

# The economic opportunity of generative AI in D9+

An Implement Consulting Group study commissioned by Google

DECEMBER 2023

# The economic opportunity of generative AI in D9+

Generative AI will boost global economic growth in the coming decade. For the D9+ to capture the full benefit, the region needs to promote innovation and use digital technologies and services to transform sectors and companies.

## THE ECONOMIC OPPORTUNITY

Generative AI could boost the D9+ region's GDP by **€500 billion**



Gains come from three sources ...



Productivity boost from people working with generative AI.



Freed-up time when generative AI helps to automate our work.



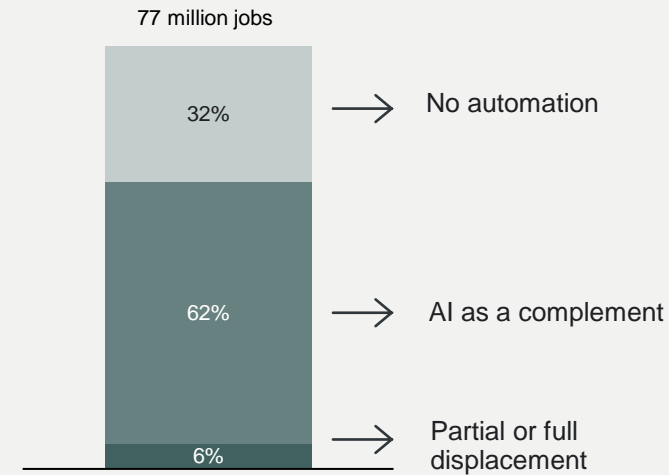
Re-employing our time to other value-creating activities.

## THE JOB IMPLICATIONS

Generative AI can help most workers do more – a productivity booster.

62% of the jobs in D9+ are estimated to work *together with* generative AI

Share of jobs exposed to automation  
% of total employment in D9+



**The D9+ region is well-placed to manage the job changes from generative AI.**

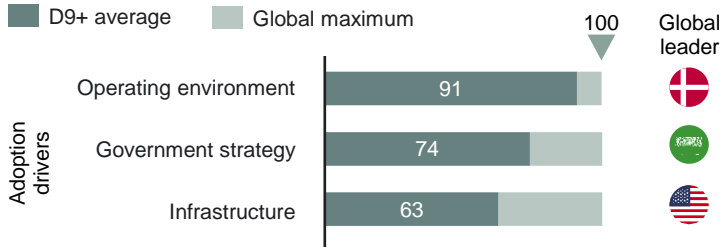
Annual re-employment needs in the D9+ from generative AI will be less than 10% of the historical annual average number of job openings and closures.

# Capturing the benefits

## AI READINESS OF THE D9+

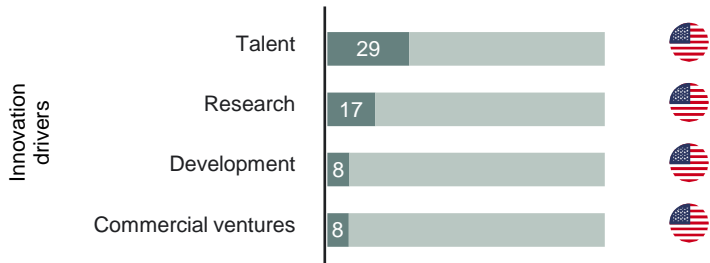
The D9+ is doing well on indicators related to early adoption ...

D9+ AI capacity according to the Tortoise Global AI index  
Global AI index, score out of 100 (global leader)



**On track**  
D9+ excels in the operating environment (e.g. trust, data governance), government strategy and infrastructure.

... but is behind on the factors that matter most for lead innovators



**Behind**  
D9+ lags behind in innovation, investment and AI-related skills.

## CONCLUSIONS AND POLICY IMPLICATIONS

Generative AI is so powerful and fast-adopting that long-term GDP forecasts of the D9+ countries will need to be raised from around 2028.

The D9+ region cannot take for granted that they will automatically capture the full value from generative AI.

**A five-year delay in the adoption and development of generative AI could reduce potential GDP gains in D9+ from 8% to 2%, reducing the potential over 10 years from €500 billion to €150 billion for the D9+ region.**

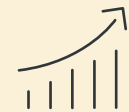
Capturing the full economic gains requires innovation capabilities and a conducive regulatory framework.



**Retrain and upskill workforce**



**Grow R&D by local innovators**



**Accelerate commercial uptake**

# Introduction to the D9+ countries



## D9+

- 37% of GDP in EU27
- 37% of the EU27 population
- GDP per capita at EU27 average

### FINLAND

- **Ranked no. 1** in DESI 2022
- 14<sup>th</sup> largest GDP in the EU27
- GDP per capita index 136



### DENMARK

- **Ranked no. 2** in DESI 2022
- 11<sup>th</sup> largest GDP in the EU27
- GDP per capita index 181



### THE NETHERLANDS

- **Ranked no. 3** in DESI 2022
- 5<sup>th</sup> largest GDP in the EU27
- GDP per capita index 152



### SWEDEN

- **Ranked no. 4** in DESI 2022
- 7<sup>th</sup> largest GDP in the EU27
- GDP per capita index 151



### IRELAND

- **Ranked no. 6** in DESI 2022
- 9<sup>th</sup> largest GDP in the EU27
- GDP per capita index 275



### SPAIN

- **Ranked no. 8** in DESI 2022
- 4<sup>th</sup> largest GDP in the EU27
- GDP per capita index 79



### LUXEMBURG

- **Ranked no. 9** in DESI 2022
- 20<sup>th</sup> largest GDP in the EU27
- GDP per capita index 331



### ESTONIA

- **Ranked no. 10** in DESI 2022
- 25<sup>th</sup> largest GDP in the EU27
- GDP per capita index 74



### PORTUGAL

- **Ranked no. 17** in DESI 2022
- 15<sup>th</sup> largest GDP in the EU27
- GDP per capita index 65



### BELGIUM

- **Ranked no. 18** in DESI 2022
- 8<sup>th</sup> largest GDP in the EU27
- GDP per capita index 133



### THE CZECH REPUBLIC

- **Ranked no. 21** in DESI 2022
- 13<sup>th</sup> largest GDP in the EU27
- GDP per capita index 72



### POLAND

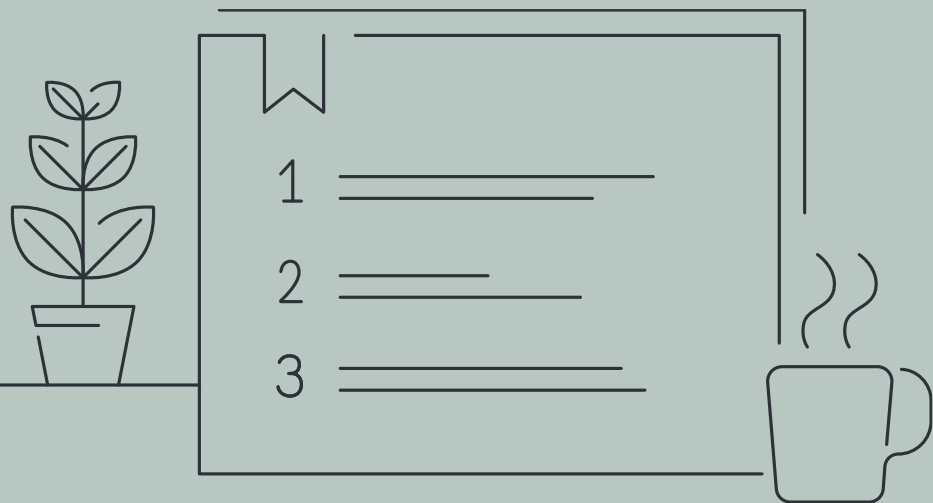
- **Ranked no. 26** in DESI 2022
- 6<sup>th</sup> largest GDP in the EU27
- GDP per capita index 50



# Contents

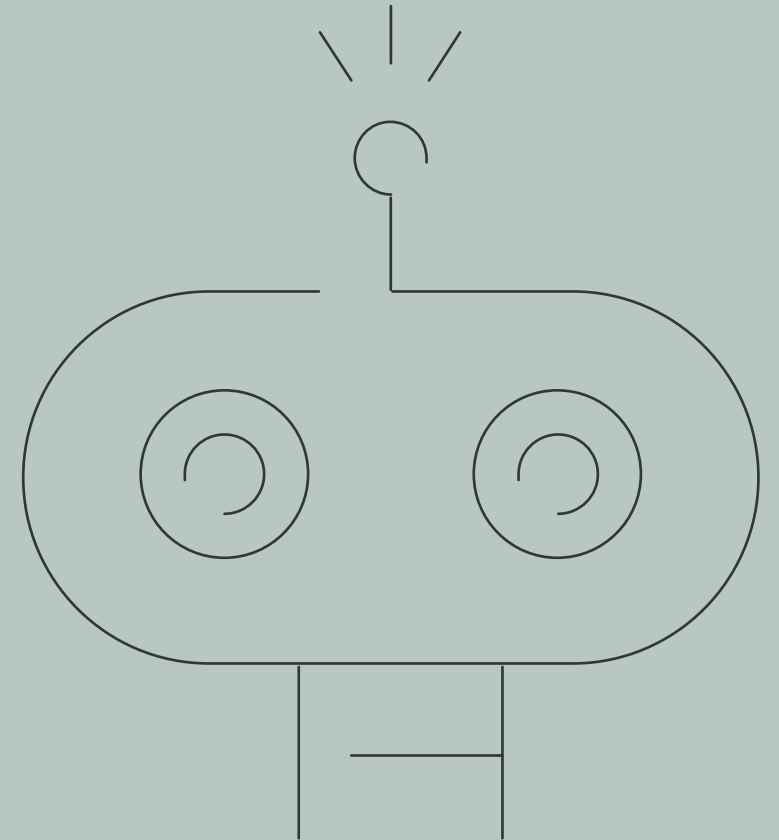
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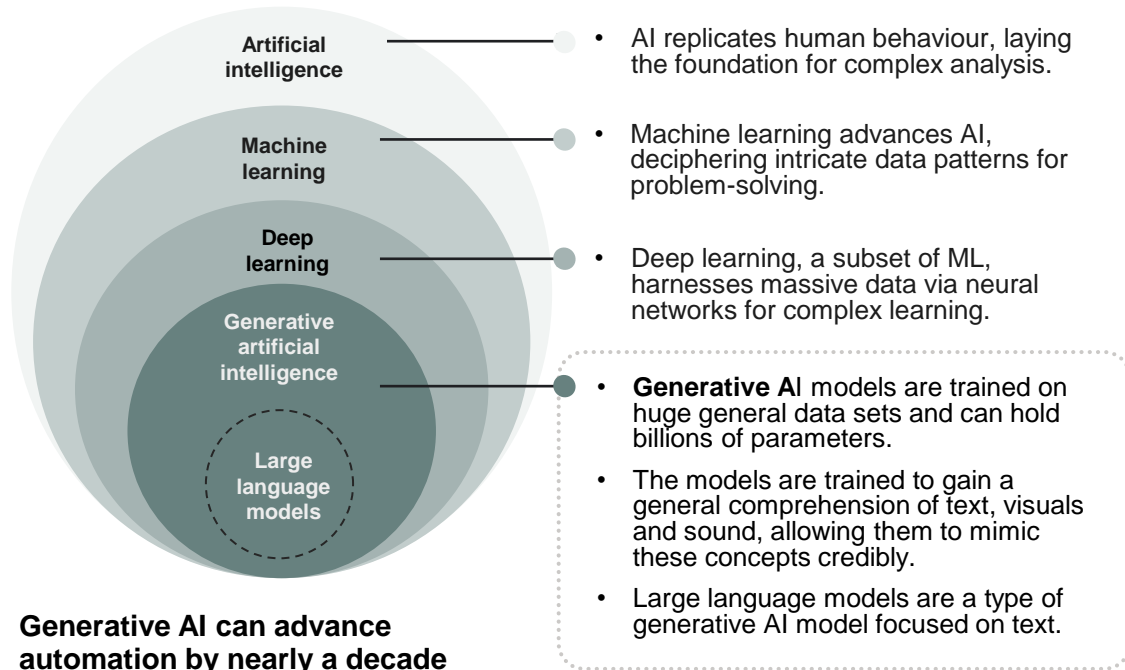
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# Introduction to generative AI



