IMPLEMENT
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The economic opportunity of AI in Estonia

Capturing the next wave of benefits from generative AI

An Implement Consulting Group study commissioned by Google

April 2024

SUMMARY

AI can boost economic growth in the coming decade

To capture the next wave of AI benefits across society, Estonia needs to promote innovation, invest in skills and ensure clear rules.

The economic opportunity

Generative AI technology is developing faster than previously anticipated, and the peak economic contribution could come sooner than expected, already in around ten years.

In the peak year, generative AI alone could boost Estonia's GDP by

€2.5-3 billion

+8% GDP
annual contribution in the peak year if Estonia achieves widespread adoption.

Gains come from three sources …

Productivity boost from people working with generative AI.

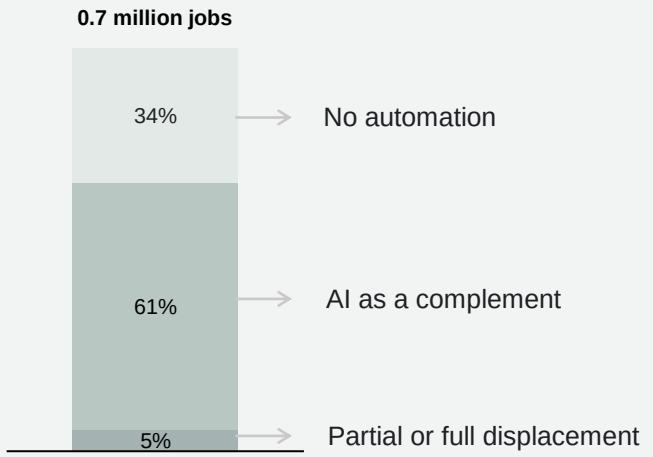
Freed-up time when generative AI helps to automate our work.

Re-prioritised and re-employed time for other value-creating activities.

The job implications

61% of jobs in Estonia are estimated to work **together with** generative AI.

Share of jobs exposed to automation by generative AI
% of total employment in Estonia



Estonia is well placed to manage the job changes from generative AI.

New jobs in the AI-powered economy are expected to replace those lost due to automation, resulting in unchanged employment levels. The highly exposed jobs represent less than 10% of the historical level of job changes in Estonia.

The transition is expected to be gradual, allowing workers time to adapt to new tasks and develop new skills.

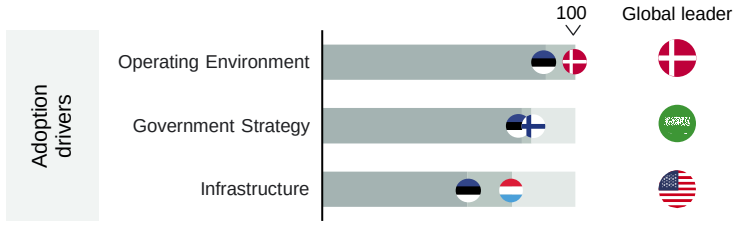
SUMMARY

Estonia leads the EU in commercial AI ventures and startups but needs to leverage EU innovation efforts to fully capture the benefits of AI

AI readiness in Estonia

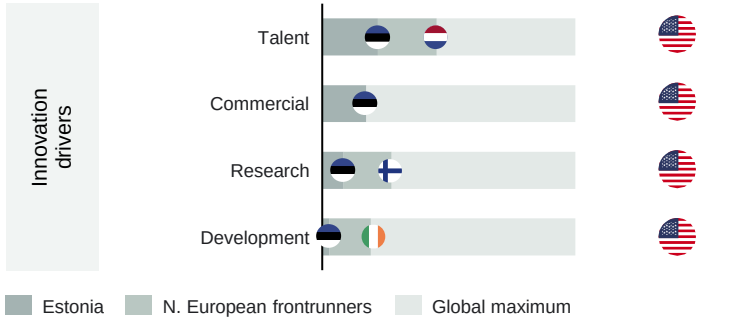
Estonia performs well on AI adoption drivers like other small, digitally advanced European economies …

Estonia's AI capacity according to the Tortoise Global AI Index
Global AI Index, score out of 100 (global leader)



On track
Estonia scores high on operating environment for AI (e.g. trust, data governance) but lags behind Northern European frontrunners in government strategy and infrastructure.

… but lags behind on innovation drivers compared to global leaders



Behind
While Estonia leads Northern European frontrunners on commercial AI capacity, it lags behind in innovation, investment and AI-related skills on a global level.

Conclusions and policy implications

Estonia's future economic growth could exceed current long-term GDP forecasts. Leading banks are raising growth forecasts from as early as 2028.

The 8% boost to annual GDP at peak assumes that Estonia achieves widespread adoption in line with leading countries.

A five-year delay in adoption will reduce the annual GDP potential of generative AI in Estonia from 8% to 2% of GDP i.e. from €2.5-3.0 billion to €0.5-0.7 billion.

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

Accelerate commercial uptake

Grow R&D by local innovators

Retrain and upskill workforce

Note: The Tortoise Global AI Index is underpinned by 111 indicators collected from 28 different public and private data sources and 62 governments. Northern European frontrunners refers to nine European countries comparable to Estonia in terms of size and level of digitalisation.

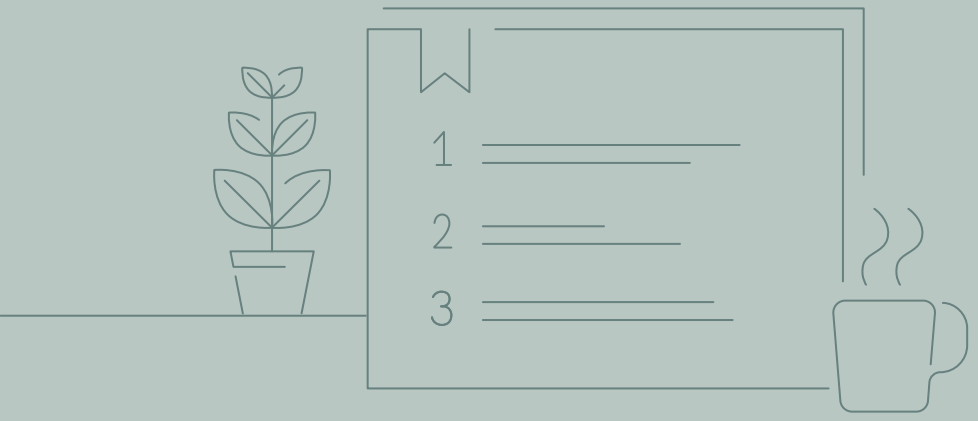
Foreword

Making AI benefit society as a whole requires an adaptive, human-centric and trustworthy approach

AI and the next wave of generative AI have the potential to be the most powerful technology in decades. Responsible AI can help solve global challenges like climate change and access to quality medical care.

AI can make countries more prosperous, productive, innovative, creative and secure. At the same time, there are plenty of pitfalls, paradoxes and tensions that decision-makers will need to navigate.

AI has evolved rapidly with the breakthrough of generative AI in 2022 and its fast adoption in 2023. This report estimates the economic potential of generative AI while recognising the significant economic potential of other types of AI.



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01

Introduction to AI

This report covers all types of AI with a particular focus on generative AI.

AI can help humans solve tasks faster and better – and with generative AI, machines can now understand and interact in language, sound and images

Artificial Intelligence (AI)

- AI is a general term for anything that allows computers to carry out human-like behaviours, including rule-based programmes.

