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Time to place our bets: Europe's AI opportunity

Boosting Europe's competitiveness across the AI value chain.

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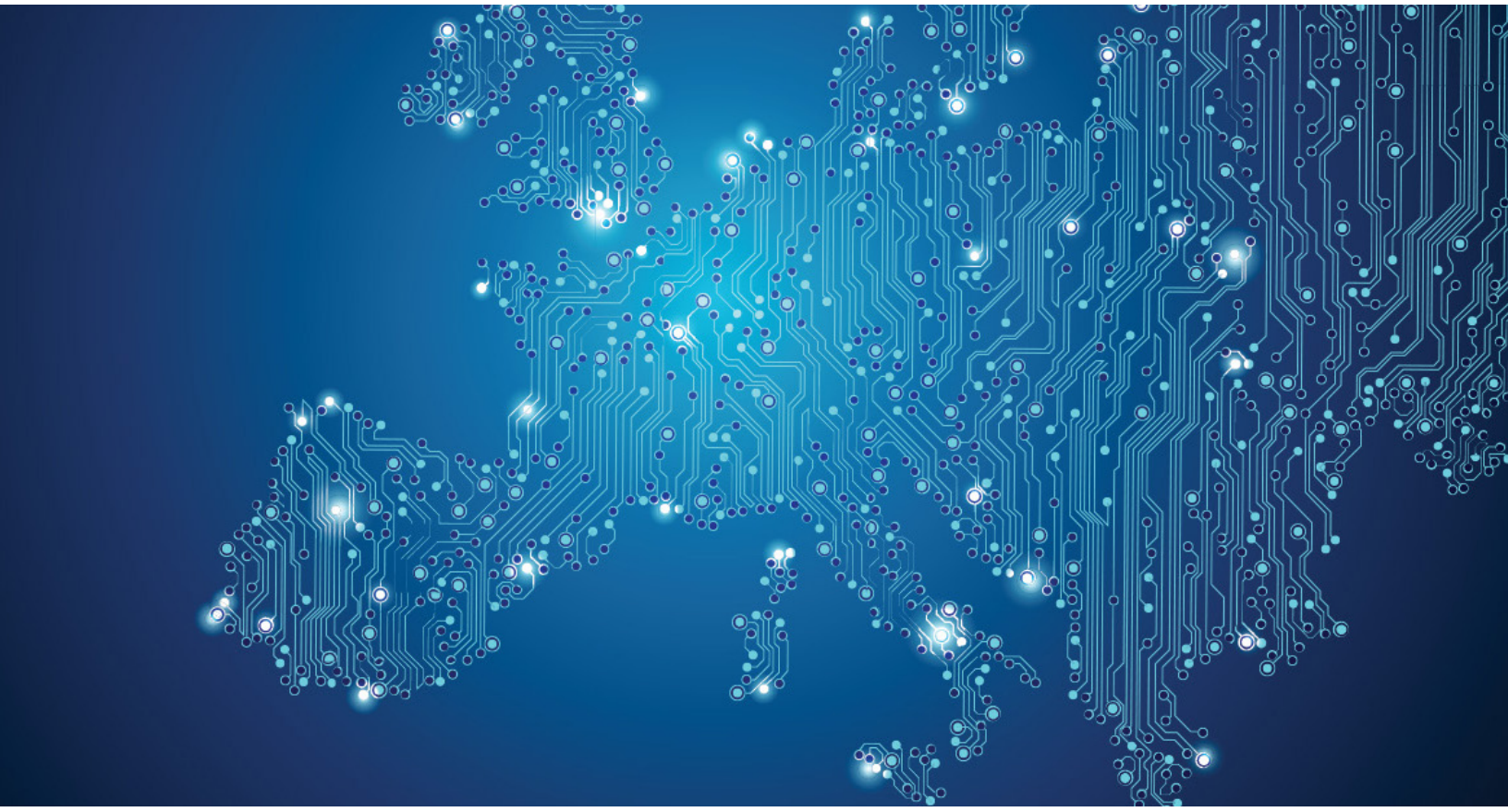

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At a glance

- **A three-lens approach—on adoption, creation, and energy—is required to assess Europe's competitiveness in the emerging generative AI (gen AI) economy.** While much of the current discourse centers around large language models (LLMs), European policy makers and business leaders must look beyond LLMs. Adopting a holistic approach to capitalize fully on gen AI's potential could boost European labor productivity by up to 3 percent annually through 2030.

- **On adoption, European organizations lag behind their US counterparts by 45 to 70 percent.** Yet this is where most of gen AI's economic potential lies. With the technology still in its early stages and much of its productivity gains yet to be unlocked, the window of opportunity for Europe remains wide open.

- **On creation, Europe leads in only one of the eight segments of a simplified gen AI value chain: AI semiconductor equipment.** Europe is a challenger in three other segments: foundation models, AI applications, and AI services. But it has below 5 percent market share in the remaining four: raw materials, AI semiconductor design, AI semiconductor manufacturing, and cloud infrastructure and supercomputers.

- **On energy, gen AI is expected to accelerate data center power demand, potentially accounting for more than 5 percent of Europe's total electricity consumption by 2030.** Without competitive electricity prices, it becomes less likely that European data centers will host gen AI applications and services.

- **Europe has made major progress in raising AI awareness and setting commitments, but major bottlenecks persist.** Policy makers and business leaders could explore several levers, including increasing investments (such as a public innovation procurement in AI applications for healthcare and defense sectors), leapfrogging in emerging semiconductor technologies (such as quantum and neuromorphic computing), and addressing talent retention. Additionally, preparing the workforce through reskilling and mobility programs will be crucial in fully leveraging the benefits of gen AI adoption.

A holistic approach to help Europe realize generative AI's full potential

For generative AI (gen AI),[1] the blockbuster release of OpenAI's ChatGPT in November 2022 marked the beginning of a boom.[2] Since then, much of the conversation around the technology has focused on foundation models, particularly large language models (LLMs). In this field, Europe[3] appears to be lagging behind its counterparts. However, LLMs are just one part of the gen AI landscape. Engaging on gen AI adoption, creation, and energy requirements can help capture a more complete picture of where the region stands in the emerging gen AI economy.

