet of SMRs, and energy storage facilities to stabilize a system

based on renewables. At the same time, strict nuclear safety requirements are in place – EU regulations (Euratom) and International Atomic Energy Agency standards demand state-of-the-art safety measures and waste disposal plans, which increase costs and prolong licensing processes for reactors. On the other hand, the EU is beginning to treat nuclear energy and storage as key elements of the green transition, offering regulatory and financial support. In 2022, nuclear power (and gas) were - under certain conditions - included in the Taxonomy for sustainable financing by the European Commission. It was a recognition nuclear investments can be climate-friendly (provided that, p.ex. a waste repository is commissioned by 2050). This opens the door to private capital and loans for the construction of new nuclear reactors. There are also pan-European programs: for example, IPCEI Batteries and the European Battery Alliance have supported the creation of a complete battery value chain in Europe (from materials to recycling), while IPCEI Hydrogen funds hydrogen projects critical for energy storage. Poland is already benefiting from these initiatives – LG Energy Solution, the world's largest lithium-ion battery factory for electric vehicles (with a target capacity of 115 GWh per year), operates in Wrocław, having been established thanks to the EU's favorable investment ecosystem. The United States, through the IRA, subsidize local production of clean energy technologies (including SMRs and storage). The EU is responding to this with pro-investment regulations (NZIA) and the mobilization of funds from the recovery and cohesion policies for the benefit of green energy. Poland, with its unique strengths – high demand for new capacity, domestic resources (e.g., uranium deposits in copper waste, geothermal potential), and a leading position in battery production – should take advantage of this favorable climate.

! It is essential to accelerate the construction of nuclear infrastructure while maintaining the highest EU standards. Local supply chains (reactor components, battery parts) must also be developed so that as much of the added value as possible remains in the country. With EU support, we can achieve a green transition, but success requires a shift from competing with cheap coal-fired electricity to competing with modern energy technology.

OPPORTUNITIES AND RISKS

Opportunities: Investments in SMRs and large-scale nuclear power will provide Poland with a stable source of clean energy for decades. This will improve energy security – making us independent of gas and coal imports, as well as weather fluctuations (as is the case with renewables). Lower wholesale prices of nuclear energy will boost industrial competitiveness – electricity is a significant production cost in many sectors, from chemicals to IT (data centers). Poland could become an energy exporter in the region if it builds sufficient generation capacity (e.g., neighboring Ukraine may face shortages after 2030, and Germany has phased out nuclear power – creating space for supply from neighbors). A supply chain involving domestic

companies can be built around nuclear programs – as per current estimates, as much as 40 – 60% of the value of nuclear investments could remain with the Polish industry (construction services, steel, components, engineering services). This translates into the creation of thousands of jobs – from the Gdańsk Shipyard (the potential construction of SMR modules) to design offices throughout the country. Energy storage, in turn, presents an opportunity for the development of a new industry: demand for storage (industrial, residential, and system batteries) will skyrocket alongside further rollout of renewable energy – Polish companies can design and manufacture battery systems not only for the domestic market but also for export (e.g., Impact Clean Power Technology already delivers storage systems and batteries for electric buses to global markets). Increasing storage capacity will also enable the full utilization of the potential of wind farms and PV, which means more investment in renewable energy, cheaper electricity during the day, and no blackouts at night.

Risks: The main risks are delays and costs. The history of nuclear projects in the West (e.g., Flamanville in France, Olkiluoto in Finland) shows that multi-year delays and budget overruns are common. If Polish nuclear investments encounter similar problems, this could destabilize the system (since we will close old coal-fired power plants, and new ones will not be ready on time) and become a burden for taxpayers. Regulatory risk: changes in government or public protests could hinder construction – local communities may fear nuclear power. There may also be political shifts within the EU – currently, nuclear power is considered "green" only conditionally, but anti-nuclear movements have not gone away (e.g., Germany could block support). SMR technological risk: most SMR projects have not yet been implemented – there is no certainty that they will be licensed on time or that their cost will actually be lower than that of large reactors. By opting for the BWRX-300 SMR, Poland is betting on a fairly advanced design (Canada has already issued a construction license), but one that is still new – problems cannot be ruled out. Risks in storage: the global race for raw materials (lithium, nickel, cobalt) required to produce batteries – Poland, although it manufactures batteries, is dependent on imports of raw materials from Asia. Supply bottlenecks could hinder the development of storage facilities and drive up prices. Furthermore, our grid is experiencing stability issues: if we do not develop storage, the mass connection of renewable energy sources could pose risks (instability, outages) – meaning that a lack of investment in storage is in itself a huge risk to the system. On a macro scale, the failure of the energy transition would mean high emissions continue, which will translate into CO_2 emission fees and getting stuck in the paradigm of the "old economy".

MARKET LEADERS

- **Orlen Synthos Green Energy** – a joint venture between the Płock-based giant PKN Orlen and Synthos, the leader in the project to build GE Hitachi's SMR BWRX-300 in Poland – plans to site its first reactor near the Anwil plant in Włocławek;
- **KGHM** – the copper conglomerate has signed an agreement with NuScale (USA) for the possible construction of VOYGR small modular reactors, seeing this as an opportunity to provide low-cost electricity for its mines and smelters;

- **PGE EJ1** – a special-purpose vehicle of PGE responsible for preparing the construction of a large nuclear power plant, currently cooperating with Westinghouse;
- **Energomontaż-Północ Gdynia** – specializes in large steel structures and aims to supply reactor modules;
- **Creoteam** – a consortium of Polish companies creating simulations and VR models for training reactor operators (training technologies);
- **Ubricí** – a startup developing AI-based diagnostic systems for transmission grids (important for the integration of storage facilities and renewable energy sources);
- **GTL** – an AGH spin-off, working on innovative materials for heat storage (e.g., molten salts);
- **Impact Clean Power** (Warsaw) – a manufacturer of lithium-ion batteries and containerized energy storage systems, exporting to 50 countries;
- **BMZ Poland** (Gliwice) – the Polish branch of a German company producing battery packs (including for residential and industrial storage);
- **National Centre for Nuclear Research** (Świerk) – a Polish research institute operating a research reactor, conducts materials research and simulations, and will be crucial for supporting the nuclear program;
- **Warsaw University of Technology and AGH University of Science and Technology** – have launched new degree programs to train personnel for the nuclear energy sector and electrochemistry (batteries).

The activities of all these entities indicate that a new energy ecosystem is emerging in Poland – if the government and the private sector work together to drive things forward, within a decade we could become an exporter of energy, and also of technology (e.g., SMR modules or complete storage systems) – which would represent a qualitative leap for our economy.

8. SPACE AND DUAL-USE TECHNOLOGIES (SATELLITES, GNSS SYSTEMS, ULTRA-LIGHTWEIGHT MATERIALS)

Why it matters. The space industry is no longer a niche sector and is growing into another pillar of the global economy and security. In 2023, the global space technology market was worth approximately $630 billion, and by 2035 it could reach as much as $1.8 trillion – a threefold increase over the course of a decade. This growth is driven by demand for space-based services: from broadband connectivity to navigation, satellite data, and exploration. What is

important, space technologies are tricking down to everyday life applications and other sectors of the economy – for example, without GPS satellites and chips embedded in our smartphones, services like Uber or Glovo, which connect drivers and passengers via satellite navigation signals, would not exist. Satellites also provide critical data for agriculture, logistics, and finance (e.g., Earth imagery for crop monitoring or weather statistics). Dual-use technologies – those serving both civilian and military purposes – are particularly significant for the space sector. Global satellite navigation provides a great example: the GPS system was created for use by the U.S. military, and today it is a common public good benefiting billions of people and businesses (similar to the European Galileo, which offers both a civilian signal and an encrypted military one). It is estimated that positioning and navigation (PNT) services generate a huge portion of the sector's value – from transportation applications to the synchronization of telecommunications networks – and have become an indispensable infrastructural part of the global economy. Earth observation from space (satellite imagery) also supports civilian objectives (precision agriculture, climate protection) as well as security (military reconnaissance, border monitoring). Investments in the space sector thus translate into technological advantages across multiple fields simultaneously, which has both economic implications (new service markets) and strategic ones. For example, war in Ukraine demonstrated the importance of communication and reconnaissance satellites: the Starlink system guaranteed connectivity of the Ukrainian army, while private satellites delivered strategic imagery of the battlefield. At the same time, dependence on third-party systems can be risky – the case of Starlink (controlled by Elon Musk) showed that decisions by a private company can influence the course of military operations, which has alarmed many countries. Hence the trend toward building sovereign space capabilities (e.g., the EU is creating its own IRIS^2 satellite constellation for secure communications). Space technologies are also source of innovations that find their way into civilian life: materials and inventions developed for astronauts are put to use here, on Earth. Examples include aerogel (an ultra-lightweight insulating material, 99% air, used by NASA – now used in construction and industry) and memory foam (a shape-retaining foam invented for seats in the Apollo program – now used to manufacture orthopedic mattresses and pillows). Every dollar spent in the space sector has a so-called multiplier effect on the economy – NASA estimates suggest a return of several dollars in the form of spin-offs and productivity gains. In summary, space investments translate not only into prestige but also into real economic and societal benefits, and their dual-use nature strengthens both the economy and the nation's defense capabilities.