Machine Learning (ML)

- ML is a subset of AI where machines do not need to be explicitly programmed. They use algorithms to identify and learn patterns in data, apply that learning and improve themselves to make better and better decisions.

Deep Learning (DL)

- DL is a subset of ML where computers learn in a way that mimics the human brain. In deep learning, machines build layers of knowledge that are increasingly complex.
- These AI models are typically trained on specific data sets and used within a given field or industry.

Capabilities include:

Forecasting and prediction

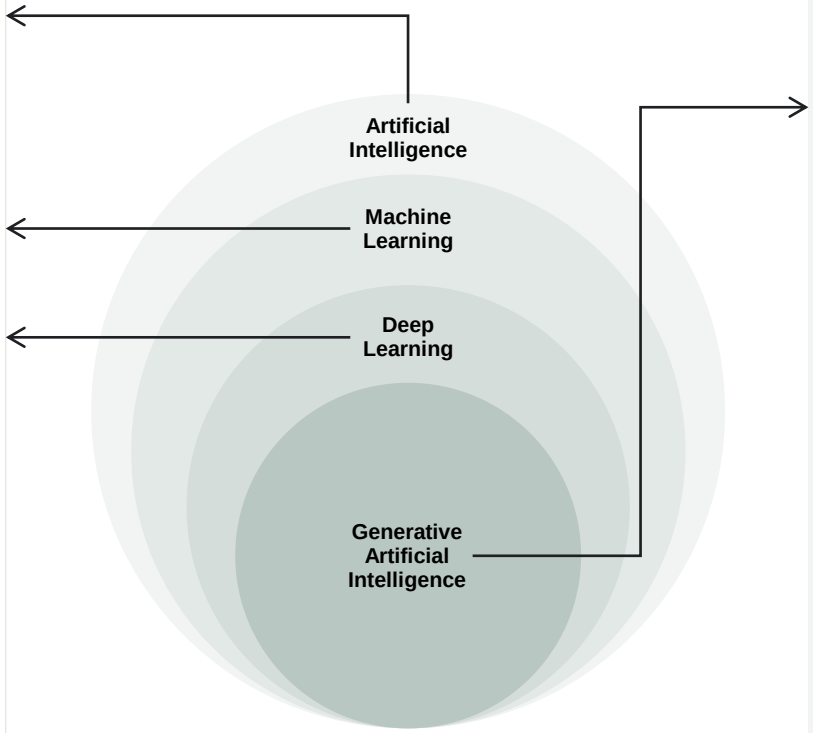
In addition to weather forecasting, similar predictive models are employed in managing warehouse inventories.

Categorisation and recognition

Beyond email spam filtering, AI can be utilised to categorise and recognise patterns in legislative documents.

Optimisation

When it comes to optimisation, AI not only aids navigation via GPS but also plays a crucial role in enhancing the efficiency of energy consumption in data centres.



Generative AI

- Generative AI is a new form of AI made publicly available in 2022. It can understand text, code, images, sound and video and can use it to generate or synthesise new content.
- Generative AI models are trained on huge general data sets to gain a general comprehension of text, visuals, code and sound.
- Generative AI can be used generally across almost any field or industry.

New capabilities include:

Create new unique images

For example, generating an image of a product that does not yet exist based on user input in natural language.

Interact with voice and sound

For example, translating a doctor's memo into a structured text or following up with a customer in writing based on a phone conversation.

Analyse and revise text and code

For example, translating text and adapting it to a different target group or translating code between programming languages.

Do research and analyse data

For example, searching the web for relevant information and synthesising conclusions from large data sets.

Note: An algorithm is a detailed set of instructions that a computer follows to carry out a task or solve a problem.
Source: Implement Economics based on expert interviews.

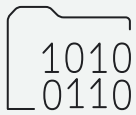
Recent developments have increased the capabilities and availability of AI models and have accelerated uptake

Generative AI models have strong built-in capabilities and are easy to work with …

01

No or low data requirements

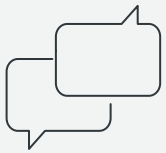
Generative AI models are already trained on huge data sets. This makes them readily available for many tasks without any further data needed.



02

Easy to use in plain language

Generative AI models can be operated using ordinary language and do not require any specific coding skills to use.

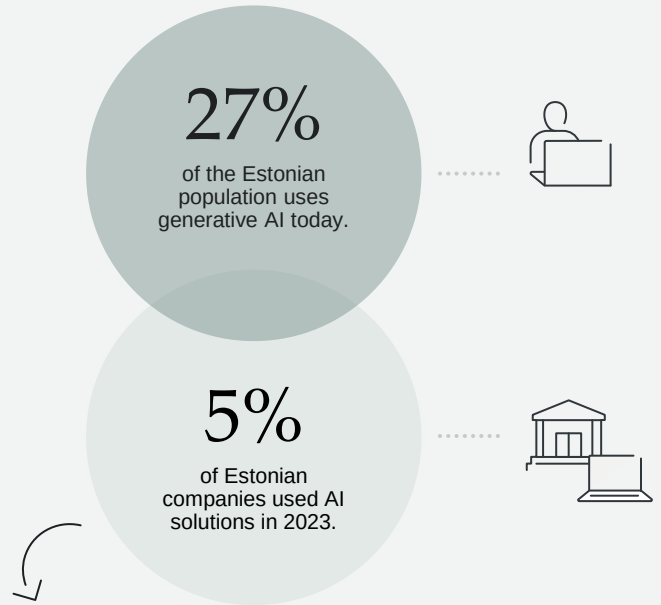


03

Many models are online and free of charge

Several high-performing generative AI models are available online and do not require local ML setups or infrastructure to use.

… and many users have already adopted the technology



Solutions adopted at a company level are driven by non-generative solutions today.

Generative AI is still at an early stage and is yet to be widely adopted at a company or institution level.

Source: Implement Economics based on surveys by Statistics Estonia and Norstat.

Leveraging the full potential of AI will require further research, development and innovation

AI capabilities and requirements by level of development

	Organisational ML-based AI	Generic pre-trained models used online	Adaption of pre-trained models using APIs	Specialised fine-tuned models	Foundation models
Solvable tasks	Specific	General	General and moderately specialised	General and specialised	Most
Example	*E.g. detection of flawed products in manufacturing*	*Online chatbots, e.g. Gemini or ChatGPT*	*Organisation-level automation solution, e.g. auto-replies.*	*Pre-trained model like Llama trained further on context-specific data*	*Model trained from the ground on new data, e.g. Mistral*
Requirements					
Competences for use	●	○	◔	◔	◔
Competences for integrating solution	◔	◔	◔	◔	●
Data and infrastructure	◑	○	◔	◔	●
	Pre-2022	Current fast-adopting models	Next level of adoption	Only adopted by few frontrunner organisations	New frontier of AI

- Generative AI is still in its early phase using generic pre-trained models.
- Future value creation from AI requires more advanced models than the pre-trained models that are available online today.
- Leveraging the full potential of AI technology requires more advanced and specialised models.
- This requires new organisational skills, more data, more computing power and better infrastructure.

Figure explanation

○ No requirements

● Highest requirements

Note: Training or fine-tuning generative AI models generally requires significantly more computational resources compared to classic machine learning training.
Source: Implement Economics based on OECD.

02

Economic opportunities from AI

The main economic opportunity in Estonia arises from humans working together with generative AI.