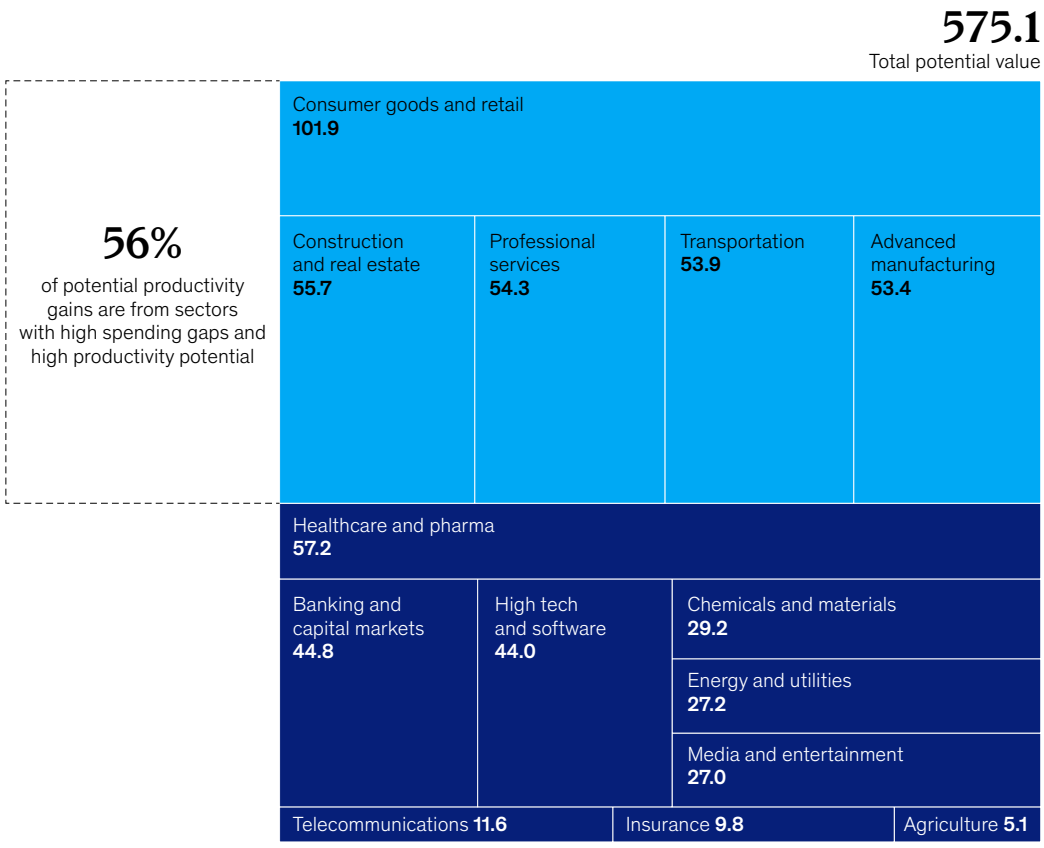
Most of the value generated by gen AI will stem from organizations' adoption and scaling of gen AI solutions[4]—an important consideration in Europe, where labor productivity has been slowing.[5] McKinsey Global Institute (MGI) research estimates that gen AI could help Europe achieve an annual productivity growth rate of up to 3 percent through 2030 (Exhibit 1).[6] This potential additional growth

[1] In this article, unless specified otherwise, "generative AI" (gen AI) encompasses all AI technologies, including the latest advancements in gen AI.
[2] By January 2023, the company had already gained 100 million users and was valued at $29 billion ($80 billion today). This triggered massive investments to fund gen AI companies ($25 billion in worldwide private investments in 2023) and spurred the release of multiple breakthrough innovations and competing models (for example, Google's Gemini and Meta's Llama). *Artificial Intelligence Index report 2024*, Stanford University, 2024; DigitalRank, Similarweb, accessed September 2024; Julia Boorstin, "Why OpenAI is the first company to be No. 1 on the CNBC Disruptor 50 list two years in a row," CNBC, May 14, 2024.
[3] In this article, "Europe" refers to the 27 member states of the European Union plus Norway, Switzerland, and the United Kingdom.
[4] Per academic research, innovators historically capture less than 5 to 10 percent of broader economic returns generated by their inventions. Adopters of the technology and society at large generate the remaining returns. For more, see William D. Nordhaus, *Schumpeterian profits in the American economy: Theory and measurement*, National Bureau of Economic Research working paper, number 10433, April 2004.
[5] For example, from 2016 to 2022, annual growth was 0.5 percent in Western Europe and 1.2 percent in North America. From 2002 to 2007, it was 1.1 percent and 1.9 percent, respectively. Chris Bradley, Jan Mischke, Marc Canal, Olivia White, Sven Smit, and Denitsa Georgieva, "Investing in productivity growth," McKinsey Global Institute (MGI), March 27, 2024.
[6] Eric Hazan, Anu Madgavkar, Michael Chui, Sven Smit, Dana Maor, Gurneet Singh Dandona, and Roland Huyghues-Despointes, "A new future of work: The race to deploy AI and raise skills in Europe and beyond," MGI, May 21, 2024.

Exhibit 1

Generative AI could add $575.1 billion to the European economy by 2030.

Generative AI productivity potential in Western Europe in 2030, by sector, $ billion[1]



[1]Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and UK. Potential value add from 2019 base period.
Source: "The economic potential of generative AI: The next productivity frontier," McKinsey, June 14, 2023

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will be critical for financing the European model, particularly in navigating the energy transition, solving the empowerment gap, and supporting an aging population.[7] It could also drive breakthrough innovations that transform daily life, such as accelerated drug discovery, improved patient care, and personalized education.

In terms of creation of gen AI, since 2022, more than 90 percent of LLM-related funding has taken place outside of Europe.[8] Moreover, European companies represent only 25 of the 101 AI models considered notable by the Stanford University AI Index, far behind US companies (which boast 61 notable models). But the opportunities for capturing the economic value resulting from the creation of gen AI technologies extend well beyond LLMs.