Poland in the global context. The global space sector is dominated by the U.S. (SpaceX, NASA, military satellites) and, increasingly, China. However, Europe also holds a strong position (ESA, Airbus, Ariane). For years, Poland was primarily a recipient of satellite data and a subcontractor. Nonetheless, recent years have seen a rapid ascent up the value chain. In 2012, our country joined the European Space Agency (ESA), which served as an impetus for the creation of a number of startups and companies operating in the industry. Today, there are approximately 400 entities related to space technologies operating in Poland. We are beginning to implement major satellite projects: Poland is building its own constellations of observation satellites – a civilian one codenamed PIAST/Camila (at least four high-resolution optical and radar satellites, by 2027) and a military one (two reconnaissance satellites in cooperation with Airbus, by 2028). Thanks to this,

for the first time we will gain sovereign access to Earth imagery – today, the lack of our own satellites means we have to purchase data from others. In 2025, Poland contributed as much as 2 billion PLN (470 million euros) to the construction of six telecommunications satellites under the European IRIS^2 system, making us one of the largest sponsors of this initiative. The European Union recognizes the need to support dual-use projects. The European Investment Bank changed its policy on financing space projects with defense significance as late as 2024, with 300 million euro loan to Poland for our defense satellite system as an example of the shift. Taking advantage of this, Poland is building the Satellite Mission Control Center (open in 2025 at the Military University of Technology), which will manage the first national satellites. This truly is a milestone – in 2025, we launched the first Polish military satellite into orbit. We are a leader in the region: neither the Czech Republic nor Hungary has its own reconnaissance satellites. It should be noted, however, that as a country we are still playing catch-up in many areas – for example, we lack the capability to launch objects into space (rockets). Polish companies are, however, working on small suborbital rockets and ultimately plan to develop orbital ones. The examples include SpaceForest from Gdynia who is developing the Perun rocket, which reached an altitude of 22 km during tests and is ultimately intended to carry 50 kg of payload to an altitude of ~150 km, or Bursztyn, developed at Łukasiewicz-ILOT (which exceeded the 100 km barrier). We are still a long way from the first Polish satellite launch with the use of a Polish rocket. We rely on foreign services – for example, SatRevolution from Wrocław places its nanosatellites into orbit using SpaceX rockets. Nevertheless, the local sector is growing: Creotech Instruments secured an ESA contract (€52 million) to build part of the Camila observation satellite constellation, and previously, together with Scanway, developed the largest Polish observation satellite to date (the EagleEye project, a satellite equipped with a telescope for high-resolution imaging). Overall, Poland is now seen as an emerging player in space technologies: we are building expertise in satellites (observation satellites, and telecommunications satellites are also in the pipeline), we have rocket ambitions, and we are developing our own technologies (from electronics to optics). Our companies are successfully competing in niche markets (e.g., PIAP Space – satellite robotics, Astronika – space mechanisms, KP Labs – AI on board satellites). However, international competition is fierce, and Poland still spends many times less on the space sector (approx. 60 million euros annually) than European leaders such as France or Germany (several hundred million euros). It is therefore important to maintain the pace of investment growth and cooperate closely with the ESA/EU so that our sector does not lose the momentum.

EU Context. On the one hand, the European Union is tightening controls on dual-use technologies and imposing high requirements on the space sector. Regulations on the export of dual-use goods are in place, which restrict the freedom to sell advanced components (e.g., satellite electronics, special materials) outside the EU – companies must obtain licenses and meet security requirements, which can hinder expansion into global markets. Furthermore, the EU prioritizes environmental issues and safety in space: satellite operators are required to take measures to prevent the creation of space debris (e.g., mandatory deorbiting of satellites upon completing the mission), which increases the costs and complexity of space projects. At the same time, in the aerospace and materials industries, EU REACH regulations restrict the use of toxic substances in new ultra-light

composite materials, and certification standards (ESA, EASA) set the bar very high in terms of quality – startups must navigate lengthy procedures before their product is approved for use in, for example, a satellite or a military drone. On the other hand, the EU actively supports the development of space and defense technologies as pillars of its strategic autonomy. It runs its own space programs worth billions of euros: the Galileo navigation system (a competitor to GPS) and the Copernicus Earth observation program provide steady flow of contracts for the European industry (satellite construction and launch, receiver development, and data-based services). In 2022, the EU also approved the IRIS^2 communication satellite constellation project, which is set to provide secure communications for Europe by 2027. This decision translates to contracts worth ~€6 billion for companies developing small satellites, launch vehicles, and encrypted communication systems. Thanks to EU initiatives (e.g., the Cassini program with a €1 billion budget), venture funds and accelerators are emerging to support space startups working on innovative materials or components. In the defense sector, the EU has launched the European Defense Fund (EDF) with a budget of ~€8 billion. It co-finances consortia working on advanced technologies for the military – many of which are dual-use (e.g., reconnaissance nanosatellites, drones, new materials for vehicles). As much as 8% of the EDF budget has been allocated to high-risk breakthrough innovations, classic examples of which include cryptography, radars, and satellite positioning systems. This means that the EU will fund the development of, among other things, the next generation of GNSS systems – jamming-resistant and more precise – which is driving research into components and lightweight materials for satellites. Poland, which is just building its space sector, stands to benefit from this: domestic companies (e.g., Creotech, SatRev) are already participating in ESA missions and supplying components for the Galileo and Copernicus programs. Global competition is fierce, however. The U.S. is investing billions in SpaceX, lunar projects, and stealth technologies, while China is rapidly developing its own navigation constellations and supercomputers for cryptanalysis. To avoid falling behind, Europe is focusing on civil-military synergy – common standards and dual-use applications of new inventions are intended to create economies of scale.

For Poland, full integration into the European ecosystems - from using EU funds for our own satellites and materials testing centers to the participation of our specialists in pan-European programs (such as PESCO or ESA) - will be the most important. This is the only way to build the capabilities that will allow us to move beyond the role of a subcontractor and become a co-creator of innovation – competing not on price, but on quality and unique technology in the space and defense sectors.

OPPORTUNITIES AND RISKS

Opportunities: The space sector could become a driving force for Poland's high-tech industry. Sovereign access to satellite data will ensure security. Our own satellites will allow monitoring, for example, of the situation at the borders (which is crucial in the context of the migration crises or the conflict in Ukraine) and reduce dependence on the whims of suppliers. This will enhance the state's defense and decision-making capabilities. At the same time, satellite data can fuel business – e.g., agriculture (precision crop maps), insurance (damage monitoring), and spatial planning. By participating in ESA programs, Polish companies gain know-how that they later export – SatRevolution is already planning the REC constellation (~1,500 nanosatellites by 2026) and is selling its satellites to customers worldwide, while ICEYE (a Finnish-Polish company) is a global provider of SAR imagery and demonstrated the value of this data when, upon the outbreak of war in Ukraine, access to the constellation was sold to Ukraine (such transactions represent a whole new market). Poland could become a hub for space services in our part of Europe; if we are the first to build a satellite center, we can provide services to our neighbors (the Baltic states, Ukraine, the Balkans). Space technology spin-offs will benefit industry since the development of ultra-lightweight materials, high-efficiency solar cells, and radiation-resistant electronics will allow for their application in the automotive, energy, and consumer electronics sectors. The development of advanced satellites, however, requires integration of many different industries (IT, optics, precision mechanics), which acts as a "school of excellence" for engineers and subcontractors raising the overall technological level of the economy.

Risks: The main risk is underfunding and the dispersion of efforts. If, following the current surge of enthusiasm, the programs are not continued (e.g., subsequent satellites after 2030) – trained personnel may emigrate, and companies may move to other markets. Another threat is dependence on external suppliers: Poland does not have its own rocket, so it will always rely on others to launch a satellite (e.g., on SpaceX – but what if U.S. priorities change?). That is why it is important to support initiatives such as SpaceForest, even if only through government contracts for suborbital test flights – to lay the groundwork for the future launch sector. Another risk is the failure of a mission – space exploration is difficult, and failures do happen. A failed launch or the loss of a satellite could dampen the enthusiasm of policymakers and the public ("wasted money"). Finally, the space sector relies on international cooperation – there is a risk that geopolitical tensions (e.g., sanctions) could cut us off from certain technologies or markets. Poland should therefore diversify its partners (the EU, the U.S., and also, for example, Japan) and ensure that local companies do not fall under the influence of entities from high-risk countries. From a defense perspective, the lack of our own space systems leaves us blind and deaf in the event of a conflict, but on the other hand, possessing them makes us a potential target for attack (e.g., a cyberattack on satellites).