AI has great economic potential which can be further boosted by generative AI

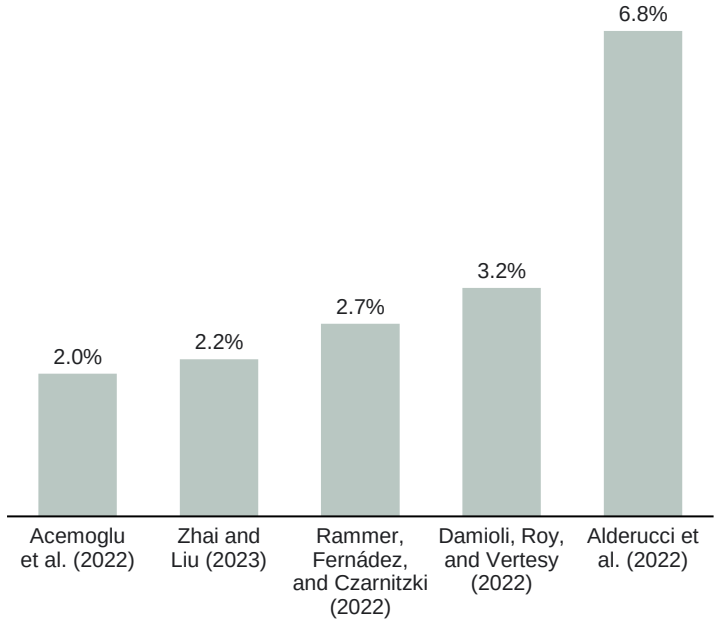
How to think about generative AI:

"What would you do if you had 1,000 well-trained interns ready to work for you day and night?"

AI can increase productivity

Academic studies conclude that labour productivity typically increases by 2-3 percentage points per year after firm-level AI adoption. The studies have been carried out on early adopters of AI technology and, as such, cannot be extrapolated to the general effects of AI on productivity.

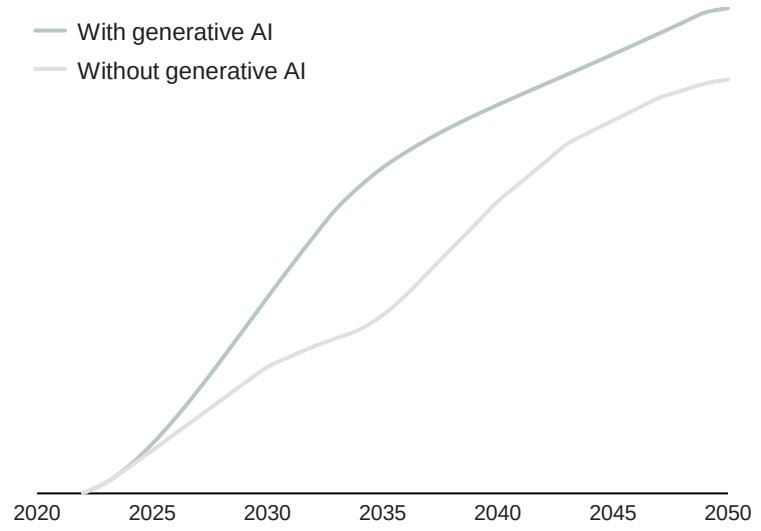
Growth in labour productivity from AI adoption
Percentage points



Generative AI advances automation

Generative AI can advance automation by nearly a decade because it is easier to use for individuals and organisations. However, significant uncertainty about adoption rates and speed of realisation of its benefits remain.

Automation potential
Adoption of AI technology



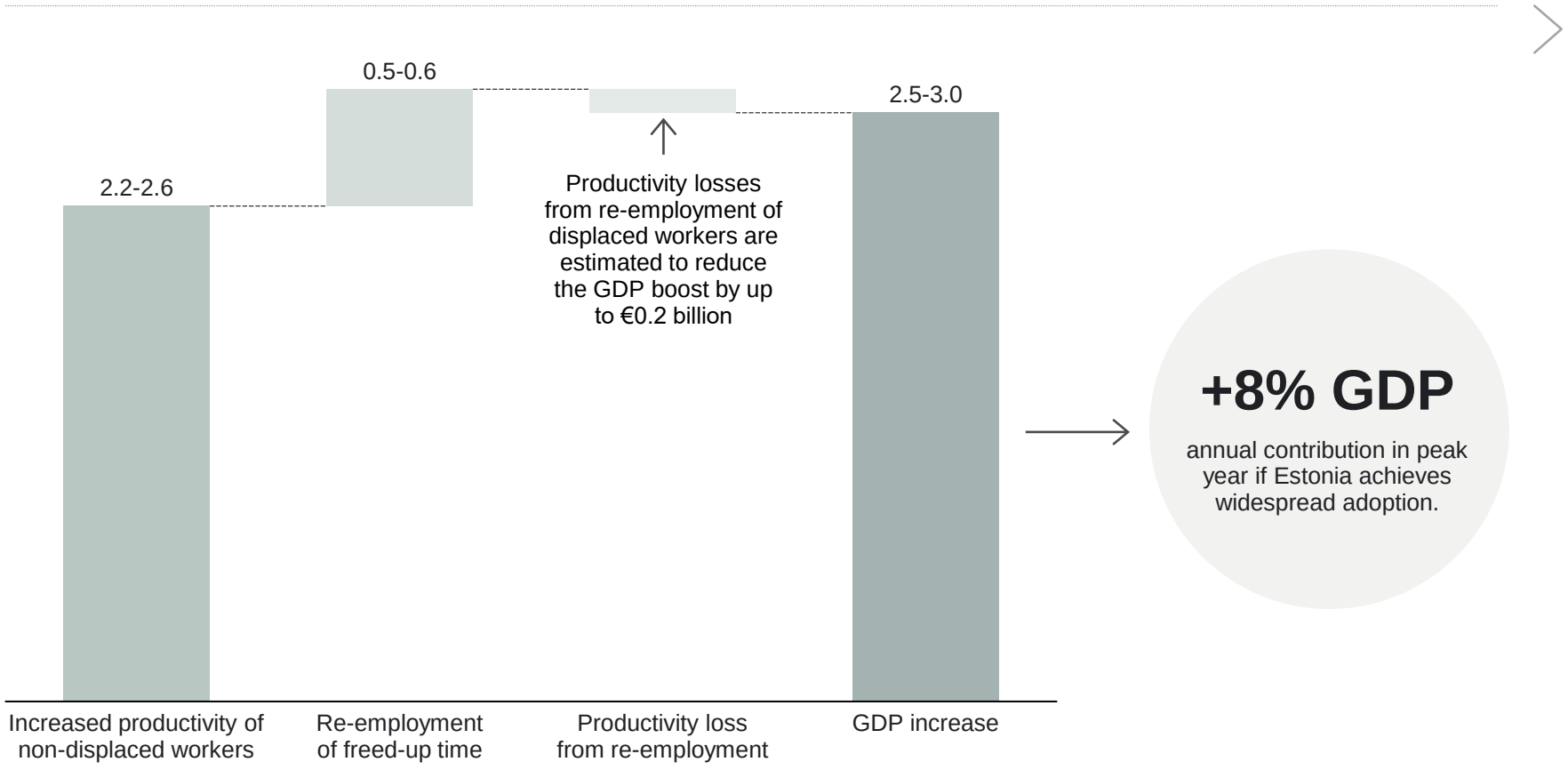
- AI has evolved rapidly with the recent breakthrough of generative AI. Due to its user-friendly nature, generative AI is expected to greatly accelerate the potential of AI to create economic impacts.
- Generative AI is only a part of AI's overall economic potential. Some studies estimate with some uncertainty that generative AI accounts for around one-third of the total effect of AI.
- This report estimates the macroeconomic potential of generative AI while recognising the significant economic potential of other types of AI.