[7] For more, see Kweilin Ellingrud, Marco Piccitto, Tilman Tacke, Rebecca J. Anderson, Ishaa Sandhu, and Kevin Russell, "A better life everyone can afford: Lifting a quarter billion people to economic empowerment," MGI, May 20, 2024; Mekala Krishnan, Chris Bradley, Humayun Tai, Tiago Devesa, Sven Smit, and Daniel Pacthod, "The hard stuff: Navigating the physical realities of the energy transition," MGI, August 14, 2024.
[8] *Artificial Intelligence Index report 2024*, Stanford University, 2024.

They are spread across an eight-segment value chain: raw materials, AI semiconductor equipment, AI semiconductor design, AI semiconductor manufacturing, cloud infrastructure and supercomputers, foundation models (including LLMs), AI applications, and AI services.[9]

Finally, to power the creation and adoption of gen AI, Europe also needs to consider its energy capacity. This is a key consideration, given that Europe's energy system will be forced by 2030 to manage a rise in consumption of more than 5 percent, triggered by the demand for data center power (accelerated by gen AI).[10]

To realize the full potential of gen AI, Europe's business leaders and policy makers must embrace a holistic view of the technology that encompasses the challenges and opportunities posed by creation, adoption, and energy (Exhibit 2). In this article, we describe those challenges, detailing where Europe stands relative to other regions, and provide a series of steps that leaders in Europe might consider if they are to fully participate in—and tap into the value created by—this impressive new technology.

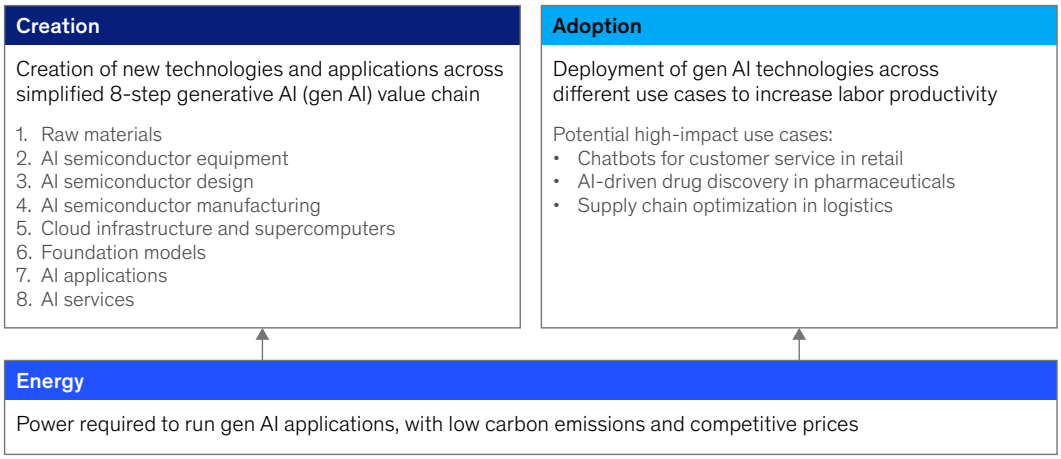
Adoption of gen AI: Opportunity remains wide open, but Europe is starting from a disadvantage

The vast majority of the economic value of gen AI is expected to come from its adoption by European organizations. The technology is still in its early stages, and most productivity potential has yet to be captured, so the opportunities here remain wide open. Yet European corporations are moving much more slowly than those in other countries.[11]

How much is Europe lagging behind? The information here is incomplete, so we sought to quantify it by examining three indicators. First, we

Exhibit 2

To fully capture the value of generative AI, European leaders can embrace a holistic approach that encompasses creation, adoption, and energy.



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[9] Simplified value chain of the most important segments (excludes other AI elements, such as distribution platforms and vector databases).
[10] Electricity Data Explorer, Ember, accessed September 2024; McKinsey research and analysis.
[11] For more, see Zach Meyers and John Springford, "How Europe can make the most of AI," Centre for European Reform, September 14, 2023.

Western Europe lags behind the United States on external spending on AI by an average of 61 percent for sectors of similar size.

looked at external AI spending of corporations, such as the purchase of AI software-as-a-service (SaaS) solutions. Since not all AI spending is external—some, such as hiring AI engineers, is internal—we also examined general IT spending, of which AI is a component, as an indicator of IT readiness and a crucial foundation for AI adoption. Finally, we factored in the responses of European executives to the McKinsey Global Survey on the state of AI.[12]

We analyzed the first two metrics both in absolute terms and relative to company sales, comparing them with US figures when possible. This relative comparison helps account for differences in sector size, which would otherwise skew the data because of economies of scale. For instance, the high-tech and software sector is 4.9 times larger in the United States than in Western Europe,[13] so we find an AI external spend-to-sales ratio of 0.4 percent for the United States versus 0.7 percent for Western Europe. But in AI external spend absolute value, we find $8.7 billion versus $2.6 billion, respectively, leading to a 70 percent gap.

Additionally, with the two first metrics, figures show that companies in Western Europe lag behind their US counterparts by 45 to 70 percent. This gap exists across all sectors. When evaluating sectors of similar size[14] in Western Europe and the United States (for example, advanced manufacturing, chemicals and materials, and construction and real estate), we find that those in Europe lag behind by 45 to 55 percent. For sectors that are significantly larger in the United States than in Western Europe (for example, healthcare and pharma, high tech and software, and media and entertainment), the gap was even more pronounced, ranging from 50 to 70 percent (Exhibit 3).

When looking at external spending on AI infrastructure, software, and services, Western Europe lags behind the United States by an average of 61 percent for sectors of similar size and 71 percent for sectors that are two or more times larger in the United States than in Western Europe.