# Generative AI enables us to do more with AI than ever before due to new capabilities in content creation, adaptation and analysis

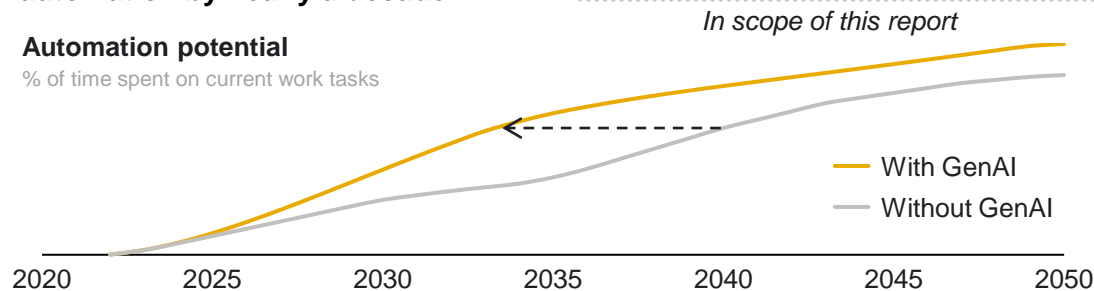
Generative AI is a subgenre of AI that is trained on vast amounts of data and can hold a general comprehension of language, visuals, code and sound



Generative AI can advance automation by nearly a decade

### Automation potential

% of time spent on current work tasks



Source: Implement Economics based on McKinsey

Generative AI models have advanced new capabilities, enabling the models to tackle complex tasks which have traditionally been reserved for humans

### Content creation

Generative AI models can help users create content based on inputs in ordinary language

#### Text creation

Produces multilingual text to meet user-defined criteria.



#### Code creation

Generates code snippets and entire programmes for various languages.



#### Image, video and sound creation

Creates visuals and audio based on text inputs.



### Content adaption

Generative AI models can revise and adapt existing content to meet new demands.

#### Translation

Automatically translates text and speech across languages.



#### Code refactoring

Optimises and translates code for improved efficiency and readability.



#### Content revision

Tailors content to audiences or revises content based on new information or criteria.



### General analysis

Generative AI models can provide insights from various data types without task-specific training

#### Large data set analysis

Processes and identifies patterns in extensive data rapidly.



#### Unstructured data analysis

Extracts insights from visuals and text.



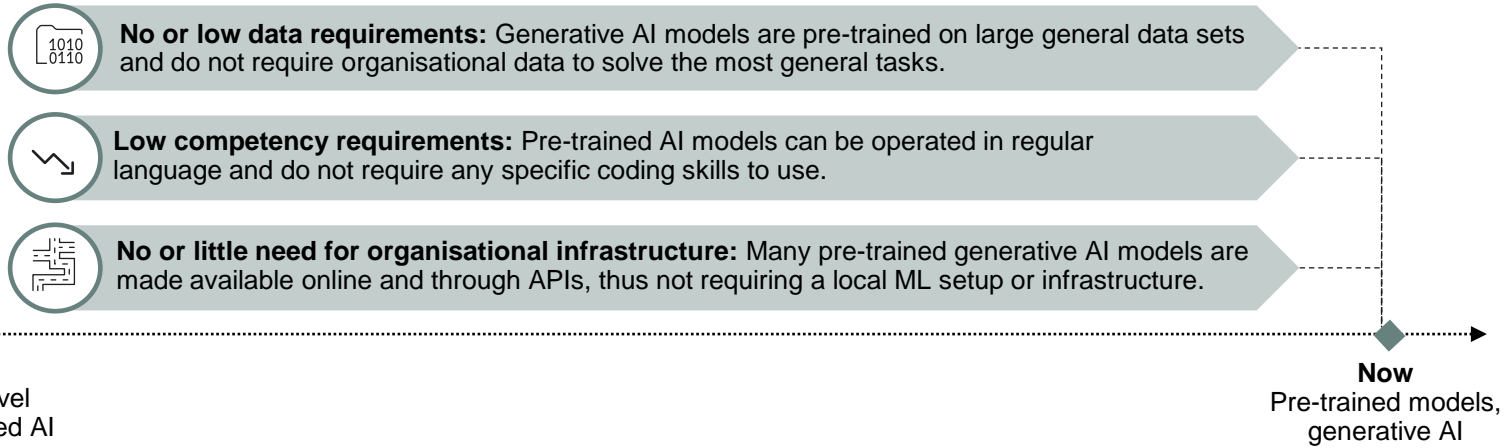
#### Online research

Performs internet research and material analysis outside of its training base.



# Free and accessible pre-trained models have made generative AI available to more users and accelerated uptake beyond expectations during 2023

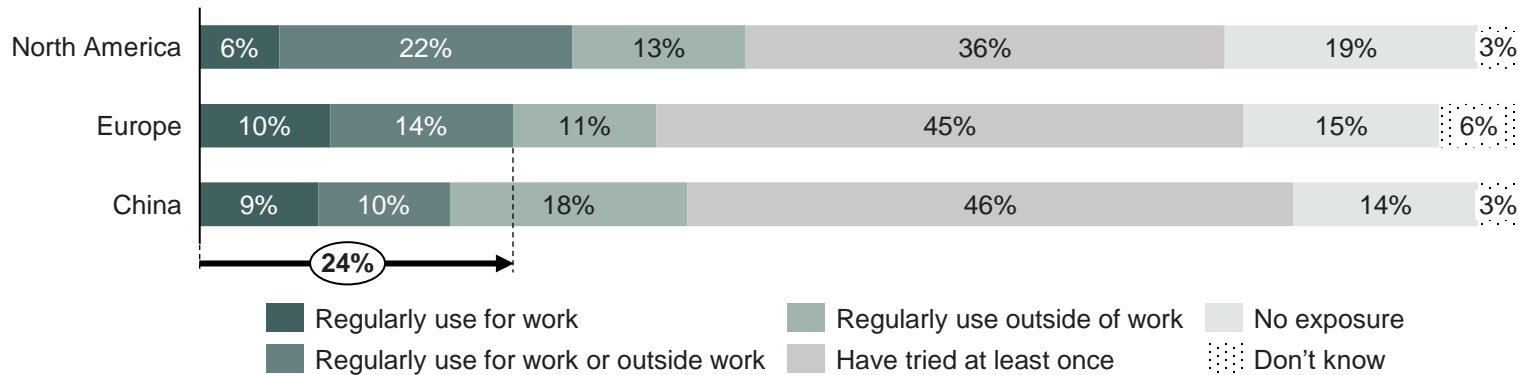
## Change in minimum requirements for AI use



- New generative AI offerings like Bard and ChatGPT are **free** and **easy to use** for everyone.
- More than **20%** of European employees use it regularly at work or outside work.
- European employees' use of **generative AI at work** (10%) is on par with or ahead of the US (6%) and China (9%).
- **9%** of EU companies report using AI (page 19).
- The technology is still at an early stage, and organisational-level uptake in the EU has yet to take off.

## Share of employees stating to have used generative AI tools online

% of survey respondents



**Notes:** Global survey conducted in April 2023. In Europe, n = 515; in North America, n = 392; in China (incl. Hong Kong and Taiwan), n = 337. Figures may not add up to 100% because of rounding.  
**Source:** Implement Economics based on McKinsey



# Leveraging the full potential of generative AI will require development and adoption of more specialised models

Requirements for using generative AI vary at different levels of adoption

<i>Adoption level</i>	AI trained specifically for the organisation	Pre-trained models accessed online	Pre-trained models used through APIs or license	Fine-tuning of pre-trained models	Development of foundation models
Adopting actor	Organisations	Individuals	Organisations	Organisations	AI providers
Solvable tasks	Specific	General	General and moderately specialised	General and specialised	Most
<b>Requirements</b>					
Data and compute					
Infrastructure					
Competencies					

Status before 2022



Current availability



Available with further development

- Before 2022, working with generative AI was demanding in terms of skills, data and infrastructure.
- Today, generative AI has become easy for individuals and organisations to use for general tasks.
- Some value-creating tasks are too demanding for free online pre-trained models to solve.
- Leveraging the full potential of the technology requires more advanced and better-trained models.
- This requires new organisational skills, more data, more computing power and better infrastructure.

**Figure explanation**

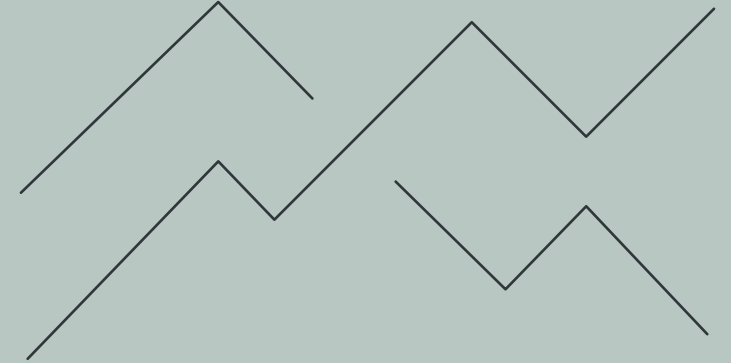
No requirements

Highest requirements

**Notes:** Training or fine-tuning generative AI models generally requires significantly more computational resources compared to classic machine learning training, leading to higher energy consumption and potentially greater environmental impacts such as increased greenhouse gas emissions. The consumption of these models, especially when deployed at scale, can also contribute to environmental strain due to the continuous use of computational power and energy, underscoring the need for efficient, sustainable computing practices and infrastructure.  
**Source:** Implement Economics based on OECD.

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# Generative AI's economic opportunity in D9+



# The D9+ countries can benefit from generative AI across many areas of society

For example ...

## Education

### **Personalised tutoring**

Boosts student performances by tailoring learning experiences to individual needs and making tutoring on demand.