MARKET LEADERS

- **SatRevolution** (Wrocław) – specializes in nanosatellites for Earth observation; has already launched ~14 satellites into orbit (e.g., Światowid, STORK) and plans a REC megaconstellation; has secured clients in the US and the Middle East;

- **SATIM** – a Kraków-based deep tech company and AGH University of Science and Technology spin-off specializing in satellite monitoring using SAR radar imagery and artificial intelligence, enabling the automatic detection, classification, and tracking of objects on land and at sea for both civilian and defense applications;
- **KP Labs** (Gliwice) – developer of an AI-powered onboard computer (Smart Mission Ecosystem) – their system will be deployed on the Intuition-1 satellite for processing hyperspectral images in space;
- **ICEYE** – a company with Finnish roots but also a large office in Warsaw, develops SAR radar microsatellites, provides SAR data to government agencies, among others, and played a significant role due to Ukraine purchasing access to its constellation (dual-use in practice);
- **Astronika** – a Warsaw-based spin-off of CBK PAN, produces mechanisms for space missions ("Kret" for NASA's InSight mission to Mars, devices for ESA missions – Juicy, Luna-Resurs);
- **PIAP Space** – a space robotics company, designs grippers and arms for servicing satellites in orbit, participates in the ESA PROBA-3 program (satellite docking);
- **Blue Dot Solutions** (Gdańsk) – a startup developing applications that utilize satellite data (e.g., for maritime logistics);
- **SpaceForest** (Gdynia) – develops Perun suborbital rockets and radio technologies; plans its first commercial flights from the Ustka launch site in 2025/26;
- **SKA Polska** – works on satellite power systems (solar panels, electronics);
- **CloudFerro** – a provider of cloud computing and the CREODIAS platform for processing Earth observation data for the European Space Agency (supports the Copernicus program);
- **EYCORE** – a Polish deep-tech company in the space sector that designs and manufactures advanced Synthetic Aperture Radar (SAR) systems and Earth observation satellites, offering modular radar sensors ready for integration with various satellite platforms for use by government administration as well as private clients.

Polish companies collaborate with our neighbors in the CEE region,: for example, the Czech firm TRL Space and the Polish company KP Labs are working together on satellite computers, and the Romanian firm ATOS uses Polish components for its CubeSats. Poland also has unique facilities, such as the radio telescope in Piwnice (UMK) and the laser station for satellite tracking (Borowiec). All these elements – companies, institutes, infrastructure – are forming an increasingly comprehensive ecosystem. Poland could become the region's space hub and a significant player in selected niches (e.g., microsatellites, orbital robotics, satellite applications) within the next 5 – 10 years.

Synergy: Although each of the areas described in the report appears distinct, in reality they are closely intertwined and subject to mutual reinforcement. The development of one becomes a catalyst for progress in others, creating synergy that strengthens the entire innovation economy. For example, Poland's success in semiconductors will serve as the foundation for all other fields: advanced integrated circuits are at the heart of both medical devices and health monitoring sensors, as well as artificial intelligence systems – it is on Polish chips that AI models processing the Polish language or analyzing research results may one day operate. Domestic chip manufacturing capacity will also boost security of the energy infrastructure – for example, by means of supplying specialized power electronics for instrumentation and control of the grid and energy storage facilities, as well as I&C components for nuclear reactors (every power plant requires hundreds of instrumentation and control systems). Artificial intelligence, on the other hand, is a horizontal technology that permeates all other areas: machine learning algorithms accelerate work on new drugs and therapies (e.g., AI helps design drug molecules and analyze genomic data in predictive medicine), support process optimization in the semiconductor industry (AI detects defects on wafers and optimizes lithography parameters), and manage complex energy systems (an AI-powered smart grid can predict demand and control energy storage facilities). AI is also the brain behind modern satellites and space probes – they are increasingly equipped with systems capable of autonomous navigation or image analysis in orbit (Polish researchers at KP Labs are developing such solutions, combining space technology with AI). The space industry also has multiple connections with other sectors: it requires state-of-the-art semiconductor chips (satellites and rockets need special, radiation-resistant chips – their development in the country therefore supports our semiconductor industry), benefits from advancements in the materials science and chemistry (e.g., advanced batteries from energy storage systems are used in satellites, and lightweight composites developed for space can be applied in electric vehicles or medical implants). Moreover, satellite systems provide infrastructure for other sectors: telemedicine and wearable devices rely on satellite communications and precise positioning, power grids use GPS for synchronization, and even autonomous cars in the future will rely on data from space. Biotechnology and medicine are not isolated either – they make extensive use of AI (image analysis, searching for new molecules), require sensors and devices (which are becoming smaller and more efficient thanks to new chips), and their development depends on stable energy supplies (digital healthcare, hospitals full of equipment must have a reliable power supply – this is where nuclear energy comes into play). At the same time, advances in medicine support other sectors through building a healthy society: longer healthy lifespans mean more experienced specialists who can work longer on complex projects (e.g., in IT, in industrial R&D), as well as a larger market for technology (the silver economy will drive demand for robotics, smart homes, and transportation – which, in turn, will utilize AI, electronics, etc.). New energy provides the material foundation for the digital economy – without clean and affordable energy, the development of AI data centers or chip factories would be limited (these sectors are highly energy-intensive). A stable power supply from nuclear energy and energy storage thus creates favorable conditions for industrial investment across all high-tech sectors. On the other hand, digital technologies support the energy transition – for example, AI and IoT monitor the efficiency of reactors and wind farms, while advanced (semiconductor) sensors control the grid in real time.

4.
THE SECOND BREAKTHROUGH IN INNOVATION POLICY. STRATEGIC RECOMMENDATIONS

INSTYTUT SOBIESKIEGO

A multitude of interrelated factors impact the innovativeness of the economy. For this reason, among others, it is likely the most challenging area of public policy. There are many building blocks that make up the economy's innovativeness, but they vary in size. They all rest on a foundation (base) that is the enterprises' ability to change: to change their business model and adapt internal processes accordingly, to penetrate new markets, and finally to invest in new products and services, followed by their effective commercialization. One of the weaknesses of the Polish innovation policy to date has been its focus primarily on the macro level (conditions and incentives for innovative activity) without a thorough diagnosis and understanding of what is happening at the micro level: from the perspective of individual companies, and - in particular - their owners and managers.

The focus on regulations that was the heart of innovation policy to date – including tax policy – stemmed not only from the fact that such policy is easier to implement (making a sensible change to a law or regulation is relatively simple). It also resulted from a failure to recognize and appreciate the barriers companies actually face. The marathon of regulatory changes concerning innovation itself, carried out between 2016 and 2022 – including the introduction of strong tax incentives for R&D investments – inevitably had to yield limited results. Consequently, we did not break through the economy's innovation glass ceiling; we merely raised it higher.

In this case, the cognitive bias was further exacerbated by the trivialized form of the free-market ideology that is prevalent in Poland. The assumption that entrepreneurs are extremely rational - and only rational - led to the conclusion that all it would take was to remove the obstacles (oh, those dreadful regulations!) from the path of this group, so heavily burdened by the state, and perhaps throw in a little money too, and companies would rush to innovate, set up laboratories, and conduct research and development. Of course, this is not what happened.

Necessary intervention should be more compared to therapy than anything else, if we can allow for such a daring and iconoclastic statement. Since what is needed when thinking about innovation is a jolt or a shock, let's follow this logic for a moment. The metaphor is not nearly as inappropriate as it might seem at first glance, since it is, after all, the deeply ingrained patterns of behavior that are the subject of change. A typical Polish company is like a patient who, over several decades, has become accustomed to patterns that, at the current stage of development (not only of the company, but above all - of the markets), are hindering progress and can be, in extreme cases, destructive. Within the framework of this metaphor, regulatory changes - and in particular tax incentives - are like medications that accompany behavioral therapy: they create a protective shield, clear the way for necessary change, and alleviate or reduce fears – but they cannot replace actual work with a good therapist.

WHAT PATTERNS AND WHAT BARRIERS AT THE MICRO LEVEL SHOULD BE ADDRESSED?

- **The absolute primacy of cost control** over any other form of business rationality.
- **A near-100% focus on the product** or service (as opposed to sales, scaling the business, innovation, etc.).
- Years of underinvestment in salaries and the expectation that people will work for a bowl of rice.
- **Lack of investment in people's skills** (this is one of the sharpest differences between companies with Polish and foreign capital; Polish companies, if they provide training at all, restrict access to a small segment of staff and a narrow set of skills, mostly very specific ones and closely related to what we do, rather than what we should be doing).
- **Too strong an attachment to "cash cows"** (this is where the greatest curse of the middle-market trap manifests itself).
- **Lack of expertise and resources to invest in research and development**, particularly internal resources (including the erroneous belief that it is cheaper to buy from outside – this is one of the biggest misconceptions). It should be noted, however, that despite significant progress in recent years, we still have thousands of medium and large companies where R&D resources are null.
- **Lack of expertise and resources to generate** and protect IP.
- **Limited ability** (and in many cases, willingness, and even imagination) regarding international expansion.