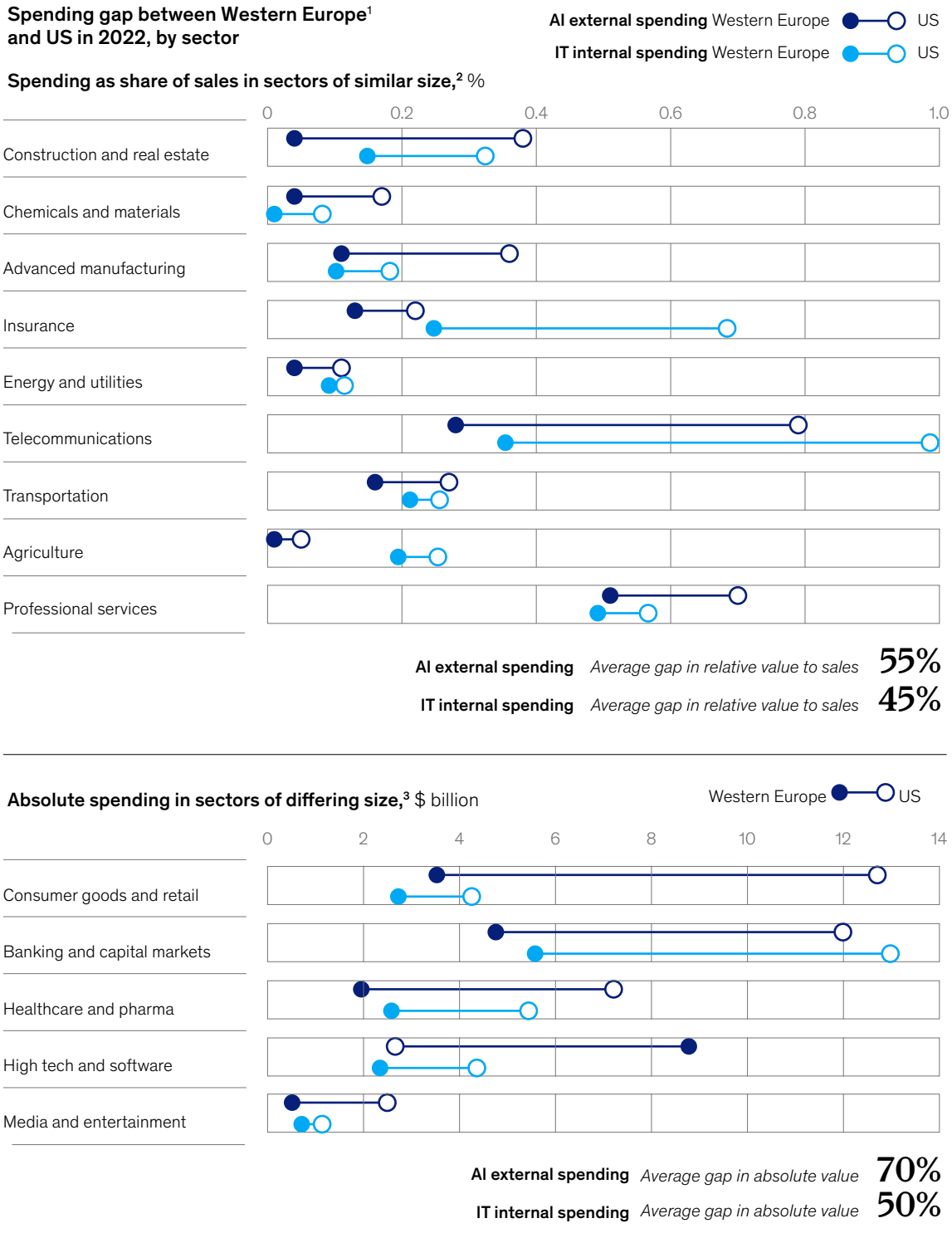
Looking at internal IT spend, we see that for sectors of similar size, Western Europe lags behind the United States by an average of 43 percent, and by 46 percent when sectors differ in size by at least two times.

Per the 2023 McKinsey Global Survey on the state of AI, Europe lags behind North America in gen AI adoption by 30 percent, with 40 percent of surveyed North American companies reporting having adopted gen AI in at least one business function, compared with about 30 percent for surveyed European companies.[15]

[12] The online survey was in the field from April 11 to April 21, 2023, and garnered responses from 1,684 participants representing the full range of regions, industries, company sizes, functional specialties, and tenures.
[13] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.
[14] Sectors with a size ratio between Western Europe and the United States below 2:1.
[15] Survey question, with 1,363 responses: Has the organization adopted AI in at least one business function?

Exhibit 3

Western Europe lags behind the United States in AI and IT spending across sectors, with an average gap of 45–70 percent.



Note: AI external spending measured as external spending on AI infrastructure, software, and services. Sectors ordered from most similar in size to least similar. IT spending used as proxy for AI internal spending. Sectors ordered from most similar in size to least similar.
[1]Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and UK.
[2]Sectors with <2:1 size ratio between US and Western Europe or Western Europe and US.
[3]Sectors with ≥2:1 size ratio between US and Western Europe or Western Europe and US.
Source: Worldwide AI and Generative AI Spending Guide, IDC, February 2024; McKinsey analysis

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Creation of gen AI tech: Europe leads in one segment, is a challenger in three, but is almost absent in four

Beyond adoption, Europe's ability to capitalize on gen AI will depend on its ability to spur the creation of gen AI technologies that spread across the simplified eight-segment value chain: raw materials (for example, germanium and silicon), AI semiconductor equipment (for example, lithography systems), AI semiconductor design (for example, development of high-end GPUs), AI semiconductor manufacturing (for example, foundries), cloud infrastructure and supercomputers (for example, infrastructure as a service and platform as a service), foundation models (for example, LLMs), AI applications (for example, AI-powered software), and AI services (for example, advisory services and implementation).

Europe is currently competitive in four of the eight segments of the value chain: AI semiconductor equipment, foundation models, AI applications, and AI services. However, the region has less than 5 percent of global market share in the remaining four segments: raw materials, AI semiconductor design, AI semiconductor manufacturing, and cloud infrastructure and supercomputers (table):

Europe's ability to capitalize on gen AI will depend on its ability to spur the creation of gen AI technologies that spread across the value chain.