### **Learning material creation**

Frees up educators' time by automating educational content that adapts to changes and student feedback.

## Legal services

### **Document review**

Reduces legal review times with generative AI's ability to rapidly identify pertinent legal information.

### **Contract generation and analysis**

Minimises contract-related risks by using AI to draft and evaluate legal documents for thoroughness and compliance.

## Software development

### **Code generation and debugging**

Shortens development cycles and improves code efficiency with generative AI's assistance in writing code.

### **Documentation and support**

Efficient maintenance by generating comprehensive documentation and user support materials based on the code.

## Healthcare

### **Diagnostic support**

Enhances diagnostic accuracy with AI by cross-referencing patient data against vast medical knowledge bases.

### **Patient interactions**

Improving patient care by facilitating patient engagement and follow-up with immediate medical advice on demand.

## Public administration

### **Automatic document handling**

Enhances public service efficiency with AI's streamlined processing of administrative paperwork.

### **Decision support**

Informs policy decisions by analysing complex data sets with AI to provide actionable insights.

## Research

### **Data analysis and synthesis**

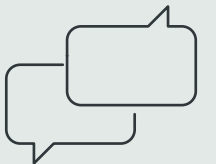
Utilising generative AI to analyse complex data sets, recognising new patterns and drawing conclusions.

### **Literature review automation**

Speeding up research by using AI to conduct thorough reviews of existing literature and summarise findings.

## Generative AI can help overcome language barriers in the D9+ countries

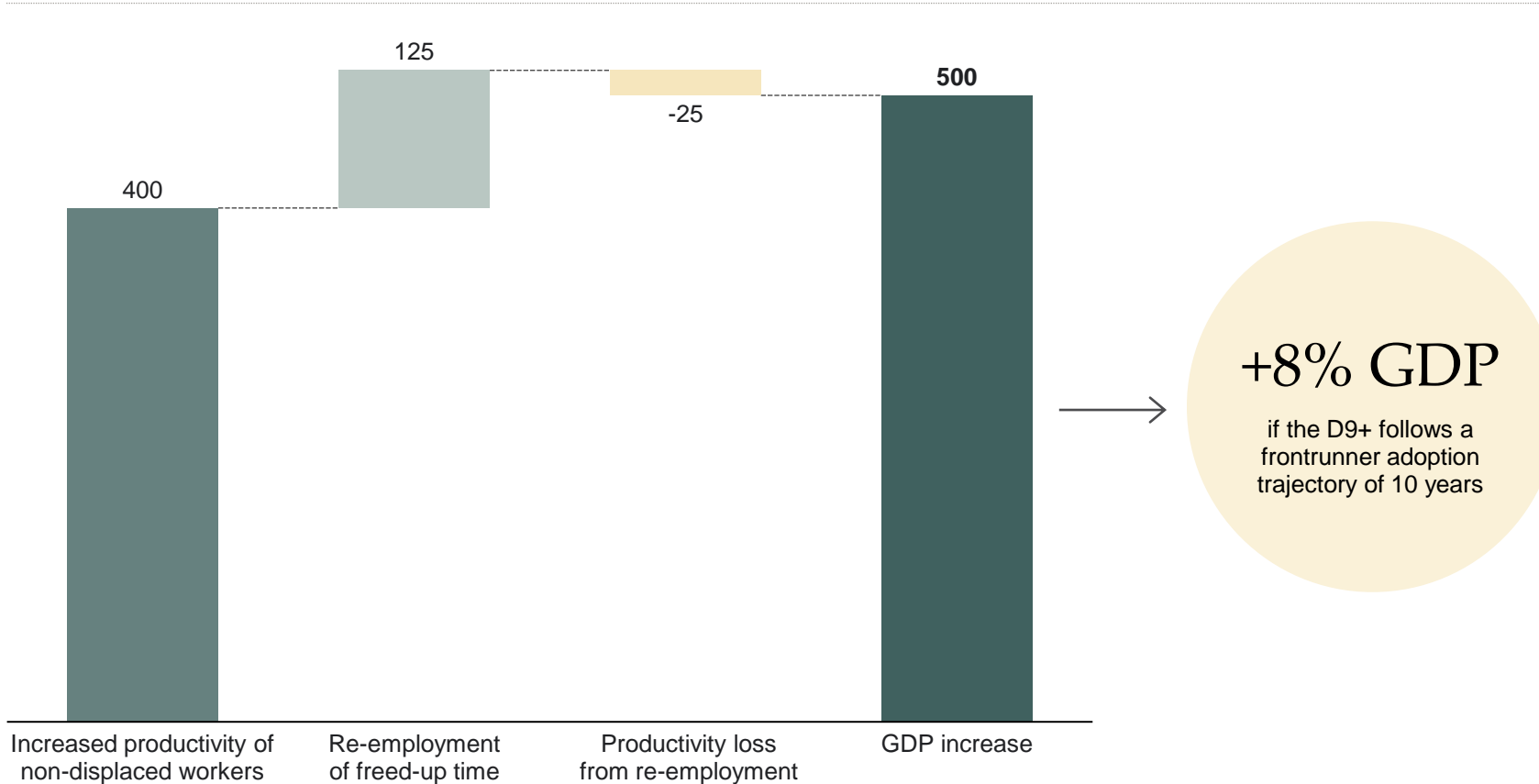
- D9+ countries are small and predominantly non-English-speaking countries.
- Trade, investment and labour mobility are hampered by language barriers.
- Large language models can analyse and translate content across languages seamlessly.
- **Thus, generative AI may have particularly high potential in the D9+ countries.**



# Generative AI could increase the size of GDP in the D9+ region by €500 billion or the equivalent of 8% of GDP

## GDP impact of generative AI in D9+ region

€ billion increase from baseline GDP after 10-year adoption period



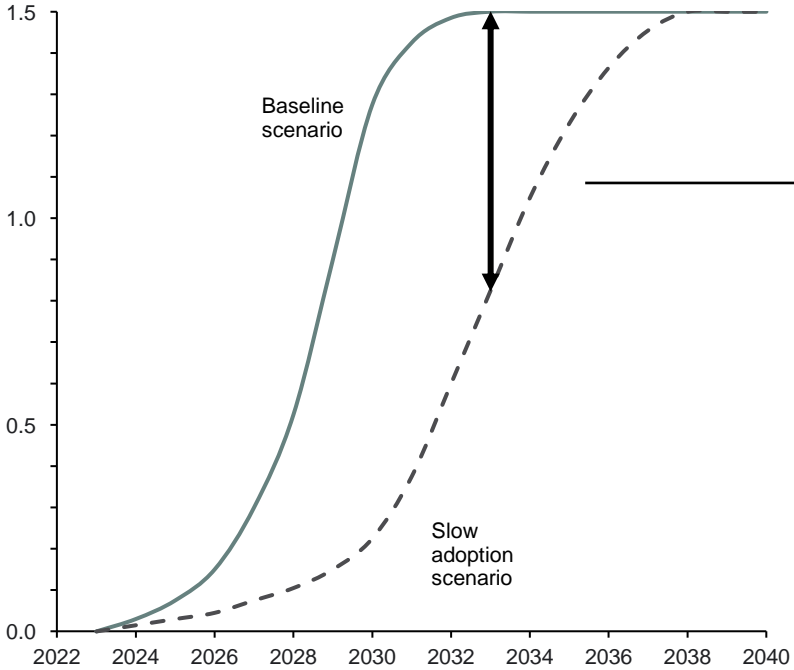
- 20-25% of work activities in D9+ can be automated by generative AI.
- Most of the D9+ workers will *work together with* generative AI, augmenting capabilities and efficiency enormously.
- If the D9+ countries adopt generative AI at the speed of frontrunner countries, this will create massive productivity gains of around €400 billion.
- It will also free up much-needed labour for other tasks, creating an additional positive impact of €100 billion (after productivity loss from re-employment).
- The long-term growth effect of full adoption of generative AI in D9+ is estimated to increase worker productivity equivalent to 1.5% p.a.
- **Generative AI is so powerful and fast-adopting that long-term GDP forecasts of the D9+ countries will need to be upgraded to lift GDP forecasts in D9+ from around 2028.**

**Notes:** The frontrunner trajectory assumes widespread adoption of generative AI for automating work activities that generative AI is capable of completing. This methodology is based on Goldman Sachs Global Investment Research. GDP is in 2022 levels.  
**Source:** Implement Economics economic model of generative AI based on Eurostat and O\*Net.

# A five-year delay in adoption of generative AI could reduce the potential GDP gains from 8% to 2%

## Realisation of productivity increases from generative AI

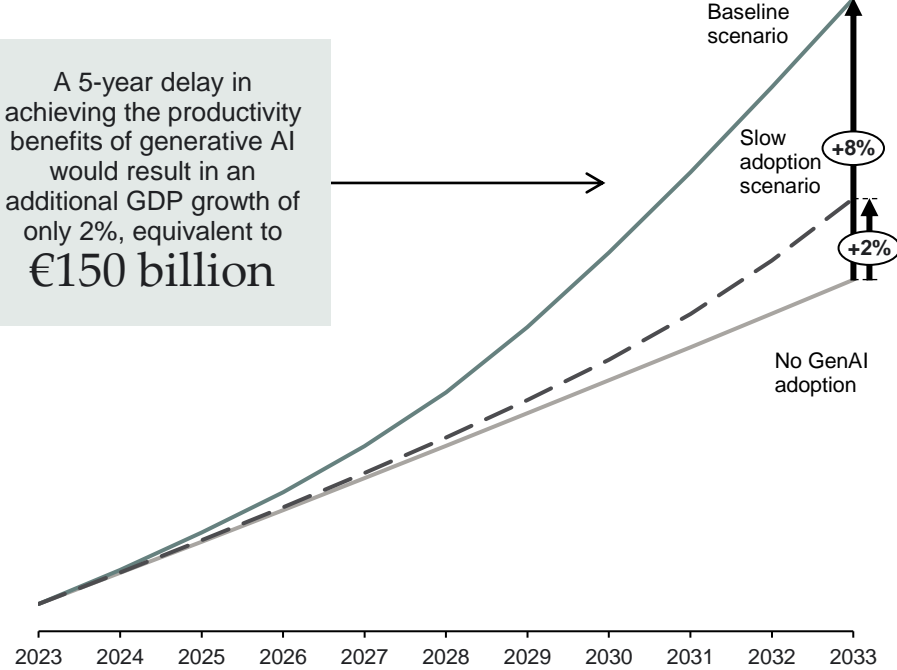
Productivity growth, % p.a.