Source: Implement Economics based on Brynjolfsson et al. (2019), Acemoglu et al. (2022), Andersen, Harmsen, Rants and Schröder (2023), Alderucci et al. (2022), Rammer, Czarnitziki, and Fernández (2022), Damioli, Roy, and Vertesy (2022), Zhai and Liu (2023).

Generative AI could increase Estonia's GDP by 8% in ten years

GDP potential of generative AI in Estonia

€ billion annual increase from baseline GDP after a ten-year adoption period



+8% GDP

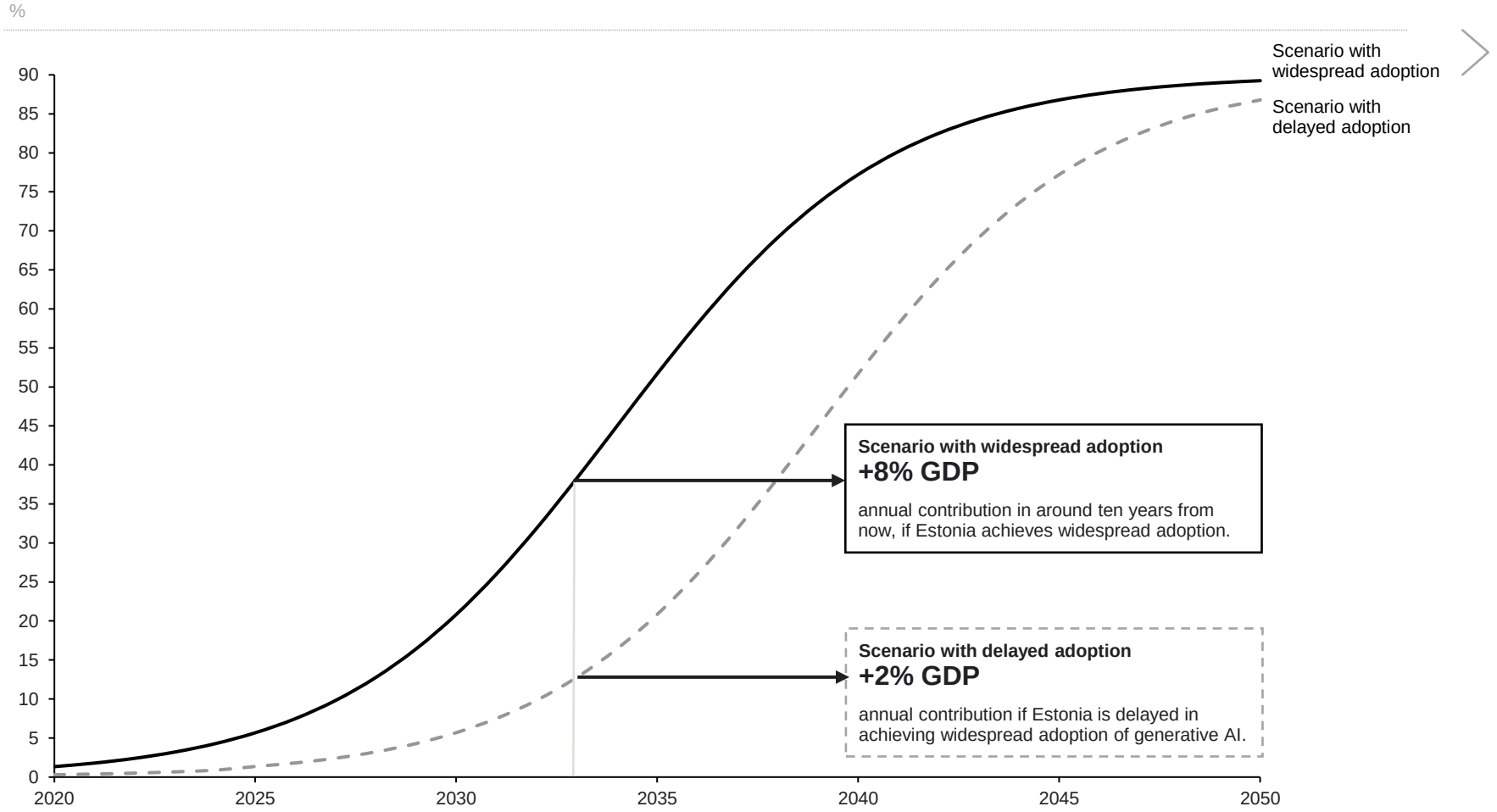
annual contribution in peak year if Estonia achieves widespread adoption.

- If Estonia achieves widespread adoption of generative AI, we estimate an annual GDP potential of €2.5-3.0 billion in the peak year, which could be already in around ten years from now.
- The dominant impact of generative AI is a productivity boost to the majority of workers (61%) by augmenting their capabilities, quality and efficiency, which is estimated at €2.2-2.6 billion for Estonia.
- The estimate includes impacts of re-employment of a small share of workers (5%), where generative AI is freeing up a significant share of work for other tasks. This is estimated at €0.5-0.6 billion in Estonia.
- The estimate accounts for the possible productivity loss associated with re-employment to other occupations. This reduces the estimate for Estonia by up to €0.2 billion.
- At its peak, the productivity effect of generative AI in Estonia is estimated to be equivalent to 1.4% annually.
- Generative AI is so powerful that Estonia's future economic growth could exceed current long-term GDP forecasts, and leading banks are raising growth forecasts from as early as 2028.

Note: The estimate assumes widespread adoption of generative AI over a ten-year period. There is much uncertainty around the capability and adoption timeline of generative AI. The size of the productivity boost depends on the difficulty level of tasks that generative AI will be able to complete and the number of jobs it can automate. GDP is in 2022 levels. The average number of work activities that potentially can be performed by generative AI across all types of tasks for both complemented and highly exposed workers corresponds to 20-25%. Our estimate is the isolated potential of generative AI around ten years from now, when the impact is assumed to peak in the widespread adoption scenario (see next page). The estimated boost from generative AI may not be fully additive to GDP trends, as the GDP forecast already assumes a growth contribution from new technologies and generative AI may substitute some of that. Also, the boost from generative AI may be partially offset by an underlying growth slowdown.
Source: Implement Economics based on Eurostat, O*Net, Briggs and Kodnani (2023a), BNP Paribas (2023), and Dell'Acqua et al. (2023).

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

Adoption of generative AI



- Generative AI is a new general-purpose technology and will take time to adopt.
- Our estimate of Estonia's GDP potential from generative AI is reliant on the widespread adoption and development of the new AI technology within the next ten years.
- A five-year delay in capturing the benefits of generative AI is estimated to reduce the annual potential at peak from 8% (€2.5-3.0 billion) to only 2% (€0.5-0.7 billion) of GDP.
- Estonia can enhance the welfare and GDP contribution of generative AI by ensuring that policies are in place to capture the benefits as assumed in the widespread adoption scenario.

Note: GDP figures are expressed in 2022 levels. The figure shows generative AI adoption expressed as a share of economywide firms exposed to AI automation. The estimate is made for a ten-year adoption period to align with the time-horizon for widespread adoption by the most advanced countries apart from the US. The "widespread adoption" scenario assumes adoption in line with "other developed markets" in Briggs and Kodnani (2023b).
Source: Implement Economics based on Eurostat, O*Net and Briggs and Kodnani (2023a&b) .

Generative AI models have the potential to boost SME AI adoption to new levels, but regulatory uncertainty and lack of skills can stand in the way

SMEs lag behind larger corporations on AI adoption

Estonian SMEs account for
~81% of total employment

Like other European countries, Estonian SMEs are slower to adopt AI compared to large enterprises.

