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ARTICLE

Quantum technology as a determinant of technological sovereignty and cybersecurity of the European Union

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Abstract

Over the past decades, a gradual technological marginalisation of Europe could be observed, as it became dependent on imports of advanced microchips from the United States and Taiwan. However, despite planned investments in the development and production of semiconductors in the EU Member States, Europe is still unlikely to be able to compete with the United States and China in this area. The solution to this problem may lie within quantum technology, the economic use of which is in the initial phase in all world centres. The performance of quantum computing surpasses algorithms used in silicon technology by several tens of orders of magnitude. This means that access to quantum technology will become a basic determinant of security in the coming years. The aim of this paper is to present the issue of quantum technology and its most important implicationsin the context of the technological sovereignty of the European Union.

Keywords

quantum technology, microchips, European Union, cybersecurity, technological sovereignty

Introduction

In the third decade of the 21st century, much public attention has focused on the development of artificial intelligence (AI) and its possible impact on economies, societies and nation states[1]. Over the past dozen or so years, the number of computations used to train leading AI systems has increased 350 million-fold[2], breaking through previous limitations and enabling the creation of models such as ChatGPT, DALL-E or DeepSeek. However, this new quantum technology[3], which will offer a level of computational complexity unattainable with previously used silicon processors, may completely change the paradigms of technological development[4].

This means that access to quantum technology will become one of the fundamental determinants of national security in the coming years. On the one hand, quantum computers will make existing cryptographic methods obsolete and will no longer ensure data confidentiality. On the other hand, they will contribute to a rapid increase in the productivity of economies by raising the quality of supply chains management, investment portfolios and design processes to an unprecedented level[5].

The aim of the article is to present the issue of quantum technology and its most important implications in the context of technological sovereignty of the European

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1 K. Rybiński, J. Królewski, *Algokracja. Jak i dlaczego sztuczna inteligencja zmienia wszystko?* (Eng. Algocracy. How and why artificial intelligence is changing everything?), Warszawa 2023, pp. 11–23.

2 L. Heim et al., *Computing Power and the Governance of AI*, Centre for the Governance of AI, 14 II 2024, https://www.governance.ai/analysis/computing-power-and-the-governance-of-ai [accessed: 30 III 2025].

3 For the purposes of this article, quantum technology is referred to as a new technology. This approach stems from recent technical advances. It was only in the second decade of the 21st century that it became possible to commercially apply quantum technology in computational algorithms, which are the main axis of further analyses. It should be remembered that quantum mechanics has been a topic discussed in theoretical physics since the end of the 19th century, and the potential use of quantum algorithms was first mentioned by Richard Feynman in 1982. However, prototypes of quantum computers were created at the turn of the first and second decades of the 21st century, and government as well as private investments enabling the dynamic development of quantum technologies began to be made only in the third decade of the 21st century. See: L. Chen, *A Brief History of Quantum Computing*, Medium. Quantumpedia, 2 IV 2023, https://quantumpedia.uk/a-brief-history-of-quantum-computing-e0bbd05893d0 [accessed: 30 III 2025].

4 C. Chou, J. Manyika, H. Neven, *The Race to Lead the Quantum Future. How the Next Computing Revolution Will Transform the Global Economy and Upend National Security*, "Foreign Affairs" 2025, vol. 104, no. 1, pp. 154–167.

5 Ibid.

Union. The article is divided into three parts. The first examines the geopolitical and economic conditions of the silicon microchip market. The second part compares the computing capabilities of silicon technology with quantum technology and describes the most important application possibilities and limitations of the latter technology. The third part presents the issue of the development of quantum technology in the context of technological sovereignty of the EU.

The publication uses literature review, statistical data analysis and deductive reasoning. Due to the nature of the issues analysed, the article also uses numerous internet sources.