All these barriers, competency gaps, or negative patterns of behavior can only be effectively addressed at the micro level, through direct engagement with a specific company and its staff. Unfortunately, we cannot count on the diffusion effect here, nor on the good examples being spread through the networks of connections among the companies themselves. Due to the low level of social capital and the systemic destruction of clusters by a disastrously implemented EU policy, Polish entrepreneurs cannot learn this from one another. There are too few good examples, and the network of relationships in which such learning could take place is simply too sparse. For this reason, the state must assume this role, finally breaking free from under the spell of yet another neoliberal mantra about the inherent incompetence of public administration and its agencies.

Without such a step – let's tentatively call it the second breakthrough in innovation policy – the bulk of the work done between 2016 and 2022 will remain either useless or used only to a negligible. The effectiveness of innovation policy is, after all, the product of regulatory policy and the state's institutional capacity. Even if the first value is very high, if the second is low, the result of the multiplication cannot be satisfactory.

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In practice, we need a policy that combines elements of the Asian innovation model (strong role of the state, clear concentration of support, and deliberate cultivation of national champions) with the European legal framework, particularly competition policy. This requires an approach that is both agile and "clever": EU law must be used as both a shield and a lever.

What would a "second innovation breakthrough" and adding an institutional pillar to the regulatory work actually mean?

REFORMING THE INNOVATION SYSTEM CONTROLS

Today, Poland is not losing the innovation race due to lack of ideas. It is losing the race due to lack of governance. Without clear state accountability, effective coordination, and a results-oriented culture, even the best instruments will disintegrate into small projects lacking scale.

CLEAR AND CONSISTENT POLITICAL ACCOUNTABILITY FOR THE INNOVATION SUPPORT ECOSYSTEM

Transfer all key innovation support agencies under the supervision of the Ministry of Economy/Deputy Prime Minister responsible for the government's economic policy: PFR, PARP, NCBR, PAIH, ABM + a new agency dedicated to innovation in the defense sector. The current, fragmented model leads to a blurring of responsibilities, contributes significantly to the fragmentation of tools, support channels, and specific programs, resulting in sometimes absurd overlaps in the competencies or instruments applied by specific institutions. Above all, however, the integration of the entire system under the supervision of the ministry responsible for the economy is intended to anchor the system's logic around the primary target group – business – and, consequently, around a business-oriented logic of support. Without this, we will not escape the biggest and oldest trap in terms of innovation policy: confusing it with science policy.

INTEGRATION AND COORDINATION OF SUPPORT INSTITUTIONS

We are much better at creating new institutions than fixing the old ones. It is essential to complete the plan to network the support ecosystem under the leadership of PFR, this time executing the task in a realistic timeframe and consistent manner (the sound plan from 2016 got stuck on the reefs of political party's and personal ineresets). PFR should not replace the Ministry of the economy in its supervisory role, especially when it comes to setting the objectives or evaluating the quality of work. The benefits of this coordination should be felt primarily by the system's end users: companies and their employees, who should have an integrated (one-stop shop) and standardized (service design) access to all support services, without having to navigate between the websites of various institutions. An entrepreneur should not have to wonder which institution to approach with any given question – institutions should, in a sense, be "hidden" behind a common, outward-facing service interface.

DEMARCATION LINES BETWEEN INSTITUTIONS

Establishing clear demarcation lines in terms of competencies of individual institutions:

- **Polish Development Fund** (in the section dedicated to innovative businesses) – overall coordination, managerial expertise within companies, one-on-one work with industry teams, a "permanent consulting" program for medium and large companies.

  Target: large companies.
  Main tools: 1:1 consulting, one-stop-shop, Foreign Expansion Fund.

- **PFR Ventures: VC market** (without any exceptions!!!), comprehensive support for capital funds from the pre-seed phase through Series B or further.

  Target: fund management teams (indirectly: startups and scale-ups).
  Main tool: fund of funds.

- **Polish Agency for Enterprise Development:** support tools other than hard R&D, including so-called "deep seeding" of startups, competency-building tools (excluding top management), including business education with a particular focus on end-user-centered methodologies (including at universities!).

  Target: all enterprises.
  Main tools: accelerator programs, training (including large-scale e-learning).

- **National Center for Research and Development:** research and development activities, including deep tech, non-repayable support for projects with high technological risk.

  Target: companies conducting R&D.
  Main tool: R&D grants.

- **Medical Research Agency** – a specialized agency funding R&D projects involving clinical trials.

  Target: biotechnology and pharmaceutical companies.
  Main tools: R&D grants for clinical trials.

- **ORION (Poland's DARPA),** a new defense innovation agency (launched with a large budget and a focus not on startups), operating on a challenge-driven model basis, with a strong role for program managers, lean administration, reactive oversight by support services in the background rather than formalization at the outset, and a very high tolerance for risk at the bottom of the funnel. An interesting proposal for a Polish defense innovation agency was recently presented by the Jagiellonian Club; we present our own, which is very similar in several aspects and also inspired by the best benchmarks of such institutions in other countries.

The new agency, ORION (Center for the Development of Innovation and New Technologies), should have an autonomous budget of PLN 2 – 3 billion annually, enabling the simultaneous pursuit of 30 – 50 high-risk projects. Such funding will make it possible to respond dynamically to the country's technological needs and invest in projects that would be considered too risky under the traditional public system.

ORION's activities should focus on strategic priority areas for Poland's development: artificial intelligence, cybersecurity, modern materials technologies and semiconductors, biotechnology, and energy. This selection will maximize the potential for breakthrough technological achievements in sectors of the greatest economic and strategic importance.

ORION's operational model should be flexible and focused on achieving results quickly. Projects should be funded through short-term grants and implemented by interdisciplinary teams bringing together experts from academia, industry, and startups. Rotation of management staff will ensure a constant influx of fresh ideas and best practices from the market, while open competitions and hackathons will enable the engagement of innovative teams from across the country. Project evaluation should be conducted according to Technology Readiness Levels (TRL) to objectively measure progress and the technology's readiness for commercialization.

Reporting and oversight of the agency should be direct: ORION should report to the Prime Minister, and all investment decisions must be transparent and executed swiftly. This approach will help avoid typical delays and excessive bureaucracy, while ensuring that public funds are allocated efficiently and in a manner that maximizes benefits for the development of the national innovation ecosystem.

ELEMENT	ORION PROPOSAL
Mission	Breakthrough technologies for security & industry
Team	40–50 contract project managers + 50 support staff
Core pillar	AI, cybersecurity, microelectronics, energy, biotechnology
Funding	At least PLN 1 billion annually for launch, for 30–40 projects
Partners	Universities, startups, companies, consortia
Team Work	Dynamic, project-based, rotating
Jury/Evaluation	International experts and rotating panel ex-ante/ex-post
Knowledge transfer	Commercialization programs and IP spreading

Poland's DARPA should be provided with funding amounting to (initially) 0.5% of defense budget expenditures, rising over the next 10 years to 3% (or even 5%) of that expenditure.

Target: defense or dual-use sector companies.
Main tool: R&D grants and "equity grants."

- **Łukasiewicz Research Network:** transfer of oversight and funding to the ministry responsible for the economy. Complete the reform of research institutes by consolidating the remaining ministry-affiliated institutes (e.g., consolidation of institutes under the supervision of the Minister of Agriculture). Significant funding for their operations and linking them to industry-specific support policies.

  Target: companies seeking R&D support.
  Main tool: Business + Łukasiewicz grants, B2B agreements.

CENTRAL BUSINESS SUPPORT INSTITUTIONS OUTSIDE THE INNOVATION SECTOR:

- **Polish Investment and Trade Agency** (in the section aimed at Polish companies): exports and international expansion.

  Target: companies expanding beyond the domestic market.
  Main tools: trade office, trade shows, B2B networking.

- **Bank Gospodarstwa Krajowego** (in its business-focused segment): repayable funds for business development for companies for whom offers by commercial banks' are insufficient.

  Target: companies seeking capital for growth.
  Main tools: loans and guarantees.

- **Agency for Industrial Development:** ARP's innovation support tools and programs should be transferred to PARP and other implementing agencies.

  Target: enterprises of strategic importance requiring state intervention, including restructuring.
  Main tools: management support and capital.

SCIENCE POLICY INSTITUTIONS:

- **FNP** – transfer of tools supporting the commercialization of research results to PARP.
- **NAWA** – its offer is already clearly addressed at researchers.
- **National Science Centre** – agency funding fundamental research (a significant increase in the NCN's budget is necessary so that the success rate from the applicants' perspective is at least 25%).

In the next step, mergers of some entities (à la Business Poland) may be considered, but only upon them acquiring qualitative competence in their core domain, i.e., over the course of many years.

FROM AN IMPLEMENTATION-BASED APPROACH TO A RESULTS-BASED APPROACH

A shift from the logic of implementation indicators to the logic of outcome indicators at the level of program design and institutional evaluation. That is: a given VC program should lead to the creation of at least X companies that will generate Y in market revenue. Applying this framework to the evaluation of the support institutions themselves, not just projects and companies.