23%
of large enterprises in Estonia adopted AI in 2023.

5%
of SMEs in Estonia adopted AI in 2023.

The gap in AI adoption between SMEs and large enterprises is not specific to Estonia but reflects a **general challenge** among EU countries:

30%
of large enterprises in the EU adopted AI in 2023.

7%
of SMEs in the EU adopted AI in 2023.

Generative AI could boost SME AI adoption …

No or low data requirements means that SMEs can readily use generative AI for many tasks without any further work needed.

Ease of use in plain language means that SMEs can use many generative AI models without the need for coding skills.

Free online availability means that SMEs do not need to invest in new computing power or new infrastructure to use generative AI.

… but SME uptake can be slowed down because …

Lack of broader skills required to fully leverage the potential of new generative AI technologies can hamper uptake.

Regulatory uncertainty around generative AI can increase implementation risks and compliance costs, notably for SMEs lacking in-house legal capabilities.

Note: According to the classification by the European Commission, SMEs are defined as enterprises with 1-249 employees, and large enterprises are defined as enterprises with 250+ employees. The percentage of total employment accounted for by SMEs is based on 2022 data.
Source: Implement Economics based on the European Commission and OECD (2024).

03

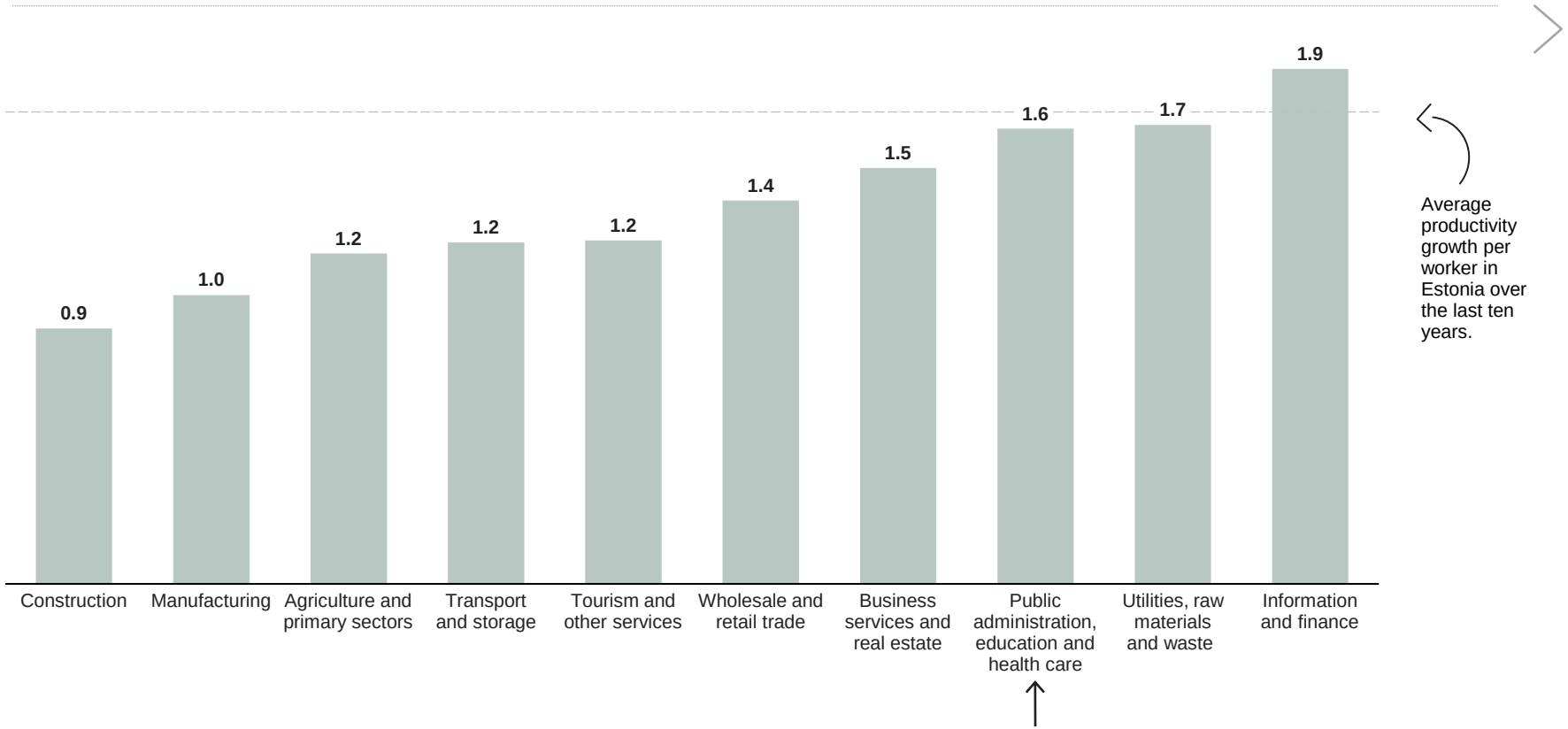
Key sectors benefitting from AI

Some sectors are expected to gain more from generative AI, mostly owing to the types of tasks performed.

AI can boost productivity across all sectors

Productivity boost from generative AI

% productivity growth p.a. at peak



- The complementary role of generative AI prevails in most Estonian industries, meaning that most occupations are estimated to use AI to augment and improve human capabilities.
- In contrast to past automation, such as robots, generative AI has the ability to boost productivity in the service sector.
- Displacement mainly occurs where administrative and repetitive knowledge-based tasks make up a large part of the work activities.

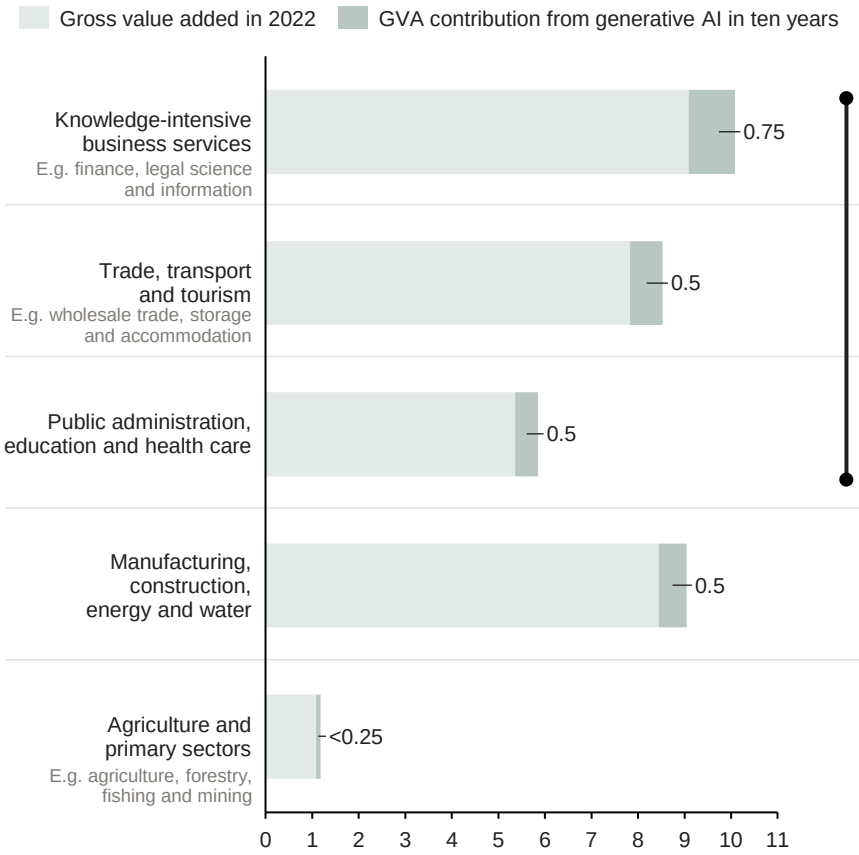
Note: Sectors are aggregated according to NACE categorisation. “Information and finance” is a combination of information, communication, financial and insurance activities. "Tourism and other services” comprises accommodation, food and other services“. Labour productivity gains are mapped one-to-one to GDP if total employment (as here) is assumed constant and the capital stock increases to match productivity improvements. The estimates take into account that the growth impact of generative AI may not be fully additive to the current GDP trend. First, AI-related gains may substitute for growth that would otherwise occur in a non-AI baseline. Second, underlying productivity growth has slowed over the past decades. The estimated boost from generative AI may be partially offset by an underlying growth slowdown.
Source: Implement Economics based on Eurostat, O*Net and Briggs and Kodnani (2023a).