Geopolitical and economic conditions of the silicon microchip market

Today, silicon microchips are used in almost every electronic device – from credit cards to household appliances to cars[6]. This means that importance of microchips to the global economy goes far beyond their share in global GDP (approx. 0.5%), as this technology drives goods and processes worth trillions of dollars. For example, although global GDP fell by 3.5% in 2020 in the face of pandemic, the demand for microchips increased by several percent, and their prices by as much as several dozen percent, due to the transfer of an increasing number of mechanisms to the digital world[7].

However, this situation is the result of changes that began several decades ago. The first microchips factories were established in the 1950s[8]. Over following decades, the global economy was strongly influenced by the US, which assumed the role of technological leader and shaped value chains[9] in international competition. As a result of economic factors (outsourcing of production processes and cost minimisation by American companies) and political factors (support by the US government for the authorities of the Republic of China, which, after the civil war and the takeover of power by the communists in mainland China, evacuated in 1949 to the island of Taiwan), Taiwan became one of the world's major microchips

[6] S. Dover, *The vital role of microchips on the global economy*, California 2023, pp. 1–2.

[7] This resulted in a global shortage of microchips. See: W. Mohammad, A. Elomri, L. Kerbache, *The Global Semiconductor Chip Shortage: Causes, Implications, and Potential Remedies*, "IFAC-PapersOnLine" 2022, vol. 55, no. 10, pp. 476–483. https://doi.org/10.1016/j.ifacol.2022.09.439.

[8] C. Miller, *Chip War. The Fight for the World's Most Critical Technology*, London 2022, pp. 19–28.

[9] During the Cold War the Soviet Union was seen as the main economic rival of the US, but in reality, Soviet scientists largely copied American solutions. See ibid., pp. 41–44.

manufacturing centres. Taiwan's importance in the semiconductor industry remained significant for decades. In 2019, the island's share in total microchip production was 20%, and in the case of the most advanced chips, it reached as much as 92% (Table 1). This began to change in the second decade of the 21st century with the geopolitical situation.

The COVID-19 pandemic, the war in Ukraine, the war in Palestine and Donald Trump's return to the White House have accelerated reshoring, nearshoring and friendshoring trends[10], as a result of which the global economy ceased to be as strongly globalised as it was at the turn of the 20th and 21st centuries. As a result, major global economic centres such as the US, the People's Republic of China, and the EU are seeking to make their value chains independent of geopolitical risks. This can be seen in the example of microchip market[11]. Between 2022 and 2024, the US announced that it would invest USD 450 billion[12] in microchips production, China plans to spend a total of almost USD 100 billion[13] and the EU, as part of so-called European Chips Act, announced investments of USD 43 billion by 2030[14].

The contribution of EU Member States total global microchips production is only 10%[15], while the European Commission estimates that demand for this product is close to 20%. Based on the investments planned by major international players, it is expected that this share will remain unchanged (Table 1), i.e. that Europe will not achieve independence in the microchip sector. Between 2019 and 2032, semiconductor production will move away from Taiwan, but mainly to the US (which plans to specialise in the latest generation of microchips, < 10 nm) and China (which will specialise in the middle and older generation of microchips, > 10 nm). The European Union will most likely take over only part of the production of specialised microchips for its own needs, e.g. in the medical sector or household appliances.

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[10] See: B. Thompson, *What is Friendshoring, Nearshoring, Reshoring and Offshoring*, IncoDocs, 26 III 2024, https://incodocs.com/blog/friendshoring-nearshoring-reshoring-offshoring/ [accessed: 30 III 2025].

[11] The article was completed in March 2025, and the data presented in it may have changed.

[12] Semiconductor Industry Association, *2024 State of the U.S. Semiconductor Industry*, https://www.semiconductors.org/wp-content/uploads/2024/10/SIA_2024_State-of-Industry-Report.pdf, p. 4, [accessed: 30 III 2025].

[13] *China sets up third fund with $47.5 bln to boost semiconductor sector*, Reuters, 27 V 2024, https://www.reuters.com/technology/china-sets-up-475-bln-state-fund-boost-semiconductor-industry-2024-05-27/ [accessed: 30 III 2025].

[14] *European Chips Act*, European Commission, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en [accessed: 30 III 2025].

[15] Ibid.