## GDP in the D9+ countries

Index, 2023=100

A 5-year delay in achieving the productivity benefits of generative AI would result in an additional GDP growth of only 2%, equivalent to €150 billion



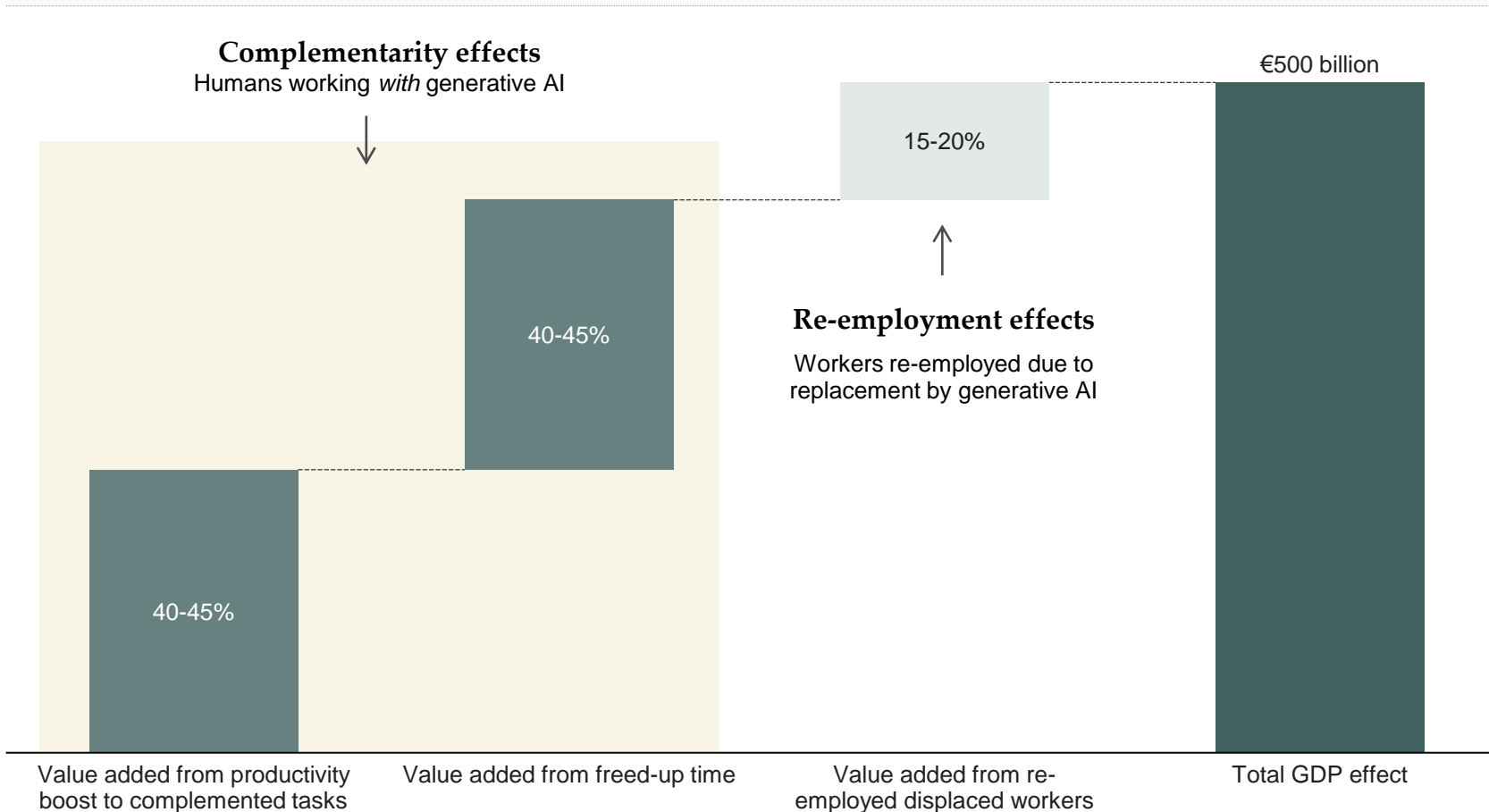
- The full economic gains are reliant on capturing the benefits of generative AI in line with the frontrunners.
- A 5-year delay in the full realisation of productivity benefits of generative AI could reduce the GDP growth potential in 10 years from 8% (€500 billion) to only 2% (€150 billion).
- **European frontrunners and policymakers can enhance the welfare and GDP contribution from generative AI by putting in place policies to capture the benefits of the new general-purpose technology.**

**Notes:** GDP figures in € billion are expressed in 2022 levels. The scenarios in this example are calculated under the assumption that all countries (developed and emerging markets) follow the same rate of realisation of productivity increases from generative AI.  
**Source:** Implement Economics economic model of generative AI based on Eurostat and O\*Net.

# The main economic opportunity in the D9+ arises from humans working together with generative AI

## Contributions to GDP effects by category

EUR billion



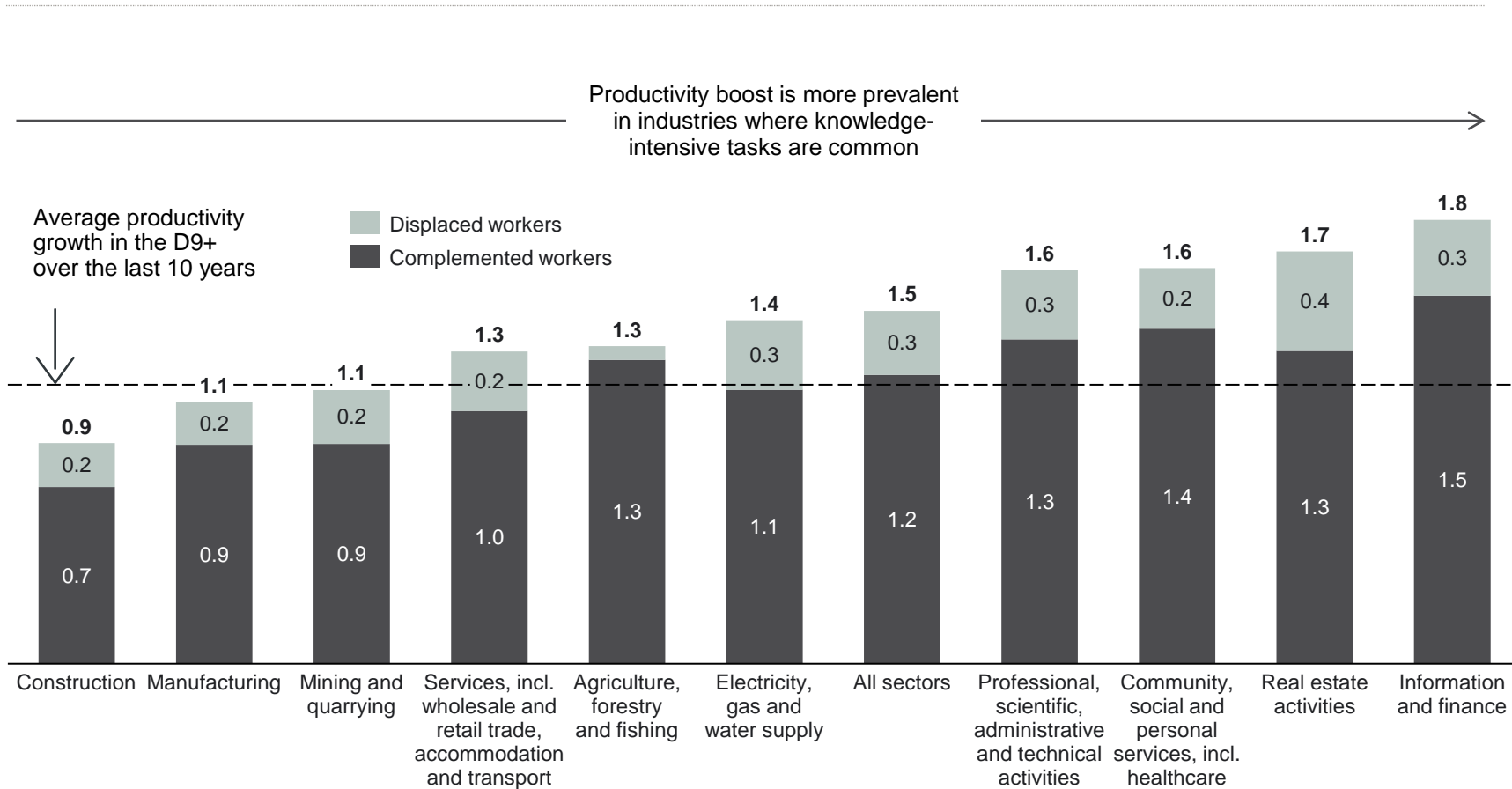
- The main benefit of generative AI arises when workers use the technology in their daily tasks (80-85% of total potential).
- The productivity potential arises from:
  - Boosting productivity from humans working with generative AI
  - Freeing up time by letting generative AI work instead of humans
- A smaller portion (15-20%) of the overall GDP increase is a result of workers being rehired into new jobs.

Source: Implement Economics economic model of generative AI based on Eurostat and O\*Net.

# Generative AI will create positive impacts across all industries, especially in knowledge-intensive industries – and will boost productivity above historic levels

## Increases in productivity from generative AI across industries

% growth in productivity p.a.

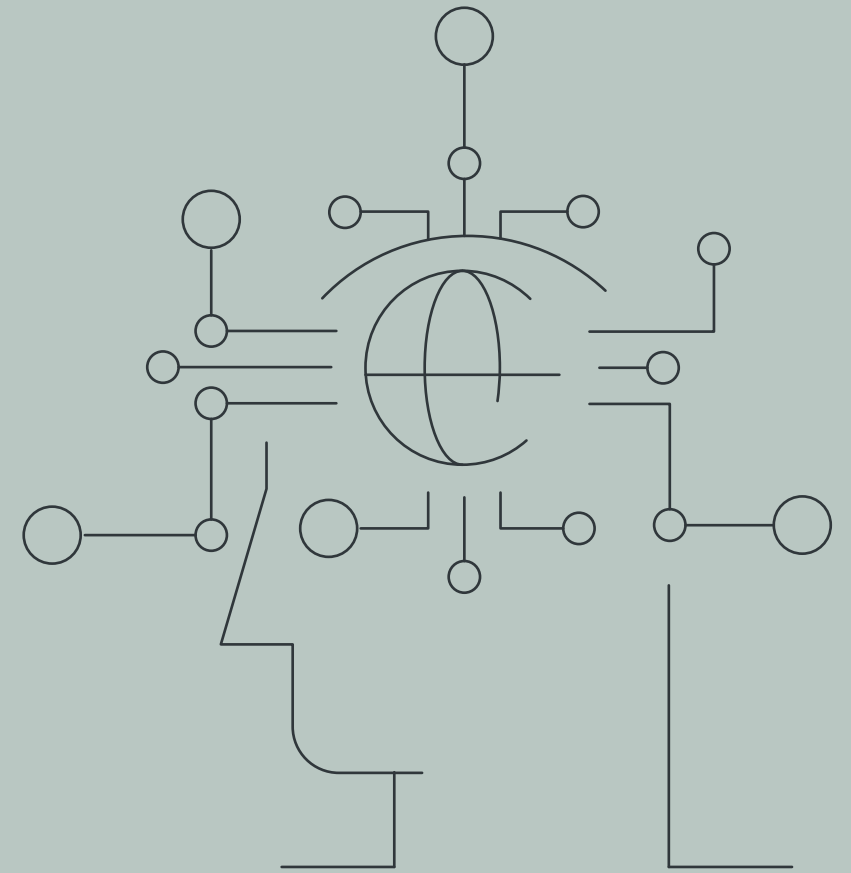


- In contrast to past automation, such as robots, generative AI has the ability to boost service sector productivity.
- Generative AI is particularly powerful in boosting knowledge work and helping highly educated people become more productive.
- This will provide a much-needed boost to service sector productivity, which has historically been difficult to increase.
- The complementary role of generative AI prevails in most industries, meaning that most occupations will use AI to augment and improve human capabilities.
- Pronounced displacement is limited to industries where administrative and repetitive knowledge-based tasks make up a large part of daily tasks.