SECTOR PERSPECTIVE

80% of generative AI's economic potential lies in service sectors, while manufacturing and other sectors can also benefit from other types of AI

Gross value added by sector

€ billion



Generative AI has the potential to boost value added in knowledge-intensive business services by around **€0.75 billion**, e.g. by generating content, assisting in research and automating complex data processing. The impact of other types of AI in these sectors is limited to automating repetitive tasks.

Although the trade, transport and tourism sector has a small percentage impact from generative AI, it still presents a significant economic potential of an estimated **€0.5 billion** due to its large size. The sector can, for example, benefit from enhanced customer service through responsive chatbots and the processing of legal documents or contracts.

Generative AI can benefit the public sector with an estimated **€0.5 billion**, e.g. through personalised tutoring in education, diagnostic support and patient interactions in healthcare and within automatic document handling and preparatory decision-making in public administration. Potentials could build on existing e-government initiatives.

Generative AI has the potential to increase productivity in manufacturing, construction, energy and water by around **€0.5 billion** although the percentage impact is assessed to be smaller than in other sectors. Other types of AI are expected to have a significant impact on these sectors, e.g. through supply chain optimisation and automation of manual processes for specific tasks.

Generative AI can, for example, facilitate predictive maintenance by processing operational reports and predicting potential system failures, thereby supporting an estimated potential of up to **€0.25 billion**.

Note: Sectors are aggregated as follows: "Knowledge-intensive business services": NACE sectors J-M. "Public administration, education and healthcare": NACE sectors O-R, U. "Trade, transport and tourism": NACE sectors G-I, N, S-T. "Manufacturing, construction, energy and water": NACE sectors C-F. "Agriculture and primary sectors": NACE sectors A-B. Estimates for GVA and GDP may vary slightly due to net indirect taxes.
Source: Implement Economics based on Eurostat and Briggs and Kodnani (2023a).

04

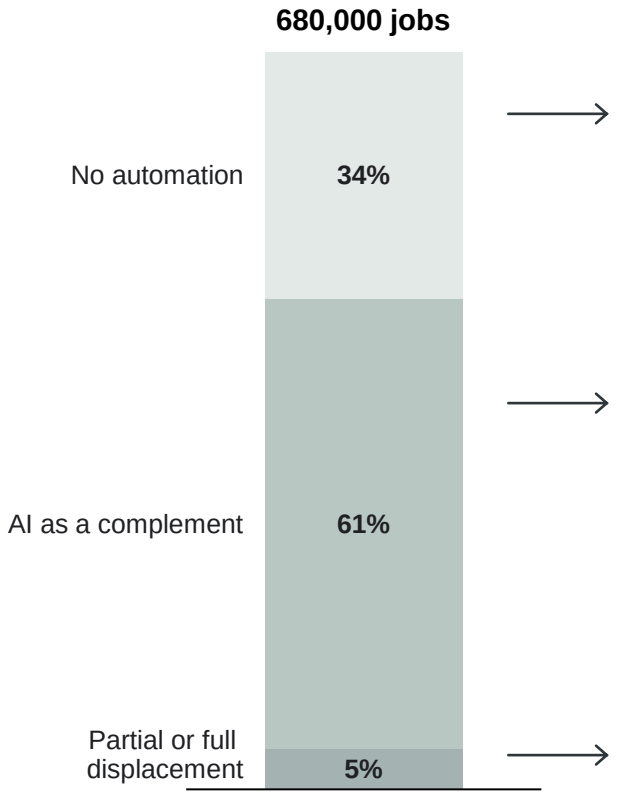
Job implications of AI

Generative AI will introduce job changes in Estonia – the nature and degree of which depend on economic and demographic factors.

Generative AI augments most jobs

Share of jobs exposed to automation by generative AI

% of total employment in Estonia



~ 230,000 jobs are unlikely to be exposed to automation

An estimated one-third of jobs in Estonia are likely to remain largely unaffected by generative AI. These jobs include manual labour, outdoor tasks, such as construction and cleaning, and human-to-human tasks, such as personal care and food services.

~ 415,000 jobs are likely to be augmented by generative AI

Most jobs (61%) are expected to be assisted by generative AI by automating a limited share of their tasks and helping to create content (text, code and images), collaborating with workers on complex problems and contributing to product design.

Unlike previous waves of automation that mainly impacted manual workers, generative AI is expected to primarily affect office-based professionals.

~ 35,000 jobs are likely to be fully or partially displaced

A small share of jobs (5%) are expected to have over half of their work activities automated by generative AI, e.g. in occupations such as clerical support workers, contact centre salespersons and translators. These workers are likely to see their jobs fundamentally change and may need to be re-employed in new occupations.

Note: Based on 2022 employment data. In accordance with Briggs and Kodnani (2023), "No automation" are occupations with less than 10% exposure, "AI as a complement" are occupations with 10-49% exposure, "Partial or full displacement" are occupations with exposure of or above 50%. Note that percentages and absolute numbers are rounded.
Source: Implement Economics based on Eurostat, O*Net and Briggs and Kodnani (2023a).

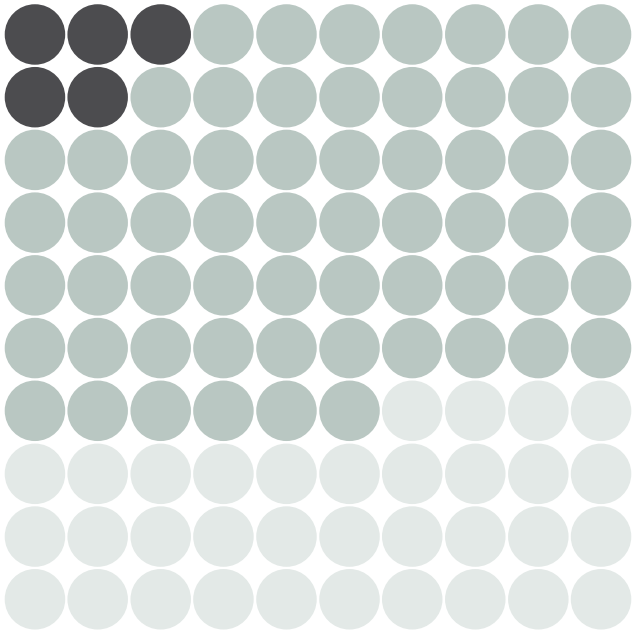
The AI-powered economy is expected to create new jobs and ensure full re-employment of potentially displaced workers

Share of jobs exposed to automation by generative AI

% of total employment in Estonia

Partial or full displacement | AI as a complement | No automation

5% of Estonian jobs are estimated to be highly exposed to generative AI, leading to some job closures.