Table 1. The share of individual countries (groups of countries)* in global microchips production by type in 2019 and 2022, and a forecast of this share for 2032 based on investments in semiconductor production announced by individual countries.

Country/ group of countries	Year	Memory chips	Logic circuits < 10 nm	Logic circuits 10–22 nm	Logic circuits > 28 nm	Other (specialised)	Total
USA	2019	5%	0%	43%	8%	19%	13%
	2022	3%	0%	28%	8%	14%	10%
	2032	9%	28%	20%	10%	18%	14%
China	2019	14%	0%	3%	21%	17%	16%
	2022	18%	0%	6%	33%	25%	24%
	2032	13%	2%	19%	37%	27%	21%
Taiwan	2019	11%	92%	28%	40%	3%	20%
	2022	20%	69%	40%	30%	5%	18%
	2032	17%	47%	29%	25%	4%	17%
South Korea	2019	44%	8%	5%	8%	5%	19%
	2022	52%	31%	4%	5%	7%	17%
	2032	57%	9%	6%	5%	5%	19%
Japan	2019	20%	0%	0%	10%	27%	17%
	2022	7%	0%	0%	10%	25%	17%
	2032	4%	5%	6%	10%	21%	15%
UE	2019	0%	0%	12%	5%	22%	8%
	2022	0%	0%	13%	4%	17%	8%
	2032	0%	6%	14%	3%	19%	8%
Other	2019	6%	0%	9%	10%	7%	7%
	2022	0%	0%	8%	9%	9%	7%
	2032	0%	3%	6%	9%	7%	5%

Source: own elaboration based on: A. Varas et al., *Strengthening the Global Semiconductor Supply Chain in an Uncertain Era*, https://web-assets.bcg.com/9d/64/367c63094411b6e9e1407bec0dcc/bcgxsia-strengthening-the-global-semiconductor-value-chain-april-2021.pdf, p. 35 [accessed: 30 III 2025]; R. Varadarajan et al., *Emerging Resilience in the Semiconductor Supply Chain*, https://web-assets.bcg.com/25/6e/7a123efd40199020ed1b4114be84/emerging-resilience-in-the-semiconductor-supply-chain-r.pdf, p. 14 [accessed: 30 III 2025].

The United States began to exploit the EU's weakness in this area by restricting exports of microchips in January 2025. The decision to introduce restrictions was officially justified by the desire to curb China's ambitions for technological hegemony[16]. The plan the White House announced provided for unlimited exports of semiconductors only to selected countries, imposed limits of 50 000 GPUs per year on most countries, and imposed a total export ban on countries hostile to the US. The division of the EU by a "technological iron curtain" caused astonishment in Europe. Some EU countries (including Poland) have been excluded from the circle of American allies[17]. All of this has contributed to discussions about the need for the EU to become technologically independent from the US, which, after several decades of close alliance, is trying to pursue policies that are increasingly less aligned with the needs of its European partners[18].

The situation of the EU is complicated by the fact that, unlike the United States and China, it does not have deposits of rare earth metals on its territory, which are necessary for the production of semiconductors. One solution would be to cooperate with Ukraine, which has deposits estimated to be worth between two and even several trillion of dollars[19]. However, the protracted war and Russian occupation of the eastern part of the country, where most of the deposits are located, limit the possibilities for their exploitation[20]. This means that the EU's chances of achieving technological sovereignty in the field of microchips are slim.

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16 *US announces new restrictions on AI chip exports*, The Economic Times, 14 I 2025, https://economictimes.indiatimes.com/tech/artificial-intelligence/us-announces-new-restrictions-on-ai-chip-exports/articleshow/117219486.cms?from=mdr [accessed: 30 III 2025].

17 *Framework for Artificial Intelligence Diffusion* caused strong opposition from many countries, including Poland. In May 2025 (i.e. after this article was written), the US withdrew from these regulations.