Table

Europe is strong in four segments of a simplified generative AI value chain and lags in the remaining four.

Negligible (<5%) Moderate (5–15%) Fair (>15%)

Segment	Description	European market share in 2023	Historical European market share, directional	Key data
Raw materials	Materials needed to produce semiconductors and their machinery (eg, gallium to make lithography tools)		Stable	Europe supplies ~5% of critical, strategic[1] raw materials needed for chip manufacturing and semiconductors
AI semiconductor equipment	Goods needed for AI semiconductor production (eg, silicon wafers, lithography tools)		Increasing	Europe has 80–90% market share for extreme ultraviolet lithography (allows for finer patterns on semiconductor wafers, essential for high-end AI chips)
AI semiconductor design	Design, including intellectual property, of semiconductors for AI		Decreasing	Europe has <2% share of design of logic semiconductors used for AI (eg, GPUs)
AI semiconductor manufacturing	Production of semiconductors for AI		Stable	Europe has <1% of world's production capacity of ≤7-nanometer logic semiconductors used for AI
Cloud infrastructure and supercomputers	Infrastructure, including basic software layer, needed for computing power and data hosting		Stable	European cloud companies have <5% market share, compared with ~85% for US hyperscalers
Foundation models	Design and training of foundation models		Increasing	25 notable models originate from Europe, compared with 61 from US
AI applications	AI-based software needed to perform specific tasks across various industries		Increasing	In 2023, European companies raised ~12% of global venture capital and private equity funding for system-as-a-service AI companies
AI services	Services needed to support design and deployment of AI use cases		Increasing	Europe has ~15% share of global AI services market, compared with US, which leads with >40%

[1] "Critical" is based on economic importance and supply risk, and "strategic" is defined as important for the green and digital transition, defense, and aerospace.

— *Raw materials.* The chip-manufacturing and semiconductor industries require more than 40 raw materials, 16 of which (for example, gallium, magnesium, and silicon) the European Union classifies as both critical and strategic.[16] About 5 percent of these materials are supplied by European companies. As a result, the region relies heavily on imports from countries such as China, which supplies about 75 percent of the European Union's needs in silicon and 90 percent of its needs in gallium and magnesium.[17] The Critical Raw Materials Act (CRMA) supports local production, streamlining permitting processes and boosting the recycling of key materials.[18]

— *AI semiconductor equipment.* The Netherlands–based ASML is the market leader for the lithography machines required to produce high-end semiconductors (up to seven-nanometer logic) suitable for AI.[19] European companies also lead in other equipment segments, such as atomic layer deposition (ASM International, also based in the Netherlands, with about a 50 percent market share) and metal–organic chemical-vapor deposition (Germany-based company AIXTRON, with 70 to 80 percent market share).[20] Yet, in other key niches, like dry etchers and dicing machines, European companies are less present.

— *AI semiconductor design.* European companies like Infineon Technologies, NXP Semiconductors, and STMicroelectronics play a global role in the semiconductor-integrated-design-manufacturing space, with about 15 percent market share in 2023.[21] But Europe has less of a presence in the design of AI-suitable semiconductors, a space led by Nvidia.[22] Nonetheless, some European players are taking steps to bridge the gap. Britain-based ARM has ambitions to launch AI semiconductors in 2025.[23] Europe also plays an important, if indirect, role in AI semiconductor design through its strong position in the design and manufacturing of power semiconductors (for example, through Infineon and STMicroelectronics).

— *AI semiconductor manufacturing.* Europe produces only about 8 percent of the world's semiconductors and fewer than 1 percent of the logic capacity semiconductors of up to seven nanometers suitable for AI.[24] Beyond that, Europe has no capacity for high-bandwidth memory (HBM) and advanced packaging. Looking ahead, global capacity for advanced semiconductor manufacturing is expected to continue to be fully owned by non-European players, such as TSMC.[25] In large part, that's because fab payback time in Europe is higher than that of Southeast Asia, notably due to higher labor and energy costs. In addition to higher costs, European companies also face complex administrative processes. It can take up to four years to get a semiconductor plant up and running in Europe, compared to one year in Taiwan.[26]

— *Cloud infrastructure and supercomputers.* Europe lags behind the United States in computing power. Europe is home to 18 percent of global data-center-installed capacity, compared with 37 percent in the United States (while European and US GDPs are comparable, with around $23 trillion and $27 trillion, respectively)—and in most cases,

[16] "Critical" is based on economic importance and supply risk, and "strategic" is defined as important for the green and digital transition, defense, and aerospace. The 16 materials include gallium, germanium, rare earths, and silicon.
[17] *Study on the critical raw materials for the EU 2023*, European Commission, March 16, 2023.
[18] Emma Watkins, Emma Bergeling, and Eline Blot, "Circularity gaps of the European Critical Raw Materials Act," Institute for European Environmental Policy, October 30, 2023.
[19] "Fitch affirms ASML at 'A'; outlook stable," Fitch Ratings, April 5, 2023.
[20] AIXTRON annual reports; ASM annual reports; DataTrack, TrendForce, accessed September 2024.
[21] Omdia, Informa, accessed September 2024.
[22] Kif Leswing, "Nvidia dominates the AI chip market, but there's more competition than ever," CNBC, June 2, 2024.
[23] Masayuki Shikata and Akira Yamashita, "SoftBank's Arm plans to launch AI chips in 2025," Nikkei Asia, May 23, 2024.
[24] World Fab Forecast, SEMI (including discrete, analog, and memory semiconductors), accessed September 2024.
[25] "Emerging resilience in the semiconductor supply chain," Semiconductor Industry Association, May 8, 2024.
[26] Florian Dèbes, "'Il faut donner envie d'investir en Europe,' plaide le patron d'ASML ("'We need to make people want to invest in Europe,' argues the boss of ASML"), Les Echos, June 6, 2024.