SYSTEMIC ACCEPTANCE OF RISK

A systemic and formal acceptance of risk is necessary when talking about tools directly aimed at innovation (R&D grants, VC investments, especially in the early stages). Such an approach will give program managers the freedom and courage to invest in truly risky businesses and projects (and only such ventures are innovative) and will relieve them of the burden of having to prove in advance that they did everything right – a process that almost always results in excessive bureaucracy, excessive oversight, and a drastic reduction in the flexibility of the funding institution during project implementation phase (which remains one of the weakest points of the Polish innovation support system to this day). Systemic acceptance of risk should mean incorporating this risk into the formal program documents, all the way down to competition rules and agreements with the entrepreneur in question. In program documents, it is even possible to estimate, in percentage terms, what proportion of supported projects may end in failure (for true deep tech – at least 80%).

A similar rational approach should be applied to state-owned companies, which in sectors such as energy, finance, or defense must possess the strategic capacity to finance and implement innovations.

SUBJECTIVE EVALUATION CRITERIA

In startup financing, two parameters (evaluation criteria) generally matter most: the team and the market. A startup's chances of success are the product of both. The same applies to R&D projects or other support tools for more mature companies; above all, a company's potential and its battle-tested ability to commercialize are the critical parameters of potential success. The system's focus on evaluating the an idea or even a business model is completely ineffective; it fuels the logic of the project-centered hustle and distances projects from the core business of

companies behind them. As a result, millions of pages of artificial narratives are created, which made no sense even before the LLM era and now, all the more, amounts to nothing more than a "race for algorithms."

Shifting the paradigm of non-repayable support from project-based to entity-based means: basing the majority of the evaluation on entity-specific indicators (such as: revenue growth, revenue structure, R&D expenditures, revenue from the commercialization of this work, export revenue, and revenue from subsidiaries operating outside Poland, etc.).

COMMUNICATION OF INNOVATION

A shift in communication away from centering the startups toward supporting fast-growing small and medium-sized enterprises (SMEs) and, in particular, mid-cap companies. The goal of the Polish innovation policy should be to support the restructuring of the size pyramid of Polish companies and to focus on a massive program to cultivate champions: first regional, and ultimately global.

RECRUITMENT FOR SUPPORT INSTITUTIONS

The more difficult the tasks and the more complex the subject matter that given institution deals with the more important the quality of human capital becomes. Institutions working with business, and especially those supporting innovation, must be removed from the "game of influence and positions"; otherwise, for the next 20 years, we will be going around in circles. At the same time, they require radical funding, because saving millions on the salaries of working people is a recipe for burning through the billions that these people oversee and spend. For this reason, the following should be introduced around the aforementioned institutions: a) consensus-based mechanisms, e.g., by inviting forces beyond the ordinary government majority (the president, the parliamentary opposition) to participate in the selection of their boards, b) radical transparency (by making recruitment results public, publishing a full ranking of candidates along with the score that individual members of the recruitment committee or supervisory board assigned to them).

EDUCATION AND CULTURE IN PUBLIC OFFICES

Educational programs for civil servants form the foundation of efforts to build an innovative public administration capable of taking calculated risks and implementing change effectively. The Polish administration, struggling with formalism, routine, and rigid procedures, requires a systematic improvement of competencies in the areas of change management, inter-institutional cooperation, and the implementation of modern tools supporting innovation policies.

Public officials must learn to make decisions under conditions of uncertainty, respond quickly to crises, and manage high-risk projects flexibly. Education should shift the perception of the administration – from a passive regulator to an active participant shaping the conditions for development. Civil servants should be prepared to serve as "innovation facilitators." Training programs should promote cross-sectoral collaboration practices, such as pre-commercial procurement, co-creation of technology strategies, and the use of public data to support innovation. Digital competencies and data management are essential. The growing importance of artificial intelligence, big data, and automation systems necessitates the inclusion of a broad digital component in educational programs.

HORIZON EUROPE AND THE EIC AS A LEVER FOR PROFESSIONALIZING THE INNOVATION SYSTEM

In the EU context, the "second innovation breakthrough" should mean the state's ability to systematically put Polish companies and projects into the top tier of innovation funding, particularly under Horizon Europe and the European Innovation Council (EIC). These are funds awarded through an open, highly competitive selection process based on team quality, the credibility of the implementation path, and market potential. For Poland, this is also a measure of the maturity of the entire support system: if the number of successes remains low, it is most often not due to a lack of ideas, but to an insufficient ability to prepare projects and companies for rigorous evaluation standards and rapid commercialization. Therefore, Poland should make a conscious effort to align its national support system with the HE/EIC framework and treat these instruments as an external quality benchmark. Three actions are a priority. First, creation of a a single, permanent support center for companies (with substantive, rather than informational, expertise) that guides them through the process: from readiness assessment through development of application and presentation. Second, launching a national rapid co-financing mechanism for projects that received a high rating in the HE/EIC but did not receive funding due to budget constraints – so as not to lose the best projects in the "gray zone" of selection. Third, ensuring a pathway from funding to initial implementations in Poland (pilot projects, references, first orders), so that projects do not die at the documentation stage but translate into products, customers, and growth.

It is worth leveraging what already exists: Industry Contact Points can become the practical "backbone" of the support system for companies, provided their role is genuinely strengthened. Instead of building parallel structures, it makes sense to base the HE/EIC service model on the Industry Contact Points as specialized, sector-specific front-line teams, and to ensure consistent coordination and service standards nationwide. Strengthening the ICPs should encompass four elements. First, stable funding and staff reinforcement (including hiring individuals with market experience: fundraising, implementation, B2B sales, and working with investors), so that the support is expert-driven rather than merely informational or limited to connecting potential partners for consortia. Second, uniform work standards and tools: shared templates, quality checklists, a database of examples of successful applications, regular project "reviews," and presentation exercises. Third, measurability and accountability for results, i.e., linking goals to outcomes (number of high-quality applications, number of projects advancing to subsequent stages, value of funding secured), rather than the number of meetings or training sessions. Fourth, a stronger "closure" of the pathway following evaluation: ICPs should collaborate with national funding and contracting institutions (pilots, initial implementations) to ensure that the best projects do not lose momentum after submitting an application or receiving an evaluation.

Such a model would build a sustainable capacity to compete in the EU, strengthen the quality of the national intervention portfolio, and shorten the path from innovation to market.

Since the reforms and institutional changes described above require more time than regulatory reforms, and their effects will be delayed, they should be given absolute priority, placing them at the very top of the new government's innovation policy agenda.

REFORMS OF IMPLEMENTATION TOOLS

The second pillar of reforms concerns tools that increase the number of implementations and the scale of technologies on the market directly. This includes smart public procurement, tax incentives, support for pilot projects and prototypes, and solutions designed to attract talent and strengthen knowledge transfer.

SMART PUBLIC PROCUREMENT

Public procurement can be an effective tool for supporting innovation, provided it is done strategically and in a way that encourages experimentation. In Poland, there are two main models that allow for stimulation of the development of new technologies: Public Procurement Law (PPL) contracts with innovative aspects and pre-commercial procurement.

In contracts subject to the Public Procurement Law, it is possible to introduce innovative bid evaluation criteria or requirements regarding the innovative execution of the contract, but these are currently used extremely rarely. Recommended actions include:

- launching pilot projects in strategic sectors (e.g., energy, health, cybersecurity, transportation);
- introducing mechanisms to support the trial implementation of new technologies in the real-world public projects;
- regularly evaluating results and publishing best practices to build knowledge and experience for future innovative procurements.

Pre-Commercial Procurement (PCP) enables the funding of research and development services, prototypes, and pilot tests that are excluded from traditional public procurement. Actions that will enhance the effectiveness of this mechanism include:

- simplifying administrative procedures to make it easier for public institutions and businesses to use PCP;
- organizing training for officials and companies to increase awareness and competence in the implementation of pre-commercial projects;
- creating mechanisms to support the transfer of innovations from laboratories to market practice.

TAX SYSTEM AND FINANCIAL SUPPORT FOR INNOVATION

The effective use of taxes and financial instruments is essential for stimulating innovation in Poland. The current system requires not only simplification but also focus on supporting projects with high technological potential, from the conceptual phase to commercialization.

SUPER TAX CREDIT FOR AUTOMATION AND ARTIFICIAL INTELLIGENCE

The introduction of a 200% tax deduction for investments in automation, robotization, and AI implementation will significantly accelerate the pace of digitalization and industrial modernization. Additionally, the possibility of refunds for non-profit companies, modeled after British solutions (e.g., the R&D Tax Credit in the UK), enables support for young enterprises and startups that are not yet generating profits but are developing breakthrough technologies. In the UK, this program has contributed to an increase in the number of innovative SMEs benefiting from the R&D tax credit by over 20% over the past five years.

REFUNDABLE R&D CREDIT

Extending the R&D credit to all forms of employment, along with the option of cash payments for pre-revenue companies and SMEs, will increase access to funding for research and development activities. France applies similar solutions under the Crédit d'Impôt Recherche (CIR) program, where refunds for early-stage startups have helped accelerate the development of biotechnology and digital projects.