18 I. Murphy, M. Hązła, *Chipping Away a Long-Standing Alliance: The Impact of Tech Restriction Communications on US-Polish Relations*, "Small Wars Journal", 27 III 2025, https://smallwarsjournal.com/2025/03/27/chipping-away-a-long-standing-alliance-the-impact-of-tech-restriction-communications-on-us-polish-relations/ [accessed: 30 III 2025].

19 R. Muggah, V. Dryganov, *Russia's Resource Grab in Ukraine*, Foreign Policy, 28 IV 2022, https://foreignpolicy.com/2022/04/28/ukraine-war-russia-resources-energy-oil-gas-commodities-agriculture/ [accessed: 30 III 2025]; G. McKenna, *Trump wants half of Ukraine's estimated $11.5 trillion in rare earth minerals. Is a deal even possible?*, Fortune, 19 II 2025, https://fortune.com/2025/02/19/trump-ukraine-rare-earth-minerals/ [accessed: 1 X 2025]; B. Aris, *Ukraine doesn't have any rare earth metals, and the strategic minerals it does have are not worth trillions of dollars*, bne IntelliNews, 23 II 2025, https://www.intellinews.com/ukraine-doesn-t-have-any-rare-earth-metals-and-the-strategic-minerals-it-does-have-are-not-worth-trillions-of-dollars-368472/ [accessed: 1 X 2025].

20 M. Hązła, *Zasobowy wymiar wojny w Ukrainie oraz perspektywy rozwojowe po jej zakończeniu* (Eng. The resource dimension of the war in Ukraine and development prospects after its end), in: *Perspektywy i wyzwania Europy*, J. Higgins, A. Moskal, M. Tomala (eds.), Poznań 2024, pp. 82–96.

Comparison of quantum technology capabilities with silicon technology

The situation on the microchips global market is not optimistic for Europe. The light at the end of the tunnel for its technological sovereignty may be the quantum technology. Although the first ideas about quantum computing appeared as early as the 1980s, it was not until the second decade of the 21st century that technological advances made it possible to implement these concepts[21].

In microchips based on silicon technology, the increase in computing power depends primarily on the number of transistors that operate on values of 0 and 1, representing bits[22]. Meanwhile, qubits, the quantum equivalent of bits, can assume any state between 0 and 1[23] and even several states simultaneously within the so-called superposition. These features increase computing power by several dozens orders of magnitude and enable multiple calculations to be solved simultaneously, which outclasses silicon technology[24]. For instance, solving the problem using a quantum computer is possible within a single day, while using a silicon supercomputer would take longer than the time that has passed since the Big Bang (Figure 1).

Quantum computers can be used in many areas requiring complex calculations[25], including drug development, the creation of new synthetic materials, supply chains and investment portfolio management, machine learning and cryptography[26]. The projected value of the quantum technology market for 2040 is over USD 100 billion[27]. This amount may be significantly higher, as current forecasts focus on public investment and do not take the private sector into account.

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21 C. Chou, J. Manyika, H. Neven, *The Race to Lead the Quantum Future…*

22 Reducing the size of transistors and the distance between them allow for the miniaturisation of microchips. The 2 nm chip generation means that there is only a 2 nm gap between individual transistors.

23 M. Pisarski, *Jak komputery kwantowe mogą zmienić naszą rzeczywistość?* (Eng. How can quantum computers change our reality?), Ernst&Young, 10 II 2023, https://www.ey.com/pl_pl/insights/digital-first/jak-komputery-kwantowe-moga-zmienicnasza-rzeczywistosc [accessed: 25 IX 2025].

24 J. Amundson, E. Sexton-Kennedy, *Quantum Computing*, "The European Physical Journal Web of Conferences" 2019, no. 214, p. 2. https://doi.org/10.1051/epjconf/201921409010.

25 M. Brooks, *Quantum computers: what are they good for?*, "Nature" 2023, no. 617, pp. S1–S3. https://doi.org/10.1038/d41586-023-01692-9.

26 M. Pisarski, *Jak komputery kwantowe…*; M. Brooks, *Towards quantum machine learning*, Nature, 24 V 2023, https://www.nature.com/articles/d41586-023-01718-2 [accessed: 30 III 2025].