At the same time, 61% of jobs are expected to see a boost in productivity. This will create new jobs due to:

I

Increase in general demand for goods and services

With higher GDP growth, the AI-powered economy will demand more labour across a wide range of occupations and skill levels.

II

New tasks and jobs created

Widespread use of AI will also create new jobs such as AI prompt engineers, AI content creators and data trainers – and create jobs we cannot preconceive.

III

Demand within occupation

Generative AI will also make highly exposed occupations, such as translators, more efficient, and hence at lower costs, which in turn can increase the demand for those occupations.

Even with accelerated and broad adoption of generative AI over a ten-year period, only around 2,000-4,000 people in highly exposed jobs are estimated to need re-employment per year, which is low compared to historical averages (see page 22).

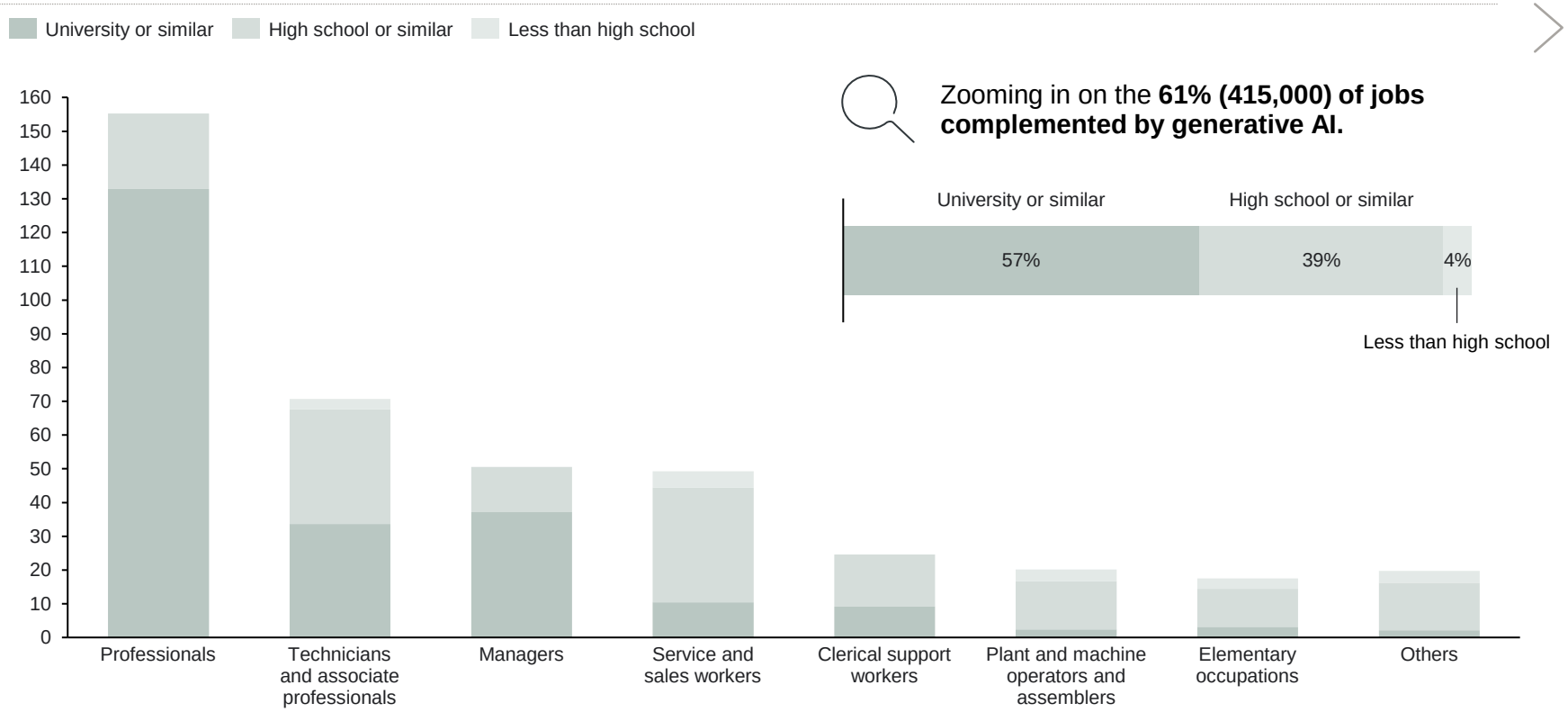
- The job development in Estonia over the next decades will depend on a range of factors.
- The isolated impact of generative AI depends on the speed of adoption and the size of the productivity boost relative to the size of the displacement effect for the jobs that are highly exposed to generative AI.
- This report assumes full re-employment of displaced workers over a ten-year period. This means no net change in total employment or unemployment.
- This assumption builds on the large size of the productivity boost compared to a relatively small share of displaced jobs. This suggests that the demand for new jobs will be sufficiently strong to create jobs for those exposed.
- Furthermore, economic theory suggests that long-term employment is determined by labour supply and skill mix of the workforce.
- The short-term job impacts will depend, among other things, on the flexibility of the labour market as well as re-training and skilling opportunities for workers.

Note: The assumption that labour supply predetermines employment is widely applied by economists. See, for example, *Principles Of Economics* by N. Gregory Mankiw (2020).
Source: Implement Economics based on based on Eurostat, O*Net and Briggs and Kodnani (2023a).

415,000 jobs are expected to be complemented by AI – mainly highly educated professionals and technicians

Jobs complemented by generative AI

Thousand jobs



Examples of jobs include …	Research, analysis and advising services (including legal)	Engineering technicians, robot controllers and air traffic safety technicians	Executives and supply and general managers	Caterers, housekeepers and travel agents	Secretaries, record keepers and information suppliers	Train drivers and machinery operators	Cleaners, washers and delivery	Police services and farmers

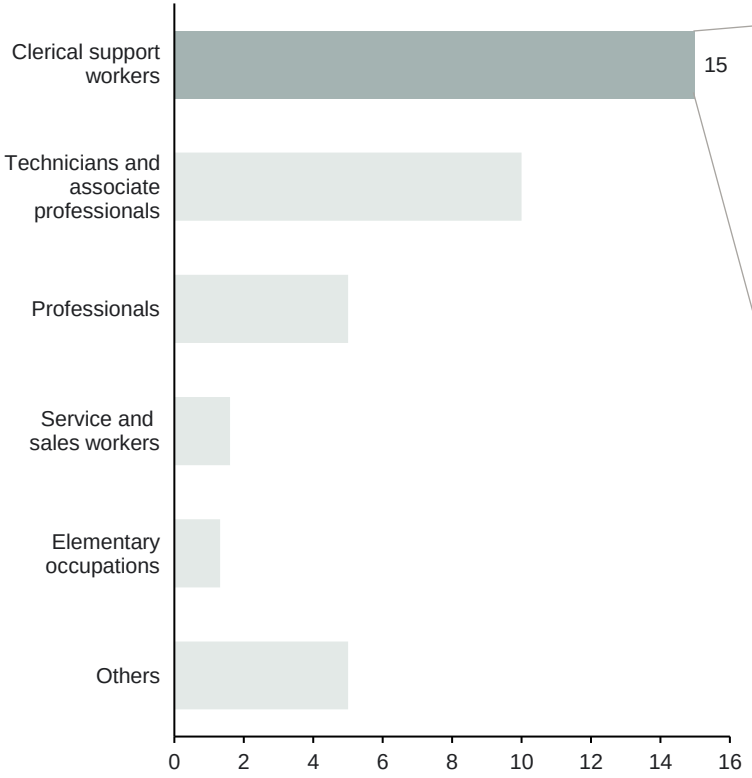
- Generative AI is estimated to augment the capabilities of around 415,000 jobs in Estonia at full adoption and around half of these over a ten-year period.
- Of the complemented workers, 57% are estimated to hold higher educational attainment such as lawyers, scientists and engineers.
- Generative AI can perform complex cognitive tasks and complement human abilities, creating opportunities for individuals to work with generative AI to create new content and free up time for other tasks.
- Unlike previous waves of automation, generative AI is less relevant in jobs carried out by those with lower levels of educational attainment.