TAX RELIEF FOR PILOT PROJECTS AND PROTOTYPES

Deducting costs associated with pilot tests, initial prototypes, and technology demonstrators in Polish industrial facilities allows for the rapid implementation of innovations into practice. In Germany, a similar mechanism under the Zentrum für angewandte Forschung and pilot programs for the automotive industry and hydrogen technologies reduces the time to innovation implementation by an average of 18 – 24 months.

IP BOX+ FOR NEW INVENTIONS

A preferential CIT/PIT rate of 4% for the first 5 years of an invention's commercialization, with the possibility of combining it with other tax breaks, increases the attractiveness of investing in innovative projects. The Netherlands and Luxembourg have been using the IP Box system for years, which has contributed to an increase in the number of patents registered by companies in the ICT and biotechnology sectors and to an increase in investments in R&D. The evaluation of projects by independent technology experts ensures that support goes to ventures with real market potential.

TAX CREDITS FOR HIRING INNOVATIVE EMPLOYEES

Support for specialized staff includes PIT exemptions of up to 70% for key R&D employees and preferential social security contributions for new employees in the R&D field. Similar solutions in Estonia and Ireland (including the Research and Development Tax Credit and programs offering incentives for hiring technology experts) allow companies to build innovative teams more quickly and enable the state to attract specialists from abroad.

A tax and financial system structured this way not only reduces the costs of implementing innovations but also increases the predictability and stability of funding, which is of fundamental importance for high-risk and deep tech projects.

SUPPORT FOR TALENT, KNOWLEDGE TRANSFER, AND BRAIN CIRCULATION

The development of an innovative economy is not possible without high-caliber talent, efficient knowledge transfer mechanisms, and the return of scientists and specialists who have gained experience abroad. Supporting intellectual mobility, creating attractive conditions for young technologists, and integrating the scientific community with business circles are crucial for building a competitive knowledge-based economy.

Implementing a system of grants and scholarships for young technology professionals will not only support the development of their competencies but also create a talent pipeline for strategic sectors of the economy. At the same time, return grant programs for Polish scientists working abroad, modeled on solutions developed by Israel (e.g., the Israel Science Foundation), Germany (the Returning Scientists Program under the DFG), the Swedish Karolinska Institute, KTH, and A*STAR in Singapore, increase the chances of transferring knowledge

and experience gained in an international environment to Polish industry and academic laboratories.

Thanks to such mechanisms, Poland can build a cohesive talent ecosystem that supports both the development of young innovators and the transfer of knowledge from science to industry, thereby increasing the country's capacity to implement deep tech projects and strategic innovation programs.

"MASTER DEPARTMENTS" IN STRATEGIC FIELDS

The establishment of "master departments" in fields such as artificial intelligence, biotechnology, and cybersecurity facilitates direct collaboration between academia and industry. Models of this type operate in Singapore (e.g., National University of Singapore – AI & Data Science Centre), in Germany (Fraunhofer Institutes in biotechnology and materials science), and in Finland (Aalto University – Digital Health & AI). These departments enable the implementation of research and development projects in close cooperation with companies, while simultaneously creating conditions for the emergence of startups and technology spin-offs.

INTEGRATING MENTORS, INCUBATORS, AND RESEARCH INFRASTRUCTURE WITH BUSINESS NEEDS

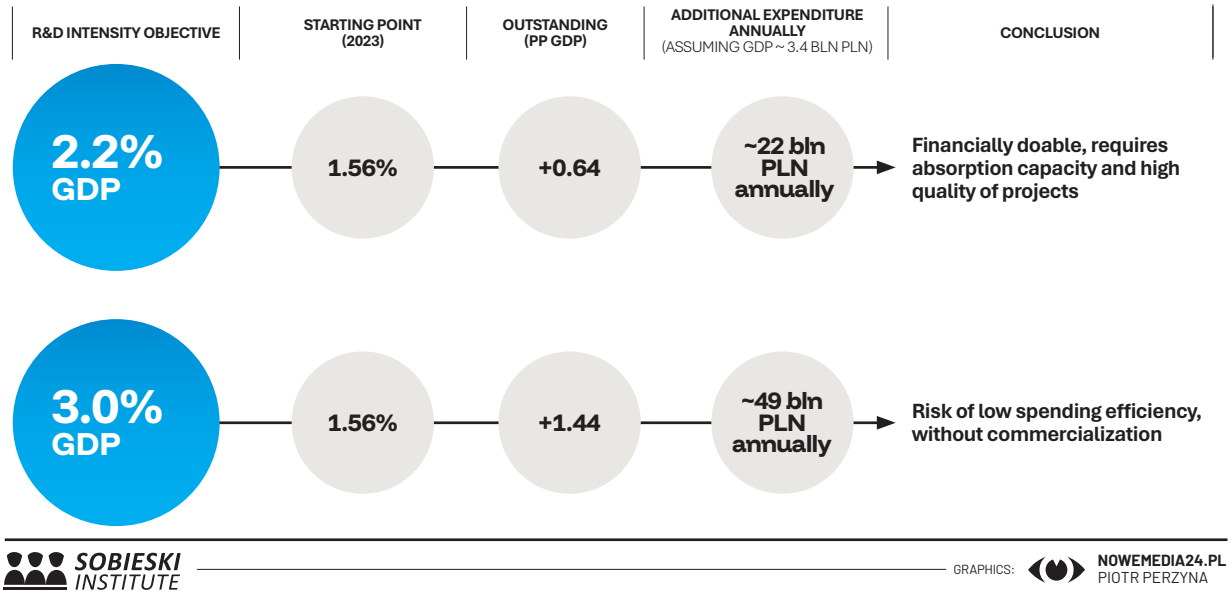
Effective talent support requires a cohesive network of mentors, accelerators, and incubators combined with access to research infrastructure and university laboratories. Examples from Finland (Aalto Ventures Program), Estonia (Tehnopol Science & Business Park), and South Korea (Digital Innovation Hubs and KI/Tech incubator programs) show that integrating these elements significantly increases the effectiveness of knowledge transfer and shortens the time from idea to commercial implementation. In practice, this allows young companies and startups to gain faster access to know-how, technology, and mentors, and facilitates the building of a national innovation ecosystem.

5.
INNOVATION AND IMPLEMENTATION PACKAGE VS. GDP GROWTH POTENTIAL 2026–2035

INSTYTUT SOBIESKIEGO

Scale of financial effort: “more R&D” only makes sense as part of an implementation package. To illustrate the scale of the challenge, it is worth calculating what reaching benchmark levels entails. With R&D expenditures of 1.56% of GDP in 2023 and a value of PLN 53.1 billion, GDP can be estimated at approximately PLN 3.4 trillion.

HOW FAR TO 2.2% AND 3% OF GDP FOR R&D (BASED ON 2023)



If we do not strengthen our capacity to implement and scale innovation, then:

1. Cost-cutting will remain a default, defensive strategy and perpetuate price competition, weakening the foundations of innovation (talent, margins for reinvestment, digitalization).

2. Increased R&D spending may remain merely an "input statistic" unless it translates into tangible results: new products and services, corporate productivity, patents, and exports in advanced sectors.

3. Both the IMF and the World Bank indicate that without productivity growth, demographic pressure and the exhaustion of convergence will dampen the growth trend.

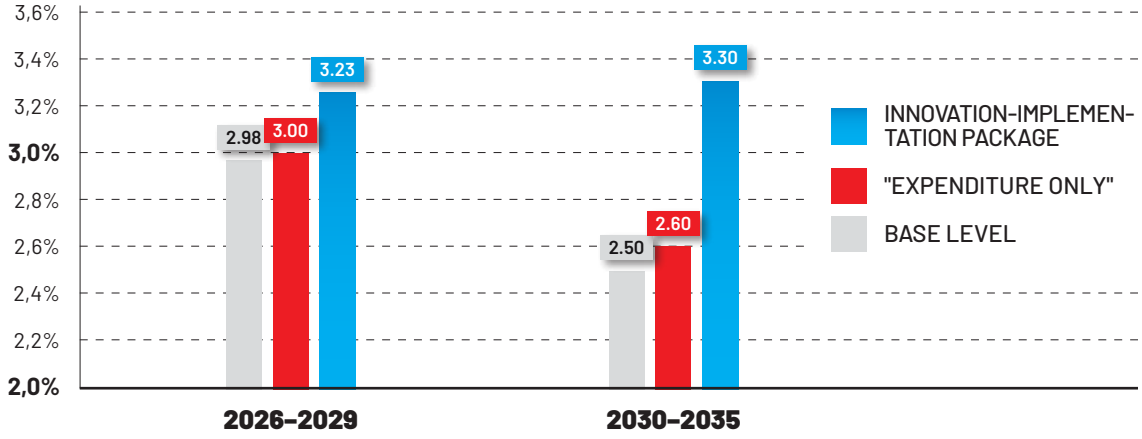
Practical implication: greater R&D funding should be directed to projects that already demonstrate the existence of a realistic path to implementation (industrial partner, expertise, intellectual property, readiness for production and expansion). The core of the strategy should be implementation and demand-side tools that create the market for innovation (including through public procurement), as the current scale of such instruments is marginal.