27 *Quantum Technology Monitor*, https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/quantum%20technology%20sees%20record%20investments%20progress%20on%20talent%20gap/quantum-technology-monitor-april-2023.pdf, p. 4 [accessed: 30 III 2025].

In addition, taking into account the increase in productivity in the industries that will be able to use quantum technology, its overall impact on the economy will far exceed its share of GDP, as is the case with microchip market.

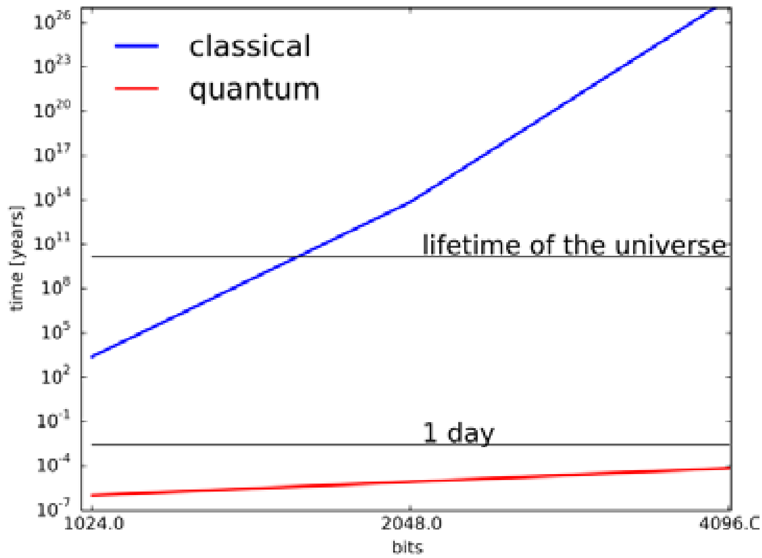

Figure 1. The time in years needed to factor a number of size 2^{bits} using silicon computer and quantum computer.

Source: own elaboration based on: J. Amundson, E. Sexton-Kennedy, *Quantum Computing*, "The European Physical Journal Web of Conferences" 2019, no. 214, p. 3, https://doi.org/10.1051/epjconf/201921409010.

Cybersecurity is an area of particular interest to policymakers around the world. The popularisation of quantum computers is linked to the arrival of the so-called Q-Day, in which quantum computers will be able to break any classical encryption[28]. The implications of this event will be significant. This will mean that countries without access to quantum technology will become vulnerable to attacks by hackers and hostile governments' special services, as all security systems could be breached in a matter of hours. At the same time, this will necessitate significant investments – both governmental and private – in new, quantum security systems

28 *Quantum communication growth drivers: Cybersecurity and quantum computing*, McKinsey & Company, 21 II 2025, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/quantum-communication-growth-drivers-cybersecurity-and-quantum-computing [accessed: 30 III 2025].

across all industries that operate with encrypted information, such as banking and telecommunications.

It is worth noting that quantum computers will most likely not be able to completely replace silicon computers due to their physical limitations. Firstly, storing qubits on storage media causes errors in the quantum information contained therein, which limits the possibilities of data replication. Secondly, as the amount of qubits added to the system increases, so does the risk of decoherence, i.e. a decrease in the coherence of the system, which necessitates continuous monitoring. Thirdly, for the quantum computers to function properly, extremely low temperatures must be maintained, and this limits their potential for industrial use. Another barrier is the availability of experts, as quantum algorithms knowledge is not yet included in the educational curricula of most universities[29].

Quantum technology development as a determinant of technological sovereignty of the EU

The fact that quantum technology is currently in its early stages of development presents an opportunity for the EU, which is entering this quantum race on an equal footing with the US and China. To date, the global investment in quantum technologies (Figure 2) has amounted to approx. USD 42 billion[30], including 15.3 billion from China (36.3%), 3.8 billion – the US (9.0%), 12.7 billion – the EU countries and the United Kingdom[31] combined (30.2%). This means that the EU has the potential to become, unlike the microchip sector described earlier, one of the main players in the emerging quantum technology market[32].