The operating costs of European data centers are typically more than 50 percent higher than those in the United States, largely driven by Europe's higher energy costs.

these European data centers are owned by US companies.[27] In 2023, European cloud companies (for example, OVH and UpCloud) had about 5 percent market share globally (about 15 percent in Europe), while US players (for example, Amazon Web Services, Google, and Microsoft) had more than 70 percent global market share.[28] Furthermore, Europe has only half the supercomputing capacity in flop/s,[29] which is increasingly necessary in basic and applied research.[30] This is partially because the United States has seen the emergence of private players specializing in this segment (for example, CoreWeave), while Europe supercomputers mostly lie in research centers. What's more, the operating costs of European data centers are typically more than 50 percent higher than those in the United States, largely driven by Europe's higher energy costs.[31]

— *Foundation models.* In 2023, 61 notable AI models[32] originated from US-based organizations, far outpacing Europe's 25.[33] A few of the European models are competing globally. One such is France-based Mistral AI, a leading open-source model provider, with $1 billion raised since 2023.[34] Yet in the technological race to constantly improve models' performances, the company remains underfunded compared with its US competitors. For example, OpenAI has raised $11.3 billion, and Anthropic has raised $8.7 billion.[35]

— *AI applications.* Europe has several emerging AI unicorns (for example, DeepL, Synthesia, and Wayve). The region also is home to leading global software companies (such as Dassault Systèmes, Hexagon, and SAP) that are increasingly building gen AI technologies into their solutions. For example, in 2023, SAP pledged to invest more than $1 billion in gen AI companies.[36] But Europe lags behind the United States, garnering only 12 percent of the global pool of private equity and venture capital funding for SaaS AI companies as of 2023.[37] What's more, several leading AI start-ups and scale-ups of European origin (for example, Hugging Face, with a $4.5 billion valuation, and Dataiku, with a $3.7 billion valuation[38]), have

[27] IDC Global data, accessed September 2024; International Monetary Fund data, accessed September 2024; McKinsey analysis and research.
[28] IDC Global data, accessed September 2024; McKinsey analysis and research.
[29] Measured by total computing power of supercomputers in floating point operations per second.
[30] TOP500 release, 62nd edition, TOP500, November 2023.
[31] Jonathan Atkin et al., "RBC Datacenter download," RBC Capital Markets, September 20, 2021.
[32] "A notable model meets any of the following criteria: (i) state-of-the-art improvement on a recognized benchmark; (ii) highly cited (over 1000 citations); (iii) historical relevance; (iv) significant use. "What is a notable model," Epoch AI, accessed September 2024.
[33] *Artificial Intelligence Index report 2024*, Stanford University, 2024.
[34] Crunchbase data, accessed September 2024.
[35] PitchBook data, accessed September 2024.
[36] "SAP advances vision of business AI with investments in Aleph Alpha, Anthropic and Cohere to complement $1+ billion AI commitment from Sapphire Ventures," PR Newswire, July 18, 2023.
[37] PitchBook data, accessed September 2024.
[38] Crunchbase data, accessed September 2024.

moved their headquarters from Europe to the United States.

— *AI services.* Europe holds about a 15 percent share of the global AI services market, positioning it just behind the United States, which leads with approximately 40 percent.[39] This significant market presence provides Europe with a foundation for expanding AI-related services.

The near absence of European companies in four of the eight segments of the simplified value chain could result in missed opportunities for the region's economy. The global market of gen AI technologies is expected to boom, with high double-digit annual growth anticipated over the next ten years.[40] This situation could be a challenge to the region's strategic autonomy, ultimately jeopardizing gen AI adoption and productivity gains. A semiconductor shortage in 2022, for example, hit the European auto industry especially hard, resulting in an estimated €100 billion GDP loss.[41] Similarly, insufficient access to cloud infrastructure and supercomputers could limit development and operations of gen AI technologies.

Energy for gen AI: Expected to drive increased electricity demand in Europe amid already-high prices

McKinsey estimates that rising data center power demand could increase Europe's electricity consumption by at least 180 terawatt-hours by 2030—equivalent to more than 5 percent of total European electricity annual consumption in 2023.[42] This is driven by demand for data center computing power in Europe, which McKinsey expects to more than triple by 2030 to reach 35 gigawatts of installed capacity. Indeed, data centers are major energy consumers: a hyperscaler's data center can use as much power as 80,000 households.[43]

These new demands will place additional pressure on a European power grid that's already undergoing significant stresses. First, electricity demand is expected to escalate in the region on the back of growing decarbonization efforts and electrification throughout various sectors, with absolute electricity demand expected to increase by 20 to 25 percent by 2030 (from 3,200 terawatt-hours in 2023 to around 4,000 terawatt-hours in 2030, including demand from data centers).[44] Also, energy price competitiveness in Europe is low, with industrial-electricity prices some 70 percent higher in Europe than in the United States in May 2024.[45] Finally, Europe has the oldest power grid in the world (45 to 50 years, on average, versus 35 to 40 years in North America and 15 to 20 years in China).[46] This can lead to inefficiencies in electricity distribution.

On the bright side, this significant increase in electricity consumption could serve as a positive incentive for energy operators to invest in new capacities. Additionally, Europe has an edge in clean energy, with 61 percent of low-carbon sources in its electricity mix, compared with 40 percent in the United States and 34 percent in China.[47]

How to boost Europe's competitiveness in gen AI

Europe clearly faces a host of challenges with gen AI, but they aren't insurmountable. Policy makers and business leaders in Europe can consider several activities to increase the region's ability to fully realize the potential economic gains of AI when it comes to adoption, creation, and energy.

[39] Riccardo Righi et al., "EU in the global artificial intelligence landscape," European Commission, 2021.
[40] "Generative AI to become a $1.3 trillion market by 2032, research finds," Bloomberg Intelligence, June 1, 2023.
[41] "Missing chips cost EUR100bn to the European auto sector," Allianz, September 13, 2022; International Organization of Motor Vehicle Manufacturers data, accessed September 2024.
[42] Electricity Data Explorer, Ember, accessed September 2024; McKinsey research and analysis.
[43] "Investing in the rising data center economy," McKinsey, January 17, 2023.
[44] Electricity Data Explorer, Ember, accessed September 2024; Patrick Chen, Tamara Grünewald, Jesse Noffsinger, and Eivind Samseth, "Global Energy Perspective 2023: Power outlook," McKinsey, January 16, 2024.
[45] Enerdata, Ember, US Energy Information Administration, Eurostat.
[46] "Winds of change," Nexans 2021 Capital Markets Day.
[47] Total electricity generation mix with low-carbon energy, including biofuel and wastes, hydro, wind and solar, and other renewable sources. International Energy Agency data, accessed September 2024.