Growth Scenarios 2026 – 2035: Why "More R&D" and Cost Cutting Are Not Enough Without an Implementation Package

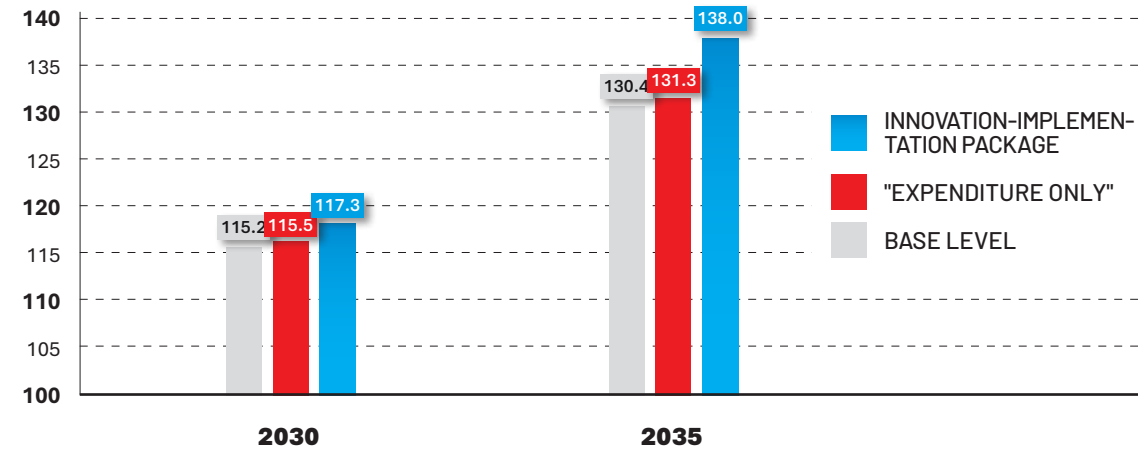
INDICATORS	2025	2026	2027
Growth (%)	3.2	3.5	2.8
Inflation (%)	3.4	2.9	3.7
Unemployment (%)	3.1	3.1	3.0
General government balance (% of GDP)	-6.8	-6.3	-6.1
Gross public debt (% of GDP)	59.5	64.9	69.2
Current account balance (% of GDP)	-0.1	-0.5	-0.8

MODELING RESULTS – SCENARIOS COMPARISON
(2026–2035; 2025=100)

AVERAGE INCREASE IN REAL GDP

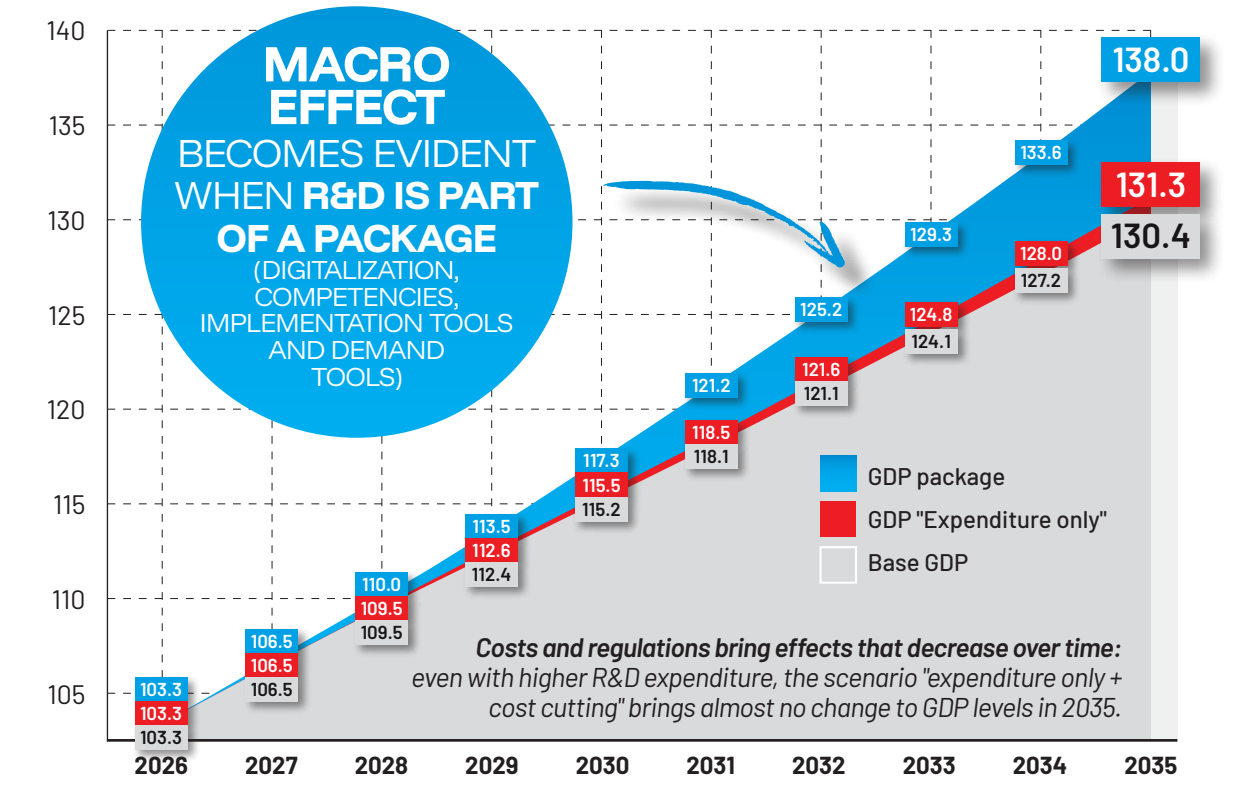


GROSS DOMESTIC PRODUCT (2025=100)



	"EXPENDITURE ONLY"	INNOVATION-IMPLEMENTATION PACKAGE
Difference in GDP level vs base in 2035	**+0.69%**	**+5.83%**
Cumulative additional GDP 2026-2035 vs base (in % GDP 2025)	**+3.8%**	**+30.1%**

ANNUAL PATH:
INCREASE IN REAL GDP AND GDP (2025=100)



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Reference point: short-term forecasts

Forecasts for 2025 – 2027 vary in magnitude but the direction is consistent: after a rebound, growth momentum will slow to around 2.7 – 2.8% in 2027.

- **European Commission** (Fall 2025): 2025 approx. 3.2%, 2026 approx. 3.5%, 2027 approx. 2.8%.
- **OECD** (Economic Outlook 2025/2): 2025 approx. 3.3%, 2026 approx. 3.4%, 2027 approx. 2.7% (IMF).
- **IMF:** (I) the projection table from the Article IV consultation indicates a downward path to 2.7% in 2029; (II) in a more recent statement following the mission of November 24, 2025, it was reiterated that growth will weaken in the medium term (approx. 2.5% through 2030) (IMF).

Scenario model: three paths for 2026 – 2035

We present a simple scenario model calibrated to the IMF's projections for 2026 – 2029, and then conservatively extended beyond 2030. The scenarios differ only in their assumptions regarding productivity and implementation capacity (IMF):

- Baseline: no breakthrough in innovation adoption; demographics and weakening convergence dampen the trend.
- "Input-only": higher R&D, but no significant improvement in implementation; additionally, cost pressures limit the propensity to invest in digitalization and skills.
- Innovation and implementation package: increased R&D combined with investments in ICT, skills, and implementation and demand-side tools; the result is more sustainable productivity growth, consistent with IMF projections for ICT and R&D.

Interpretation:

1. Costs and regulations yield diminishing returns: even with higher R&D spending, the "spending only + cost-cutting" scenario barely changes the GDP level in 2035 (approx. +0.7% relative to the baseline), since productivity and implementation capacity act as barriers.
2. Productivity and investment structure are decisive: a significant macroeconomic effect only emerges when R&D is part of a package encompassing digitalization (ICT), competencies, and implementation and demand-side tools, which translates into sustainable productivity growth. The direction of this relationship aligns with IMF findings on TFP growth determinants (IMF).
3. Conclusion for recommendations: "more R&D" should be conditional and tied to results (implementation, products, exports, productivity), because without improving the conversion of inputs into outputs, a cost-driven strategy will prevail.

6.
IMPLEMENTATION PRIORITIES: SCOPE OF ACTIVITIES, STAKEHOLDERS IN CHARGE, AND DEADLINES

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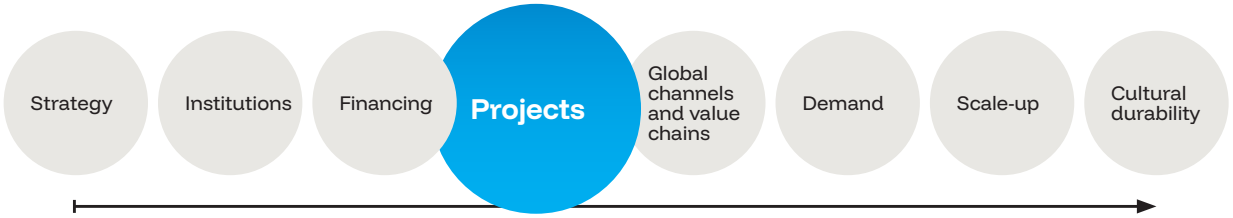
Implementation priorities: scope of activities, stakeholders in charge, and deadlines

The hierarchy of interventions is key to success: Point 0 determines the effectiveness of the entire package; Priorities 1 – 2 determine the country's ranking in the Global Innovation Index (GII) and the European Innovation Scoreboard (EIS); the remaining actions reinforce the results and ensure the sustainability of the ranking improvement.