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29 N.B.S. Vijay Kumar et al., *An Investigation on "Unlocking the Potential: Advances and Challenges in Quantum Computing"*, "International Journal for Modern Trends in Science and Technology" 2023, vol. 9, no. 11, pp. 63–70. https://doi.org/10.46501/IJMTST0911013.

30 These are figures from 2023. In press releases from March 2025 concerning announced investments in quantum technology around the world already mention the figure of USD 44 billion. See: *Quantum Initiatives Worldwide 2025*, Qureca, 25 III 2025, https://www.qureca.com/quantum-initiatives-worldwide/ [accessed: 30 III 2025].

31 Despite Brexit in 2020, the United Kingdom remains an important player in the European balance of power. Its pro-Ukrainian stance in the context of the war with Russia and numerous signals regarding the need to re-strengthen economic relations with the EU suggest that the British will be important partners in rebuilding the European security architecture. See: *Collection. Strengthening ties with Europe*, Gov.uk, 4 III 2025, https://www.gov.uk/government/collections/the-uks-reset-with-europe [accessed: 30 III 2025].

32 As with the production of microchips, the construction of quantum computers requires access to raw materials such as rare earth metals, lithium, cobalt, nickel and aluminium, albeit in smaller

Member States of the EU seem to be aware of this. Already in 2023, the European Commission drafted the European Declaration on Quantum Technologies (Quantum Pact) expressing the intention to develop the first quantum computers in 2025 and achieve global leadership by 2030. This will enable Europe to become a global Quantum Valley[33]. Initially, this initiative attracted interest from Germany, France, Denmark, the Netherlands and Ireland, whose governments were the quickest to adopt national quantum technology development strategies[34]. By March 2025, 26 European countries had signed the Quantum Pact, including Poland.

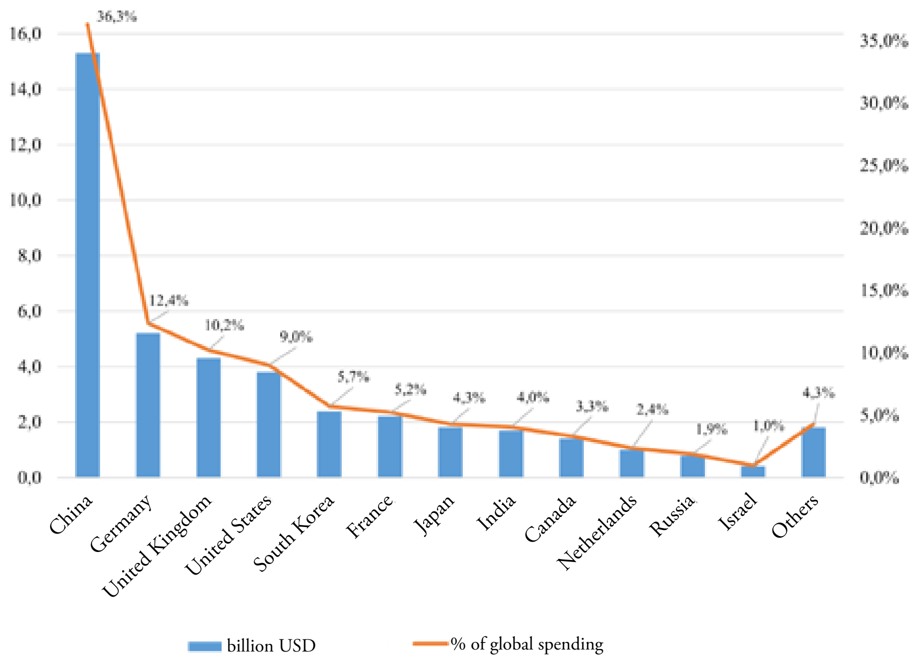

Figure 2. Investments in quantum technologies in billions of dollars and the share of individual countries in global investments in this market, data from 2023.