Notes: Average productivity growth in the D9+ reflects GVA-weighted average of productivity growth across D9+ countries.  
 Source: Implement Economics economic model of generative AI based on Eurostat and O\*Net.

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# Generative AI and the job implications in D9+

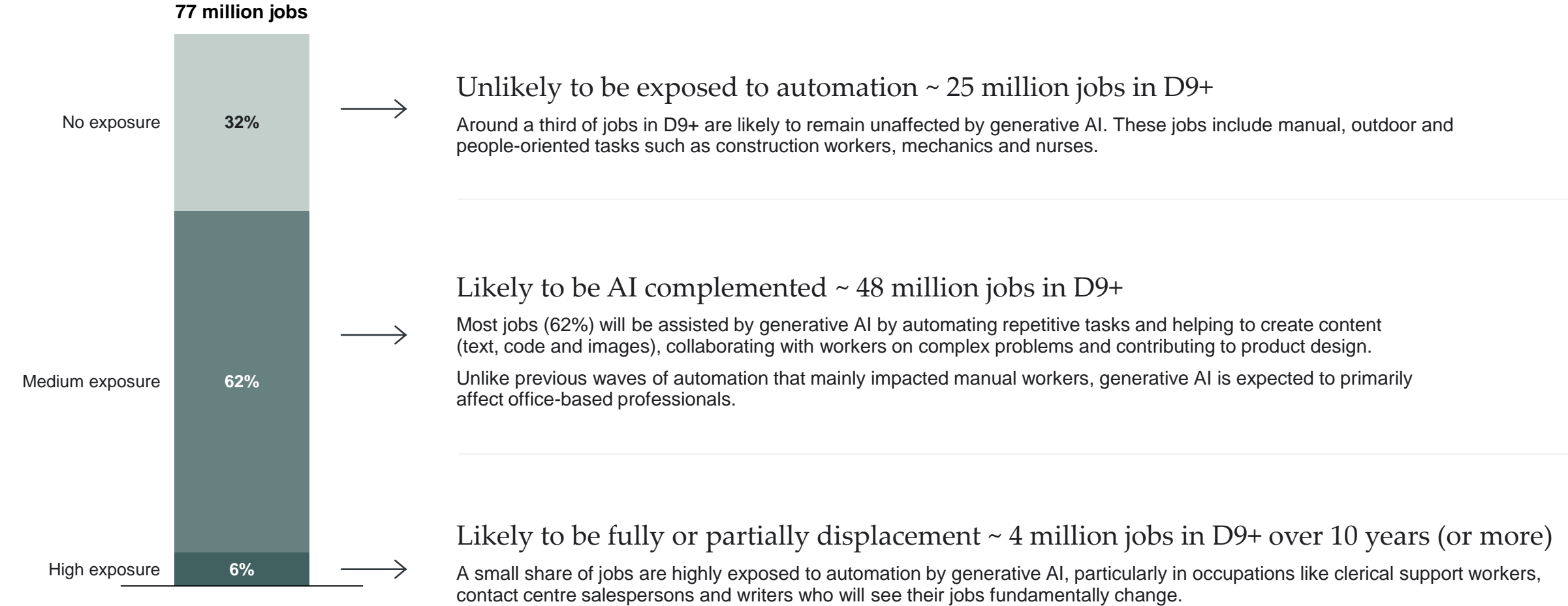




# Generative AI complements most jobs

## Share of jobs exposed to automation

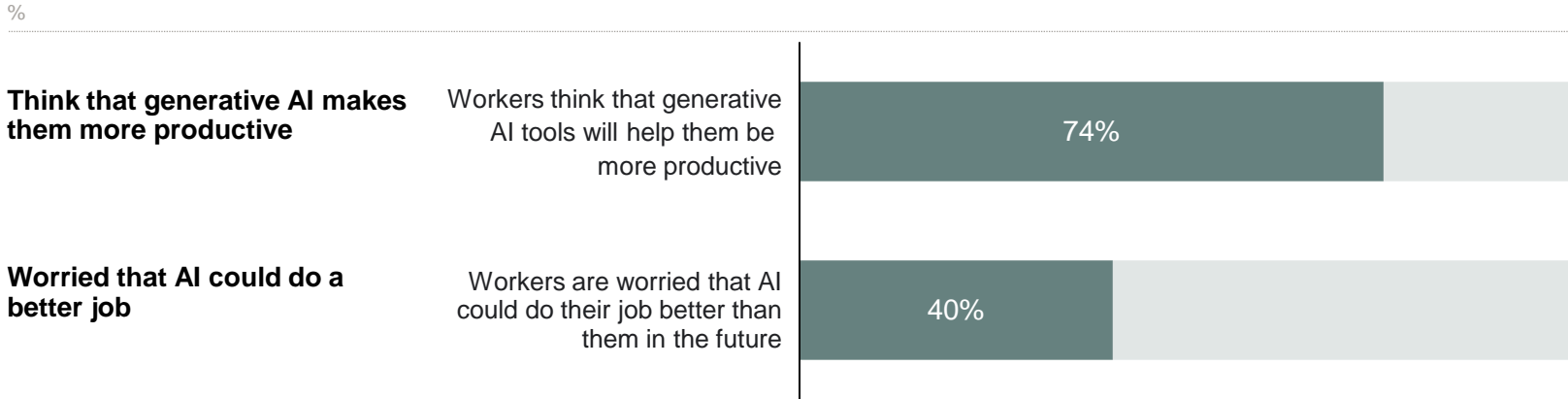
% of total employment in D9+



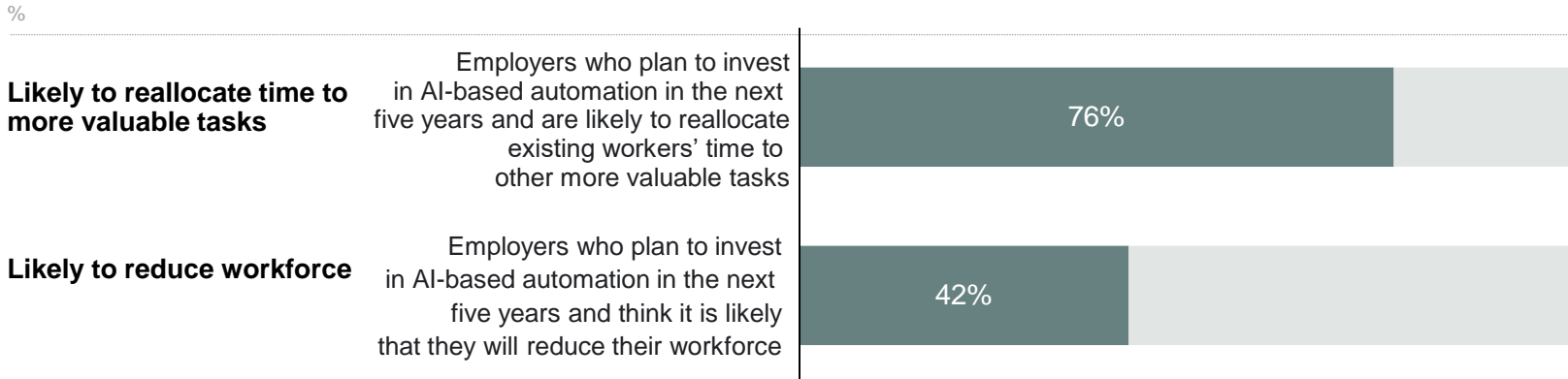
**Notes:** Based on employment data up until Q2 2023. In accordance with Goldman Sachs study, "No exposure" are occupations with less than 10% exposure, "Medium exposure" are occupations with 10-49% exposure, "High exposure" are occupations with exposure of or above 50%. Note that percentages and absolute numbers are rounded.  
**Source:** Implement Economics economic model of generative AI based on Eurostat and O\*Net.

# Both workers and employers expect the productivity-enhancing impact of AI to dominate the work displacement impact

## Workers' survey responses about AI



## Survey responses of employers planning to invest in AI-based automation



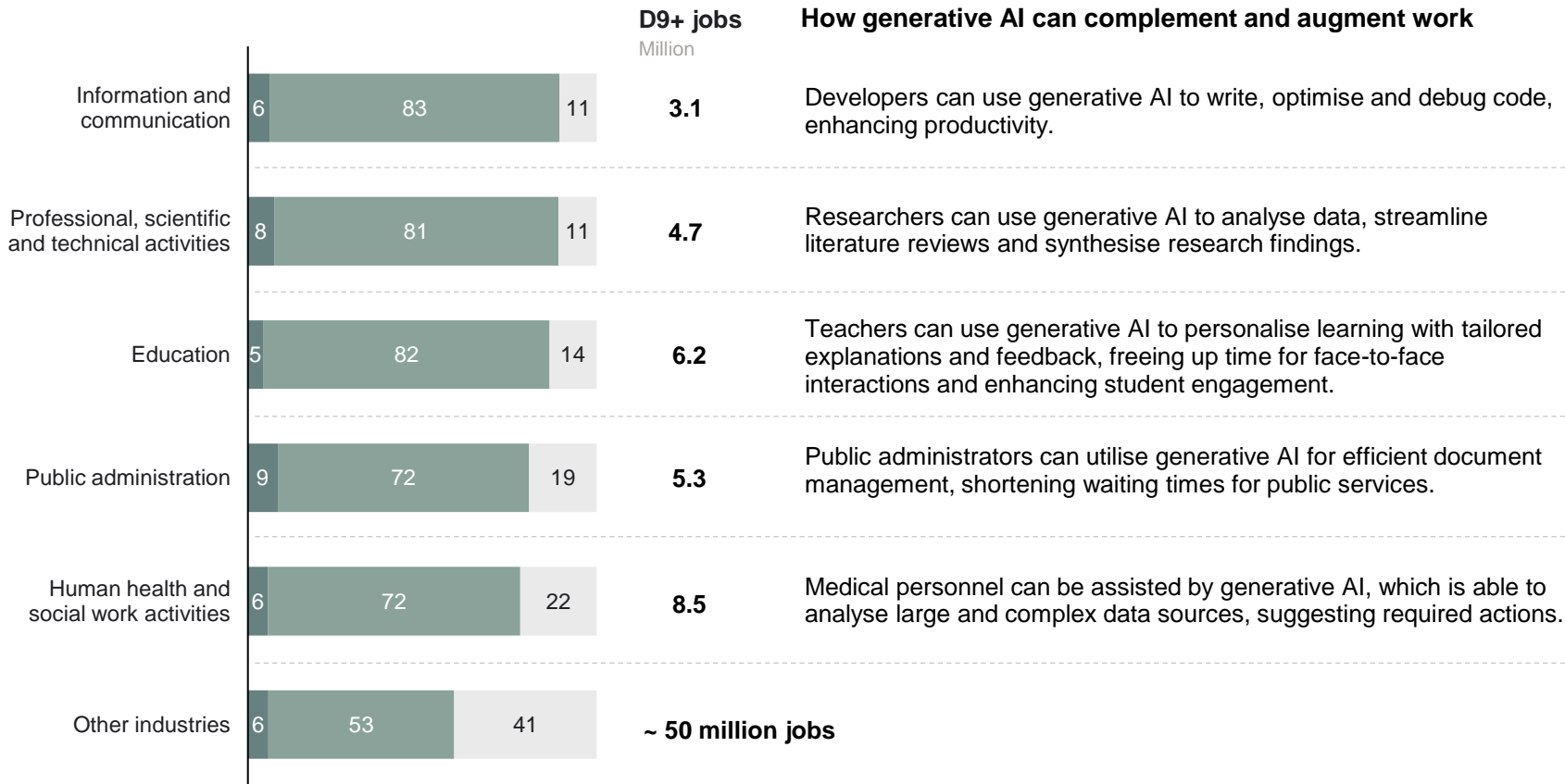
- Workers' expectations of how generative AI will affect the workforce and labour tasks are generally in line with employers' expectations.
- Workers and employers expect generative AI to have a higher impact on the jobs than we predict.
- 74-76% of respondents expect that workers will be complemented, while we estimate that it is 62% of workers.
- 40-42% of respondents expect that AI can do a better job, while we estimate that generative AI can displace only 6% of the workers.