Adoption of gen AI in Europe

To facilitate gen AI adoption, European leaders might consider the following actions:

— *Reskill and upskill the workforce.* Research from MGI indicates that to reap the full productivity dividends of gen AI, Europe would need to double its current pace of job transition—from the 0.4 percent per year seen in 2016–19, prior to the COVID-19 pandemic, to an unprecedented 0.8 percent by 2030.[48] (The effort for the United States would be lower, as transition rates have already been at such levels.) That could require the reskilling of 12 million workers, roughly 6.5 percent of Europe's current workforce. These occupational shifts herald a substantial evolution in workforce skills: by 2030, demand for technological skills is expected to increase by 25 percent compared with 2022, while demand for basic cognitive skills could decline by 14 percent. To support this change, policy makers could direct students and workers toward programs that prepare them for high-demand jobs.[49] They could also encourage partnerships among universities and businesses. In doing so, policy makers must ensure that the right trainings are developed and offered for reskilling and upskilling and set up dedicated mechanisms to fund the trainings.

— *Attract and retain AI talent.* Europe has slightly more AI professionals than the United States does (in 2023, 120,000 versus 112,000).[50] However, while 22 percent of the world's leading AI researchers[51] studied in Europe, only 14 percent continue to work in the region.[52] Compensation disparities are a significant factor: in 2023, salaries for software developers in the United States were two to four times higher than those of their European counterparts.[53] This disparity is likely attributable to the greater financial resources of US companies, which benefit from larger economies of scale and higher levels of venture capital and private equity funding. Europe also lags behind the United States in AI-related research, with only two universities in a key ranking of top institutions for AI research in 2022, compared with 15 for the United States.[54] European workers also fall behind in gen AI awareness and use: the latest McKinsey Global Survey on AI finds that employees in North America are 15 percent more likely than their European counterparts to use AI regularly.[55] To address these gaps, policy makers could implement measures to enhance Europe's attractiveness to top-tier talent (for example, premiums or tax breaks for returning or incoming top talent, support for research institutions and private labs, and public grants), and business leaders could focus on upskilling workers on gen AI use. More broadly, addressing the differences in scale and resources among European companies—through measures such as establishing a 28th tech regime,[56] simplifying business regulations, consolidating pension funds, and enhancing support for scale-up funding—could also be beneficial.

— *Fully embrace gen AI via end-to-end transformation.* Research has found that 90 percent of AI projects are stuck in the experimentation phase.[57] Many companies stumble in their gen AI transformation by either starting too small or spreading resources too thin on a few use cases. Both tactics yield minimal value. In contrast, successful companies concentrate on fully transforming a few critical

[48] Eric Hazan, Anu Madgavkar, Michael Chui, Sven Smit, Dana Maor, Gurneet Singh Dandona, and Roland Huyghues-Despointes, "A new future of work: The race to deploy AI and raise skills in Europe and beyond," MGI, May 21, 2024.
[49] For more, see "Netherlands advanced: Building a future labor market that works," McKinsey, June 18, 2024.
[50] Measured by active AI roles per region. *State of European Tech 2023*, Atomico, November 28, 2023.
[51] Defined as top 20 percent of AI researchers, based on Annual Conference on Neural Information Processing Systems' acceptance rate of papers.
[52] Global AI Talent Tracker 2.0, MacroPolo, accessed September 2024.
[53] *2023 Developer Survey*, Stack Exchange, June 13, 2023; McKinsey analysis.
[54] Global AI Talent Tracker 2.0, MacroPolo.
[55] "The state of AI in early 2024: Gen AI adoption spikes and starts to generate value," QuantumBlack, AI by McKinsey, May 30, 2024.
[56] Refers to the concept of creating a harmonized framework across European countries that could target the tech sector, including AI-related scale-ups. This would involve a coalition of the willing across Europe to align tax policies, fiscal measures, and regulatory standards to create a unified environment that supports the growth and scaling of tech companies—effectively acting as a 28th regime alongside existing national frameworks.
[57] Matthieu Quiret, "IA: les entreprises vont dans le mur prévient McKinsey" ("AI: Businesses are heading for disaster, warns McKinsey"), Les Echos, April 29, 2024.

business domains, such as innovation and R&D, logistics, and procurement, from end to end. To truly unlock the full potential of gen AI, companies must master crucial enterprise capabilities, from planning to scaling.[58] Above all, they need to supercharge their operating model, bringing together business, technology, and operations into a powerhouse of innovation. On data, the focus should be on continually enriching both proprietary and real-world data and ensuring its organization-wide accessibility to enable smarter decisions at every level.

— *Help companies navigate regulation.* Recent McKinsey research shows that eight of ten European companies report that they don't fully understand the obligations introduced by the EU AI Act, and 70 percent find them to be complex. That confusion has consequences. Meta, for example, recently stopped the rollout of its multimodal model in the EU, reportedly because of a lack of readability and predictability of the regulatory environment.[59] This situation could challenge the competitiveness of European companies by reducing their ability to access the world's most high-performing AI models.

Creation of gen AI in Europe

Regarding creating gen AI, winning in every segment isn't a realistic strategy for Europe. A differentiated approach, based on current strengths, is crucial for the region to stay relevant. Potential steps include the following:

— *Increase investment.* In 2023, US private investments in AI reached $67 billion, compared with just $11 billion in Europe.[60] This gap is even more striking when looking specifically at investments in gen AI. In 2023, US private investments in gen AI amounted to $23 billion, compared with less than $2 billion in Europe.[61] MGI published an article on strategies to enhance European investment.[62] Among the proposed solutions: public investment and precommercial innovation procurement vehicles at the EU level—say, by dedicating public funding for AI-based diagnostics and treatment in the European Union's overall healthcare budget. Aims like these could be achieved by leveraging existing investment vehicles, such as the InvestEU Fund, with an overall aspiration to dedicate 0.1 percent of European GDP a year in public investment to build gen AI infrastructure. European policy makers could also boost private capital investment through higher private equity and venture capital allocations by pension funds and insurers. (This could require consolidation of these funds and regulation changes to allow the shifting of fund allocations.)