Roadmap for implementing the recommendations – scope of actions, stakeholders in charge, and deadlines

The table below contains simplified recommendations organized according to their interrelationships and, consequently, the urgency of their implementation. In this sense, it serves as a roadmap for systemic changes, drawn up with consideration for the real potential and challenges of the Polish economy, and taking into account what has already been achieved in the field of innovation policy. The order of the items does not imply that subsequent phases should be implemented only after the previous ones have been completed; rather, the network of dependencies means that reversing the order or omitting any elements will drastically weaken the effectiveness of subsequent ones, and in extreme cases, essentially render them impossible.



Simplified recommendations organized in line with their intrarelations, i.e. the urgency of their implementation.

The table provides an overview of the area, the content of the recommendations (actions), measurable goals (output and outcome indicators), as well as the expected effect not only on the macroeconomy but also on innovation rankings – which are not an end in themselves but remain an important benchmark for building the economic image of modern nations.

ROAD MAP FOR
IMPLEMENTING THE RECOMMENDATIONS
SCOPE OF ACTIVITIES, STAKEHOLDERS IN CHARGE AND DEADLINES

The table provides an overview of the scope, content of the recommendations (actions), measurable objectives (output and outcome indicators), as well as the expected impact not only on the macroeconomy but also on innovation rankings—which are not an end in themselves but remain an important benchmark for shaping the economic image of modern countries.

PRIORITY	AREA	PRIORITY ACTIONS	MEASURABLE OBJECTIVES (4 YEARS)	RESULTS IN EIS AND GII
0.	Strategy and leadership	Single strategy encompassing education, R&D and commercialization; clear political leader; result indicators for ministries and institutions; independent monitoring	Public system of indicators; implementation team; move up in EIS 22 > 17/18, improvement in GII positioning from 38-41 to 30-35	Required in order to see improvements in both rankings
1.	Institutional synergy	Integration of NCBR and NFOŚiGW with the PFR Group; common strategy in line with the national strategy; common programs	PFR portfolio: +100% of companies and +200% in value; 10 common programs	Increase in spending effectiveness and interrelations within the system
2.	Reform and integration of support institutions	Integration and coordination of institutions; clear roles and responsibilities; accountability for results; risk acceptance; evaluation of companies; reinforcement of personnel	Shortening the path from application to agreement to 2-4 months; better project selection measured in commercialization; lowering the staff turnover	Increase in quality of institutions and effectiveness of execution
3.	Financing the innovations (development of capital programs)	Enlargement, consolidation and professionalization of development capital under programs coordinated by BGK/PFR and with participation of European instruments	At least 10 bln PLN in new commitments by institutional investors; 20 institutional investors (incl. 3-5 foreign investors); at least 10 bln PLN of private capital engaged, next to the public capital	The strongest growth leverage for GII results in terms of market financing
4.	R&D and commercialization (expenditure and market results)	Tying the grants to market results; continuity of financing; stronger role of the business community in project evaluation	Business expenditure on R&D 32.6 bln PLN (2024) -> 50 bln PLN; number of start-ups 3500 -> 8000; industrial Ph.D.s x2; EPO patents 700 -> 2200	Direct boost to EIS and GII results in the area of effects and ties

PRIORITY	AREA	PRIORITY ACTIONS	MEASURABLE OBJECTIVES (4 YEARS)	RESULTS IN EIS AND GII
5.	Public procurement and ecosystems	Pre-commercialization procurements and innovation partnerships; first procurements; pilot programs; participation of domestic suppliers in supply chains	Increase in public spending on R&D +50%; shortening decision timelines in MoD -75%; development of regional implementation ecosystems	Innovation demand and commercialization
6.	EU channel: Horizon Europe/EIC	Strenghtening Sectoral Contact Points as a stable, substantive support for enterprises under Horizon Europe and instruments of the European Council on Innovation in a uniform, national format; quick co-financing of projects that were highly evaluated without the funding; pathway to first implementations in Poland	At least doubling the amount of funding received by the Polish enterprises under Horizon Europe; at least doubling the number of projects by Polish companies in the most important instrument of the European Council on Innovation for companies; at least 200 companies supported "from diagnosis to submission" annually; at least 50 projects annually co-financed upon receiving good evaluation; at least 100 pilot programs within 4 years	Clear increase in quality and quantity of projects and quicker move to implementations
7.	"Top 10" program - business leaders	Individual development support; acquisitions and consolidation; expansion abroad; development of supply chains	Increase in value of business leaders by 300%; 50 ecosystems around business leaders	Increase in economic impact of the effects of scale
8.	Education and talents	Dual education; incubators and accelerators; technology transfer centers; support for academic enterprises	15% of schools in dual mode; +50% of STEM students; x5 more spin-off companies	Boosting competencies and the pool of human resources
9.	Legal reform: Business Judgement Rule	Code of good practice for BJR application (KSH 2022); compliance standards; uniformization of judicial practice	Wide-spread BJR application; higher proclivity to taking well calculated and calibrated risks by the management	Unblocking investment and innovation decisions
10.	Promoting innovation	Catalogue of successes; role models; social education to support enterpreneurship and innovation	Improvement in the results of polls on public attitude to innovation and enterpreneurship	Indirect impact on culture nurturing innovation

7.
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8.
ABOUT THE PUBLISHER

INSTYTUT SOBIESKIEGO

SOBIESKI INSTITUTE

The Sobieski Institute is a Polish private think tank whose mission is “Creating ideas for Poland.” It was registered in 2005 as a foundation, having began its activities in 2003. Between 2003 and 2010, the Institute published “Międzynarodowy Przegląd Polityczny”, a quarterly. From 2011 to 2015, it organized the annual “Poland – The Great Project” congress. In 2017, it organized the National Innovation League. Since 2017, the Institute has placed strong emphasis in its activities on publishing studies and recommendations aimed at demonstrating how the Polish economy should capitalize on the opportunities associated with the Fourth Industrial Revolution, innovation, and new technologies.

The Sobieski Institute also conducts educational activities through the "Academy of Young Experts" project, which supports young people in developing leadership skills and soft skills. Each edition of the program focuses on a different key issue, addressing the current needs of the younger generation. Currently, during its 6th edition, the project focuses on European Union, imparting knowledge and preparing participants to take part in European Personnel Selection Office (EPSO) competitions. The program opens the door for its participants to international careers in the EU institutions. It is a unique opportunity to gain practical skills and pursue professional development at the highest level.

One of the Sobieski Institute’s latest projects is the “Sobieski Channel,” which we invite you to subscribe to on YouTube. The channel was created to feature inspiring conversations on topics important for Poland. We meet with interesting personalities there to foster space for substantive debate in a joint effort.

Over the years, the Sobieski Institute has collaborated with many organizations. To date, these have included:

- non-governmental organizations: Polish Automation and Robotics Forum, Mutual Insurance Support Foundation, Republican Foundation, Jagiellonian Institute, New Confederation, Ambitious Poland, Youth for Poland, Students for the Republic, Konrad Adenauer Foundation, Central European Energy Partners, Sławomir Skrzypek Foundation, Wacław Felczak Foundation, Institute for Foreign Affairs and Trade (Külügyi és Külgazdasági Intézet), Institute for Politics and Society (Institut pro politiku a společnost), The F. A. Hayek Foundation Bratislava;

- commercial companies: Aiut, Assay Group, Rohde & Schwarz, WB Electronics, Asseco, Samsung, Lotos, Google, Procter & Gamble, PwC, Cisco, EY, Phoenix Systems, Uber, USP Zdrowie, Fortum, Orange, Energa, Zysk i Ska, Collegium Wratislaviense, 4CF;

- Government/supranational institutions: Ministry of Foreign Affairs, European Commission Representation in Poland, Ministry of Climate and Environment, Industry of the Future Platform Foundation, Agency for Development and Industry, Warsaw Stock Exchange, Bank Gospodarstwa Krajowego, Chancellery of the Prime Minister, Ministry of Digital Affairs, Law and Justice, Embassy of Hungary, Senate of the Republic of Poland, European Conservatives and Reformists Party, European Parliament Office in Poland.

A complete list of reports and publications, as well as information about the Institute’s activities, can be found at
www.sobieski.org.pl.

We also invite you to subscribe to the Sobieski Channel on youtube.com/kanalSobieski. Join us–it’s worth it!

INNOVATE OR RUN ADRIFT

POLISH GROWTH MAP 2026-2035

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