# High shares of complemented jobs are in knowledge-intensive industries, such as IT, healthcare, professional sciences and education

## Share of work activity exposed to automation

% work in industry

No automation
  AI complement
  Likely replaceable

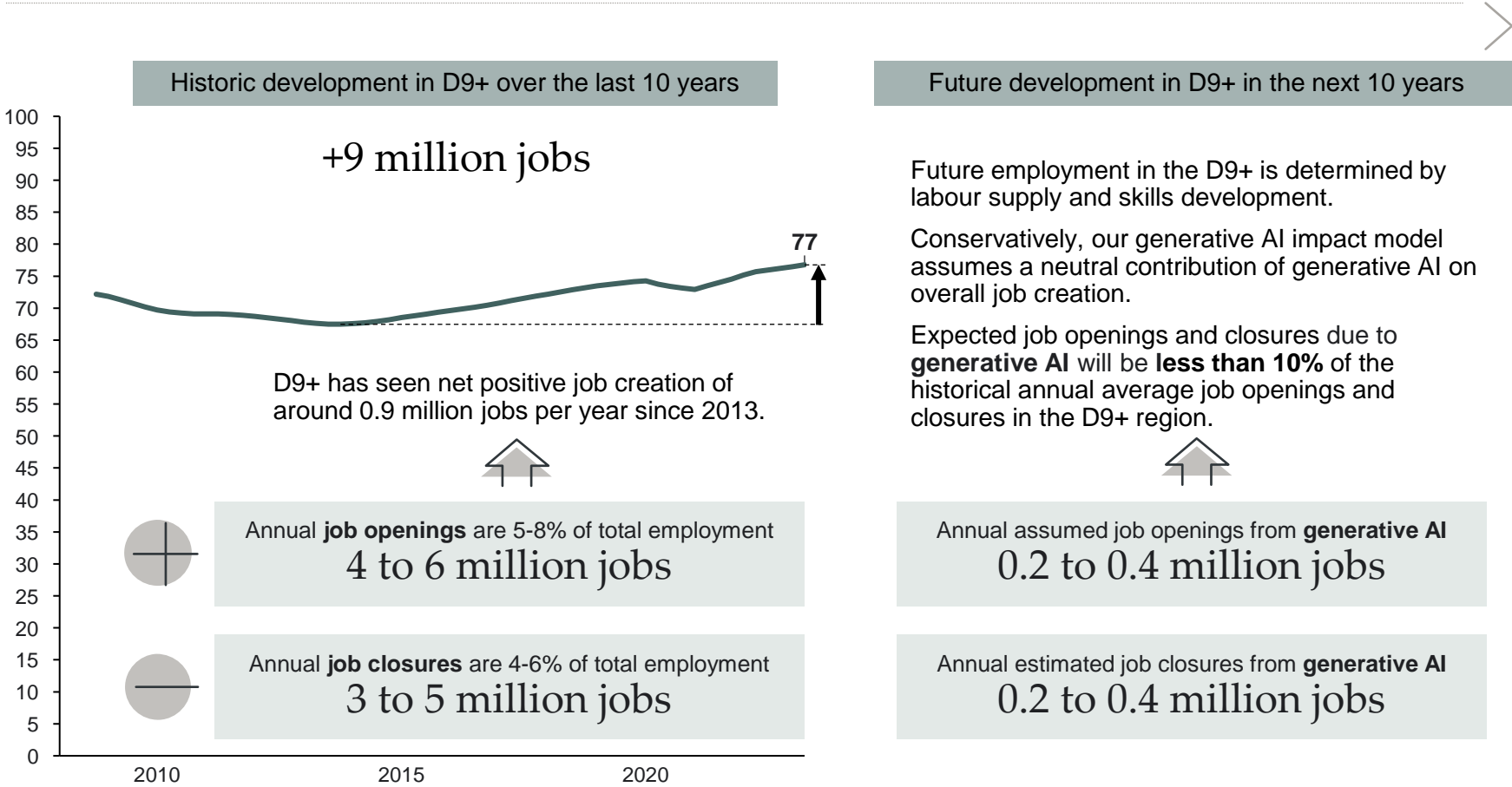


- Jobs that are complemented by generative AI tools can leverage these technologies to eliminate repetitive tasks and enhance quality.
- Professionals in roles augmented by AI can utilise these tools as professional support that allows them to challenge and refine their work processes, leading to higher-quality outcomes and innovation.
- Augmented sectors within the multilingual D9+ countries may derive additional value from large language models compared to the US.
- The model's advanced language capabilities, allowing for international information search and real-time translation, may foster more seamless international cooperation and accessibility.

# The D9+ region is well-placed to manage the job changes from generative AI

## Employment in the D9+ region

Millions employed aged 15 years and over



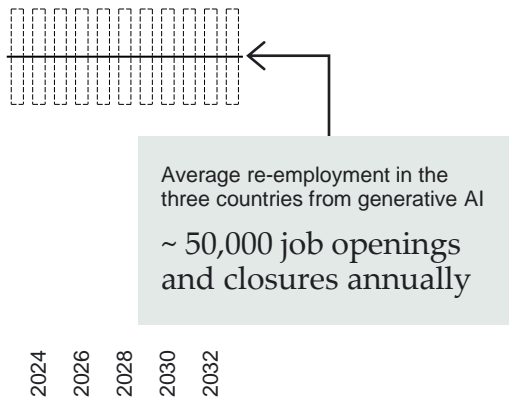
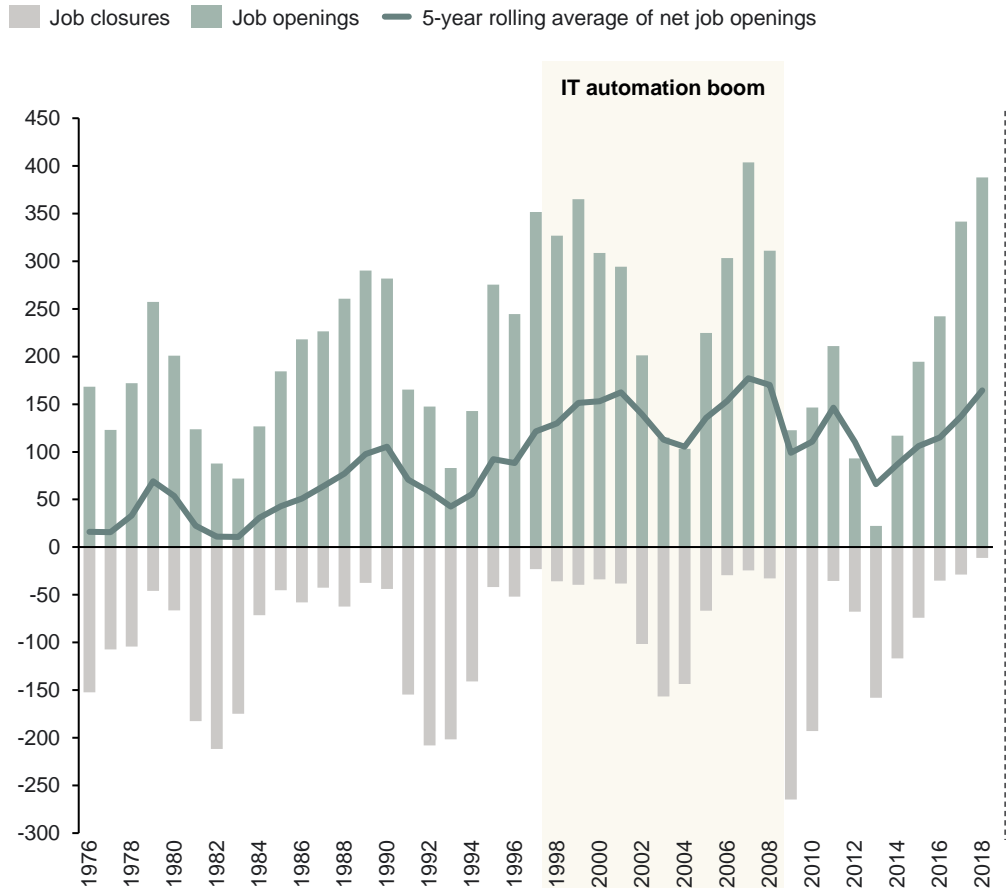
- The D9+ region has added 9 million jobs over the past 10 years, and the re-employment related to generative AI is small compared to normal job changes.
- Only a small fraction (6%) of the workforce in D9+ countries is at high risk of automation by generative AI, averaging 0.2-0.4 million people annually, assuming a 10-year adoption period.
- The productivity boost from generative AI will increase labour demand and help ensure re-employment.
- The availability of freed-up workers can help address labour market bottlenecks in D9+ countries.

**Notes:** Based on employment data up until Q2 2023. Our research shows that about 4 million jobs in the D9+ region are highly exposed to generative AI seen over 10 years. Between half of these jobs are likely to be displaced. This implies 0.2-0.4 million jobs on average per year over 10 years.  
**Source:** Implement Economics based on OECD, Eurostat and O\*Net.