Source: own elaboration based on: *Steady progress in approaching the quantum advantage*, McKinsey&Company, 24 IV 2024, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/steady-progress-in-approaching-the-quantum-advantage#/ [accessed: 30 III 2025].

quantities. See: *Google's ground-breaking quantum chip needs critical minerals*, The Oregon Group, 10 XII 2024, https://theoregongroup.com/energy-transition/technology/googles-ground-breaking-quantum-chip-needs-critical-minerals/ [accessed: 30 III 2025].

33 *European Declaration on Quantum Technologies*, European Commission, 6 XII 2023, https://digital-strategy.ec.europa.eu/en/library/european-declaration-quantum-technologies [accessed: 30 III 2025].

34 H.Q. van Ufford, *From niche innovations to global powerhouse: An EU quantum strategy*, European Council on Foreign Relations, 20 XII 2024, https://ecfr.eu/article/from-niche-innovations-to-global-powerhouse-an-eu-quantum-strategy/ [accessed: 30 III 2025].

It is worth mentioning one more issue related to the level of technology development of individual countries. It concerns the phenomenon of the latecomer advantage in economics. It consists in the fact that some economies are able to use their lower level of development as an asset – because they are not geared towards certain solutions, they find it easier to move on to the next phase[35]. China is taking advantage of this pattern, deliberately skipping certain stages of technology development. For instance, instead of investing in combustion engine cars, China became the global leader in the electric car market[36].

The countries of Central and Eastern Europe, which until 1991 were behind the political Iron Curtain, are in a similar situation. Due to their lower level of technology development after the collapse of the USRR, they were able to 'leapfrog' some industries and become the European digital technology leaders. This is reflected in the above-average share of their Information and Communications Technology (ICT) services in total exports of services from the EU and the Three Seas Initiative[37] (Figure 3). This is evidenced by the inclusion of both Poland and the Czech Republic (along with Germany, France, Spain and Italy) in the list of countries where the quantum computers will be located[38]. The equipment acquired as part of the European initiative is expected to arrive in Poznań in 2025[39]. Regardless of this, a consortium of the Warsaw University of Technology, the Military University of Technology and the Military Institute of Armament Technology is working on a Polish prototype of such a computer, adapted to the needs of the military and special services[40].

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35 M. Hązła, E. Mińska-Struzik, *How to assess economic progress in the era of discontinuity?*, "Global Policy" 2023, vol. 14, no. 2, pp. 331–348. https://doi.org/10.1111/1758-5899.13180.

36 D. Jolly, *The New Threat. China's Rapid Technological Transformation*, London 2022, p. 124.

37 This is an indicator to measure the degree of digitisation of society used by the United Nations. See: *Digitally deliverable services boom risks leaving least developed countries behind*, United Nations Conference on Trade and Development, 28 IX 2023, https://unctad.org/news/digitally-deliverable-services-boom-risks-leaving-least-developed-countries-behind [accessed: 30 III 2025].

38 K. Kurowski, *Pierwsze komputery kwantowe w Polsce i Europie* (Eng. The first quantum computers in Poland and Europe), Poznańskie Centrum Superkomputerowo-Sieciowe, 15 VII 2024, https://www.pcss.pl/pierwsze-komputery-kwantowe-w-polsce-i-europie/ [accessed: 30 III 2025].

39 M. Woźniak, *W Poznaniu powstanie pierwszy komputer kwantowy w Polsce! Minister cyfryzacji: „Dla kraju to epokowe wydarzenie"* (Eng. The first quantum computer in Poland will be built in Poznań! The Minister of Digital Affairs: "This is an landmark event for the country"), Głos Wielkopolski, 30 X 2024, https://gloswielkopolski.pl/w-poznaniu-powstanie-pierwszy-komputer-kwantowy-w-polsce-minister-cyfryzacji-dla-kraju-to-epokowe-wydarzenie/ar/c3p2-26938497 [accessed: 30 III 2025].