— *Leapfrog in semiconductors.* Per McKinsey research, Europe has negligible market share in the design and manufacturing of chips smaller than seven nanometers for AI. A first step to addressing this issue could be to boost local expertise by attracting more R&D centers in the region. A second step could consist of leapfrogging in other promising semiconductor design fields, such as analog-, neuromorphic-, optical-, and quantum-computing semiconductors. European policy makers could also consider measures to attract advanced-semiconductor-manufacturing capacity in the region (for example, financial incentives and a fast-track permitting process). They could leverage recent momentum illustrated by multibillion-dollar investments across Europe in semiconductor fab manufacturing

[58] Eric Lamarre, Kate Smaje, and Rodney Zemmel, "Rewired to outcompete," *McKinsey Quarterly*, June 20, 2023.
[59] Dan Milmo, "Meta pulls plug on release of advanced AI model in EU," *Guardian*, July 18, 2024.
[60] *Artificial Intelligence Index report 2024*, Stanford University, 2024; Quid data, accessed September 2024.
[61] PitchBook data, accessed September 2024.
[62] Massimo Giordano, Sven Smit, Jan Mischke, Guillaume Dagorret, Fredrik Dahlqvist, Sylvain Johansson, Marc-Antoine de la Chevasnerie, Solveigh Hieronimus, and Pieter Ottink, "Investment: Taking the pulse of European competitiveness," MGI, June 20, 2024.

(including a state-of-the art fab in Germany).[63] The European Chips Act, signed in 2023 with a funding commitment exceeding €40 billion, represents an important initial step in strengthening Europe's semiconductor industry, although it addresses a broad spectrum of chip technologies rather than exclusively AI-specific chips.

— *Improve local computing power and resources.* In June 2024, Mistral AI executives reported a lack of hosting and computing capacity in Europe to develop and scale AI.[64] Indeed, as of 2023, Europe hosts 18 percent of global data center capacity (less than 5 percent owned by European companies), compared with 37 percent for the United States.[65] This deficit could deepen in the future, as McKinsey expects global data center demand to grow 22 percent per annum by 2030. To level the playing field for computing power, EU policy makers may want to explore ways to make Europe more competitive at hosting cloud facilities on the continent. This might include targeted incentives and support to enhance the mix of local companies and global players, as well as modernizing the underlying energy infrastructure.

— *Foster AI models and applications that cater to local specificities.* LLMs are currently predominantly trained on English data.[66] However, Europe is a diverse market with different languages and cultures. By harnessing region-specific data, local players can create differentiated models and applications suited for a region's specific needs. Additionally, local expertise provides a significant advantage in navigating the specificities of EU regulations.

Energy capacity for gen AI in Europe

Regarding gen AI energy, policy makers can strive to ensure sufficient and affordable dispatchable power for data centers while staying committed to Europe's climate-driven decarbonization goals. Addressing these challenges requires considering local variations in electricity demand and supply, such as the presence of energy-intensive industries and levels of energy independence. In addition to expanding low-carbon electricity infrastructure and streamlining permitting, Europe might also explore redesigning its power market, potentially mutualizing electricity purchases through a single EU or regulatory agency and establishing separate markets for zero marginal cost (wind and solar) and marginal cost resources.[67]

When it comes to unlocking the full potential of gen AI, Europe sits at a crossroads. Given the technology's novelty, the adoption race remains wide open. Europe has numerous opportunities to tactically reinforce its positions along the value chain while ensuring that it guides gen AI development by ethical considerations. Policy makers must understand that the stakes here are considerable and extend beyond immediate economic impacts. Europe's participation in the current AI boom is important not merely for today's gains but also to secure a foothold in future technological advances. History, after all, can point to examples of the snowball effect of technology, in which pioneering innovations typically emerge from existing industries with related capabilities.[68]

[63] For more, see "TSMC, Bosch, Infineon, and NXP establish joint venture to bring advanced semiconductor manufacturing to Europe," Taiwan Semiconductor Manufacturing press release, August 8, 2023.
[64] Cynthia Kroet, "Mistral AI warns of lack of data centres and training capacity in Europe," Euronews, June 14, 2024.
[65] Global Worldwide Semiannual Public Cloud Services Tracker, IDC Global, updated second half of 2023; McKinsey research and analysis.
[66] As of September 2024, around 50 percent of websites are in English, compared with only 5 percent in German and 4 percent in French. "Usage statistics of content languages for websites," accessed September 2024.
[67] For more, see Markus Schülde, Xavier Veillard, and Alexander Weiss, "Four themes shaping the future of the stormy European power market," McKinsey, January 27, 2023.
[68] For more, see Frank Neffke, Martin Henning, and Ron Boschma, "How do regions diversify over time? Industry relatedness and the development of new growth paths in regions," *Economic Geography*, July 2011, Volume 87, Number 3; Jing Xiao, Ron Boschma, and Martin Andersson, "Industrial diversification in Europe: The differentiated role of relatedness," *Economic Geography*, 2018, Volume 94, Number 5.

European leaders can rely on the continent's strong economic fundamentals to elevate their gen AI ambitions. The region boasts a vast market of 500 million people, a strong industrial ecosystem comprising world-leading companies,[69] a world-class talent pool, and an edge in clean energy. All of this provides a strong foundation on which to build an AI infrastructure and turn a strong present position into a leading role in the future.

[69] In 2023, Europe is home to 118 of the 500 largest companies around the world, including LVMH, Nestlé, and Volkswagen. Fortune Global 500, *Fortune*, accessed September 2024.

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