# Historically, the digital frontrunners have created more job openings than closures – even during the IT automation boom

## Job openings and closures in Finland, Denmark and the Netherlands

1.000 employees

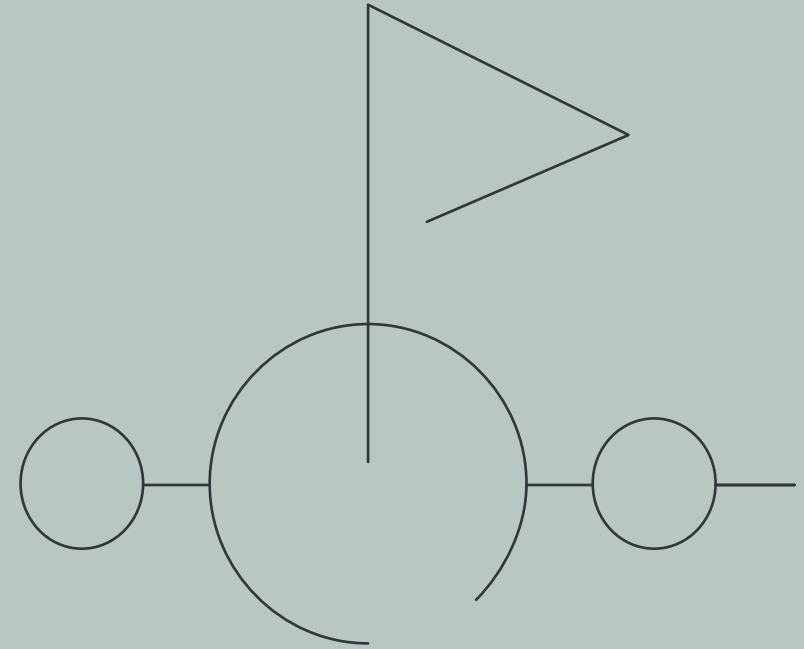


- Throughout history, technological advancements, economic circumstances and structural changes have shifted the labour market and led to continuous job openings and closures.
- Looking at three digital frontrunners in the D9+ since 1975 shows a positive net job creation in all three countries.
- Despite drastic technological changes since 1975, net job openings have, on average, been positive throughout the entire period.
- Looking ahead to the next 10 years, we find that the expected scale of re-employment due to generative AI is small compared to the historical and recent number of job openings and closures.

Source: Implement Economics based on economic modelling and Eurostat.

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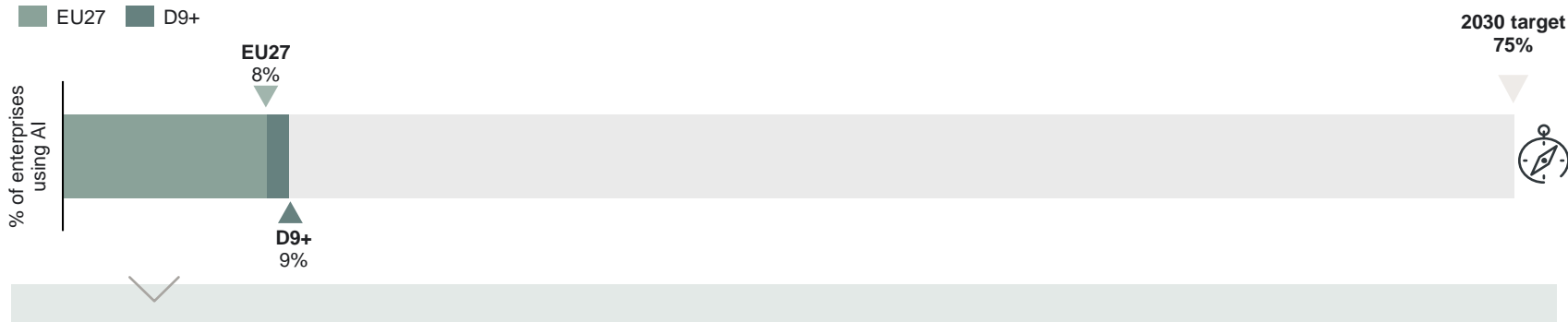
# AI readiness of D9+



# The D9+ is slightly ahead of the EU average on firm AI adoption, but at least five years behind a frontrunner trajectory to full economic potential of generative AI

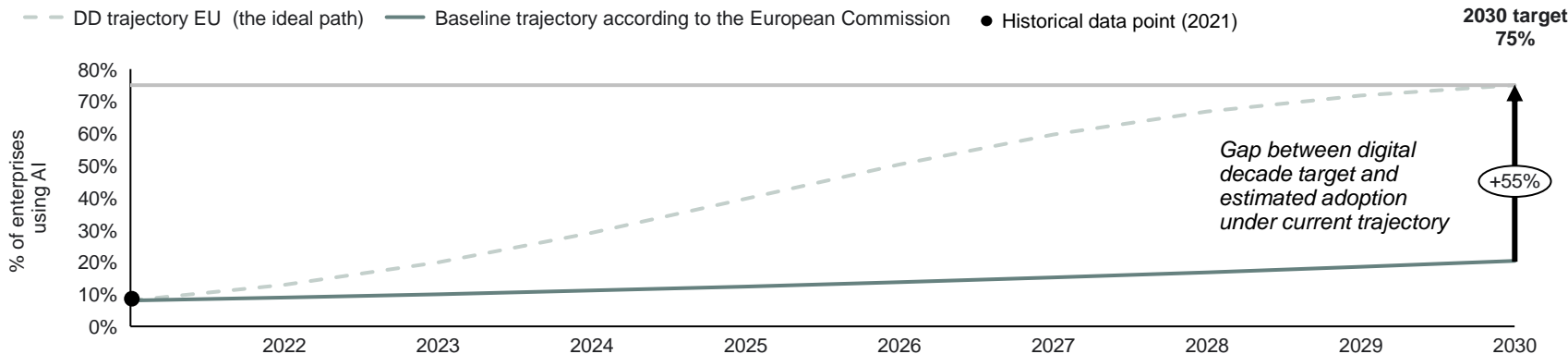
## Adoption of AI technologies in enterprises

% weighted average of enterprises with ten or more employees (excluding financial services) using AI, 2021



## Digital decade trajectory and baseline trajectory for the EU towards 2030

% of enterprises with ten or more employees (excluding financial services) using AI



- AI adoption varies greatly within the D9+ with 24% adoption in leading countries and only 3% in the slowest adopters.
- In its most recent assessment (bottom graph), the European Commission concludes that the EU is set to fall significantly short of its target on AI adoption for 2030.
- The baseline trajectory by the European Commission points to a risk of the EU and the D9+ adopting slower than frontrunner trajectory, suggesting the possibility of a short 10-year adoption period. A delay of at least five years seems likely.
- Firm-level adoption data underestimates actual use in business settings (see slide 7) as many instances of individual-level AI use are not captured.

**Notes:** The European Commission assumes the same speed for the diffusion parameter as in the big data baseline trajectory for the AI baseline trajectory, as they argue that AI adoption is usually a process complementing big data adoption. Data only includes enterprises with ten or more employees, excluding financial services.  
**Source:** Implement Economics based on Eurostat and the European Commission.

# Recent data from 2023 indicates accelerated generative AI adoption in D9+ but not enough to be on a trajectory to capture full economic potential

## Survey responses from business on their 5-year outlook on generative AI

% weighted average of enterprises, 2023

### FIRM-LEVEL INVESTMENT

in AI automation

% of companies that plan to invest in AI-based automation in the next 5 years

38%

### PRODUCTIVITY

from generative AI

% of companies that think that generative AI will significantly improve the productivity of their business in the next 5 years

34%

## Survey responses from workers on their 5-year outlook on generative AI

% weighted average of employees, 2023

### USE AT WORK

of generative AI

Workers expect to use generative AI tools in their jobs in the next 5 years

50%

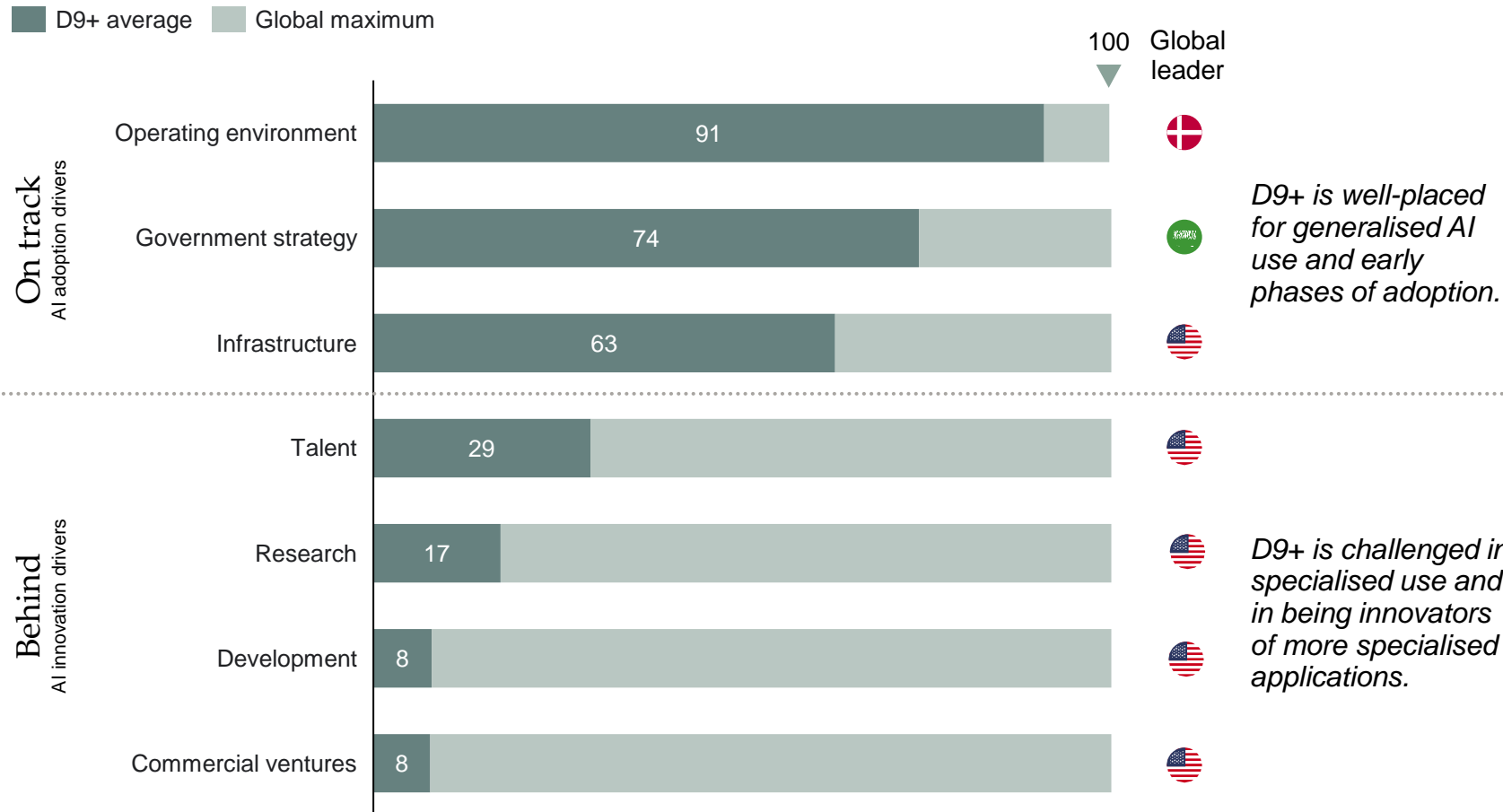
- **38% of companies** in D9+ claim that they are **likely to invest** in AI-based automation in the next 5 years.
- **34% of companies** expect generative AI to have **significant productivity impacts** on their business in the next 5 years.
- **50% of all surveyed workers** expect to **use generative AI** tools in their jobs within the next 5 years.
- While this suggests a faster pace of adoption, it is unlikely to be enough for the D9+ to capture the full economic potential of generative AI.