40 K. Nowak, *Polska buduje komputer kwantowy dla wojska. Prace są już zaawansowane* (Eng. Poland builds a quantum computer for military. The work is progressing well), Forsal, 22 I 2025,

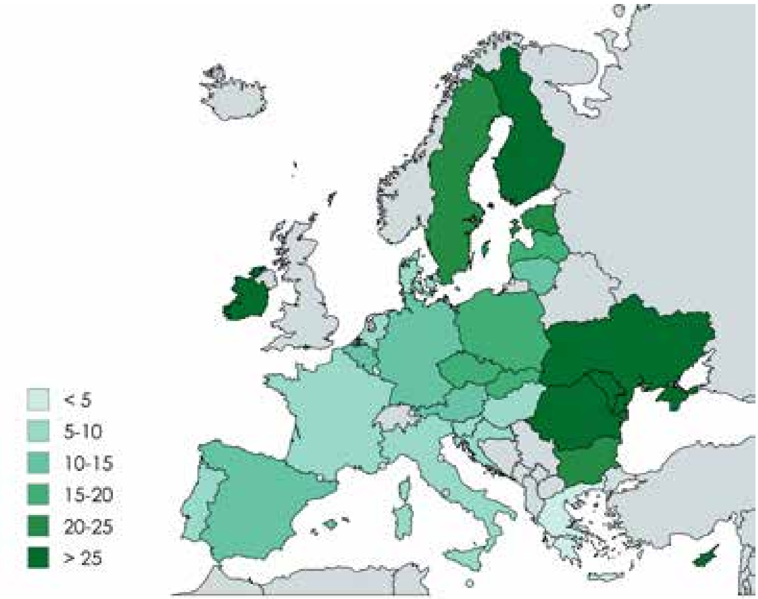

Figure 3. Percentage share of ICT services in total service exports of the EU countries and the Three Seas Initiative, data from 2023.

Source: own elaboration based on: World Development Indicators, World Bank Group, https://databank.worldbank.org/source/world-development-indicators [accessed: 29 III 2025].

In view of the growing availability of quantum computers, attention should also be paid to the possibility of training a sufficient number of employees to operate them. In Poland, only Adam Mickiewicz University in Poznań offers engineering studies in quantum computing, which were launched for the first time in the 2025/2026 academic year[41]. One may postulate that similar courses should be opened at the University of Warsaw and the Jagiellonian University in Kraków, which would contribute not only to the geographical diversification of staff training, but also to their increase in numbers.

https://forsal.pl/kraj/bezpieczenstwo/artykuly/9717653,polska-buduje-komputer-kwantowy-dla-wojska-prace-sa-juz-zaawansowane.html [accessed: 30 III 2025].

[41] Quantum informatics – information about the programme, Adam Mickiewicz University in Poznań, https://rekrutacja.amu.edu.pl/kierunki-studiow/informatyka-kwantowa,573 [accessed: 19 V 2025].

Conclusions

Unlike the silicon microchip market, where Europe is dependent on imports from the US and Taiwan, the emerging quantum technology sector represents tabula rasa. This gives the EU Member States the opportunity to join the ranks of technology leaders, which can have a significant impact on cybersecurity and many sectors of the economy.

The development of quantum technology is at an early stage, so Europe can still plan its research and development strategies. Due to many possible applications of quantum computers, there are opinions about the need to develop several quantum clusters simultaneously, each of which would be tasked with cooperating with the local scientific, business and financial ecosystem and would take into account regional conditions[42]. One example is the French-German-Dutch cluster, which could specialise in commercial solutions[43].

It seems that, given the ongoing research and development work for the military, its geographical location and the tense geopolitical situation, Poland and the Czech Republic could lead a Central and Eastern European cluster specialising in cybersecurity. In the future, the Baltic states, Bulgaria, Romania and eventually Ukraine and Moldova could join this group, given their experience in combating Russian cyber attacks[44]. This would fit in with the priorities of the Polish Presidency of the EU Council in the first half of 2025, which focused on issues related to security[45]. At the same time, this would be consistent with Poland's emerging vision as a regional leader in security in recent years[46]. Polish policy makers and diplomats should therefore make efforts in this direction, as such a development would be beneficial to Poland and the entire European Union.

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