# Drivers of AI adoption suggest that D9+ is likely to step into a super-user role rather than emerge as lead innovators

## D9+ AI capacity according to the Tortoise Global AI index

Global AI index, score out of 100 (global leader)



*D9+ is well-placed for generalised AI use and early phases of adoption.*

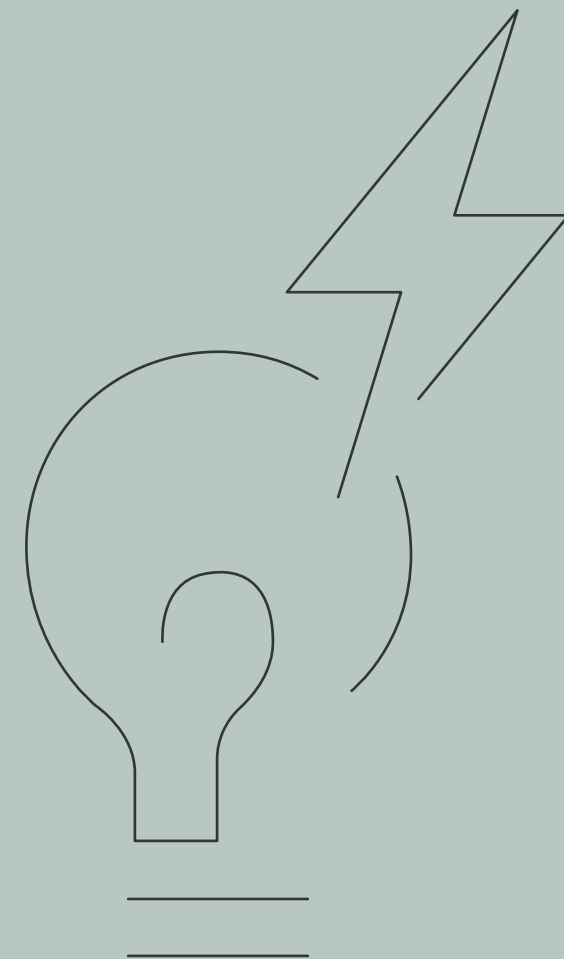
*D9+ is challenged in specialised use and in being innovators of more specialised applications.*

- D9+ is best positioned on the early **foundational drivers** of AI adoption that ensure a safe and reliable AI-ready environment: **operating environment** (e.g. trust, data governance), **government strategy** and **infrastructure**.
- However, more specialised AI use and the realisation of full productivity gains will require a cohesive and competitive innovation ecosystem that is conducive to development and commercial uptake. **D9+ lags behind on complementary innovations, investments and AI-related skills.**
- Current gaps suggest that the D9+ is likely to step into a **super-user role** in the future rather than emerging as **lead innovators**.
- This is similar to past digital revolutions, such as the ICT revolution, where the Eurozone fell short of the US due to similar gaps.

**Notes:** The Global AI index looks at seven sub-pillars for AI capacity: talent (availability of skilled practitioners in AI solutions, including IT graduates, data scientists, AI professionals etc.), infrastructure (download speed, supercomputing capabilities etc.), operating environment (regulation, cybersecurity etc.), research (AI publications and citations etc.), development (fundamental platforms and algorithms etc.), government strategy (national funding commitments to AI etc.) and commercial ventures (AI startup activity, investments etc.).  
**Source:** Implement Economics based on Tortoise Media and Capital Economics.

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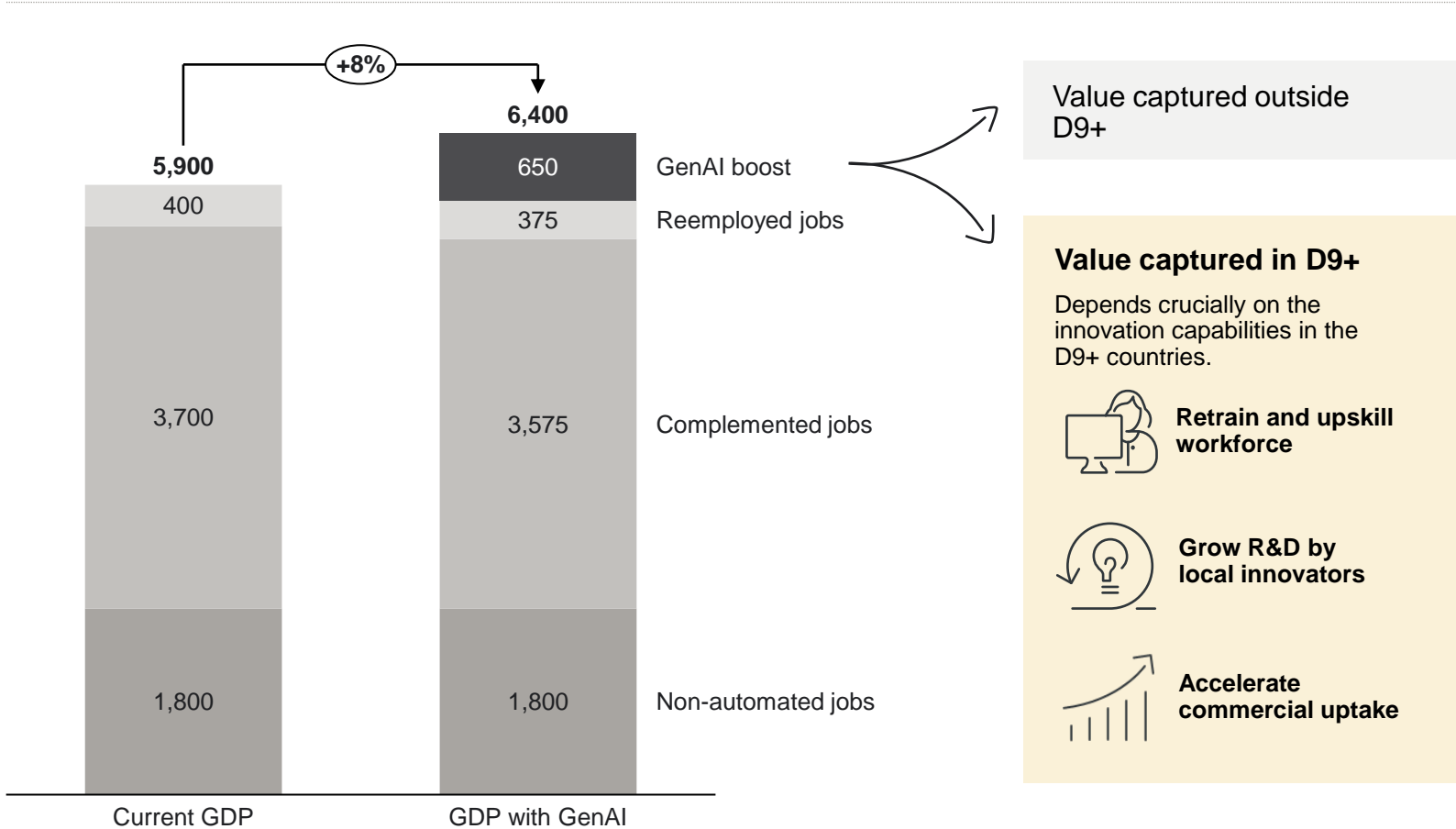
# Conclusions on the opportunity of generative AI in D9+



# Capturing the full economic gains requires innovation capabilities and a conducive regulatory framework

## GDP in the D9+ region

EUR billion



- The total value pool in the D9+ region from generative AI is estimated at around €650 billion.
- The D9+ region cannot take for granted that they will automatically capture the full value of generative AI.
- Capturing the full economic gains requires innovation capabilities and a conducive regulatory framework.
- As super users of AI, the D9+ countries will be able to adopt more advanced AI.
- Due to the lack of innovation capacity, the D9+ is at risk of losing out on the full potential of generative AI.
- If the D9+ wants to maximise the value added that is retained, it needs to ramp up its innovation capacity.
- In a worst-case scenario, the D9+ region could see a shrinking GDP if left with only the reduced labour demand and a productivity loss from re-employment.

Source: Implement Economics economic model of generative AI based on Eurostat and O\*Net.



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# Annex

Modelling the impacts of generative AI in the D9+ region

# Modelling the economic opportunity for the D9+ region

Overview of the methodological approach to calculating economic growth and productivity impact from generative AI

The economic effects are calculated in the following steps

1

**Automation potential of work activities:** First, the exposure to generative AI is calculated by breaking down the automation potential of 39 different work activities/tasks in the occupational task database O\*NET. The database includes an estimate for the share of each activity (e.g. getting information, performing administrative activities etc.) that can be automated by generative AI (if the activity is above level 4 on a O\*NET defined scale of difficulty 1-7, no automation potential is assumed).

2

**Mapping automation potential of work activities to occupations:** The automation potential of the work activities is mapped into ten European industry aggregates in two sub-steps. First, the 39 work activities are mapped to 900 US occupations using importance-average activities for each occupation, leaving us with an estimate of the share of each occupation's total workload that AI has the potential to automate. Secondly, this number is projected from US to European occupations through the European Commission's crosswalk between ESCO and O\*NET and finally compiled into aggregated occupations (using the sub-occupation employment). This leaves us with the three shares that describe how big a share of the work activates for each occupation is expected to see: No automation, AI complement and Likely Replacement.

3

**Quantifying productivity gains in each sector:** Generative AI is assumed to affect the productivity of the work activities for each occupation as follows (see section 3 for further details). The "No automation" share of work activities is assumed to be unaffected by generative AI. "AI complemented" work activities experience a productivity boost from automation. "Likely Replacement" is the share of working hours in a sector that is expected to be entirely automated/replaced. These workers are expected to be re-employed in slightly less productive jobs. The three effects are calculated across sectors and scaled by each sector's value added to determine the full productivity potential/generation of new jobs from generative AI across the economy, once the technology is fully phased in.

4

**Aggregate GDP impact:** Based on the estimated increase in labour productivity resulting from AI adoption, the result is aggregated to an overall GDP. Only part of the total long-run productivity increases from generative AI is expected to materialise in the economy during the initial 10-year period of technology adoption following an S-curve adoption trajectory.

- The method used to calculate productivity and GDP effects of generative AI in this paper is in line with the methodology developed by Goldman Sachs Global Investment Research in "The Potentially Large Effects of Artificial Intelligence on Economic Growth".

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# Disclaimer

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