Note: Based on 2022 employment data.
Source: Implement Economics based on Eurostat, O*Net and Briggs and Kodnani (2023a).

Around 35,000 Estonian jobs are highly exposed to generative AI, but the AI-powered economy will help create new jobs

Jobs highly exposed to generative AI

Thousand jobs



Highly exposed jobs in total ~ 35,000

***Example*: Estonian clerical support workers and job transition**

Of the 15,000 highly exposed clerical support workers, only around half are assumed to be affected by generative AI over ten years, and all of these are assumed to be employed either outside or within the occupation.

Most are expected to be re-employed in other occupations due to:

I **Increase in general demand for goods and services** due to increased income in the AI-powered economy, leading to job opportunities in other sectors.

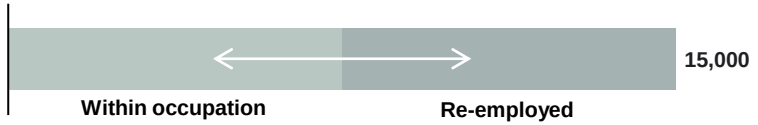
II **New tasks and jobs created,** arising from the introduction of generative AI.

A smaller share is expected to be employed *within* occupation because:

III **Not all highly exposed workers will be displaced**. Some will continue to hold employment with new tasks replacing the exposed tasks.

Increased demand within occupation due to the increase in productivity and lower costs.

The proportion of employment within occupations and in new occupations is uncertain.



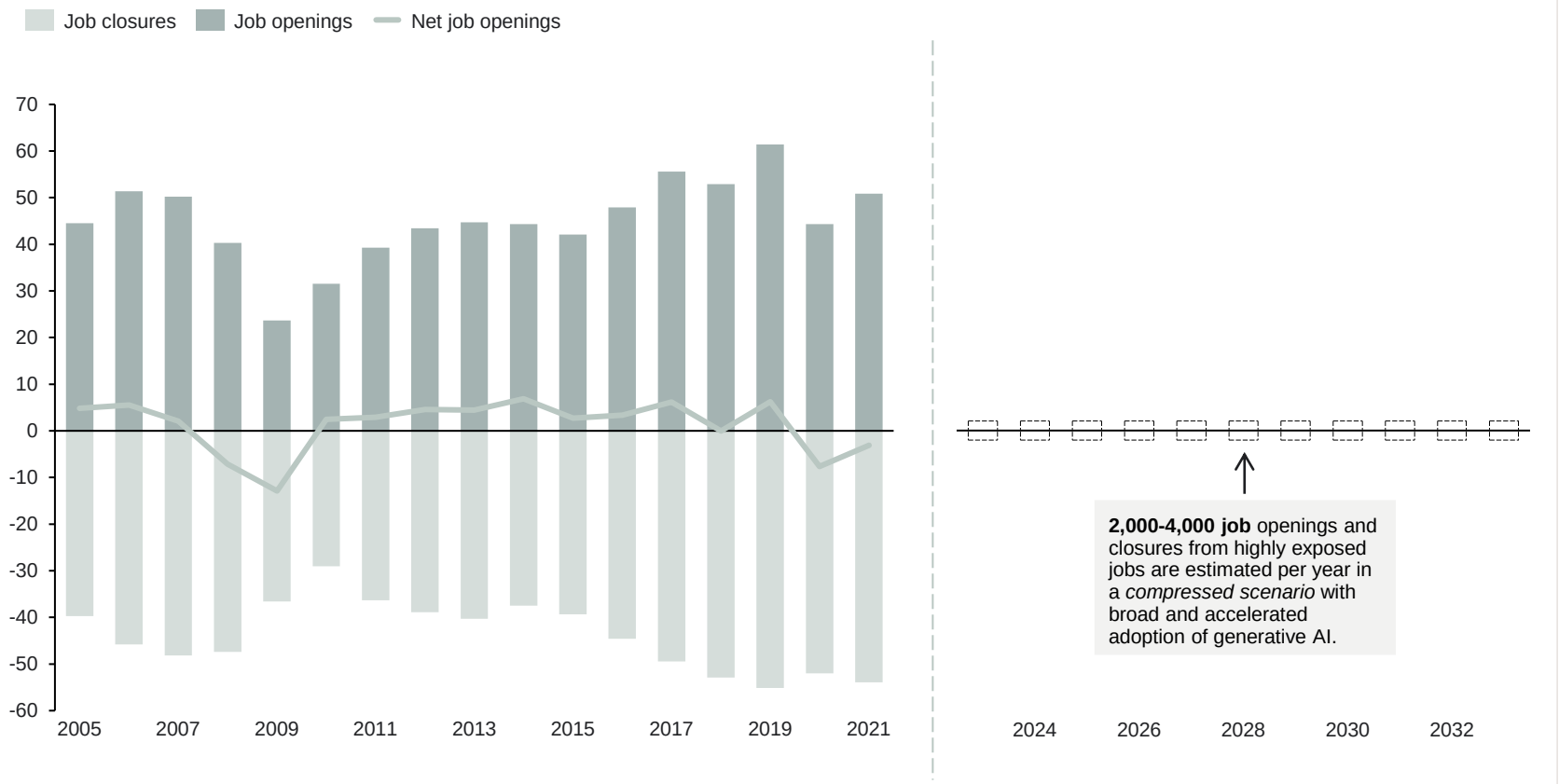
- Around 35,000 jobs in Estonia are estimated to be highly exposed to generative AI at full adoption, and around half of these are expected to be affected over a ten-year period.
- This report assumes full re-employment of displaced workers. This means no net change in total employment or unemployment.
- Clerical support workers, technicians and service and sales workers are highly exposed to generative AI and up to a third of these jobs are expected to see significant change.
- The transition is likely to be gradual, allowing workers time to adapt to new tasks and skills.
- The AI-powered economy will gradually lead to new jobs through three channels and support employment within the occupation or re-employment in other sectors.
- Historically, worker displacement from automation has been offset by the creation of new jobs, and the emergence of new occupations following technological innovations accounts for the vast majority of long-run employment growth.

Note: Based on 2022 employment data. High exposure to AI does not automatically imply full displacement of all workers in that occupation. In the GDP estimates, we conservatively assume low automation potentiala to avoid over-estimating GDP impacts. In the job exposure and potential displacement assessment, we show the full size of the potential displacement to avoid underestimating the job implications. The size of each re-employment channel is uncertain and depends on how the technology is adopted and the interplay between increased efficiency and how unmet demand translates into increased or decreased employment in various occupations.
Source: Implement Economics based on Eurostat, O*Net and Briggs and Kodnani (2023a).

Job changes from generative AI are small compared to historical averages

Job openings and closures in Estonia

Thousand jobs

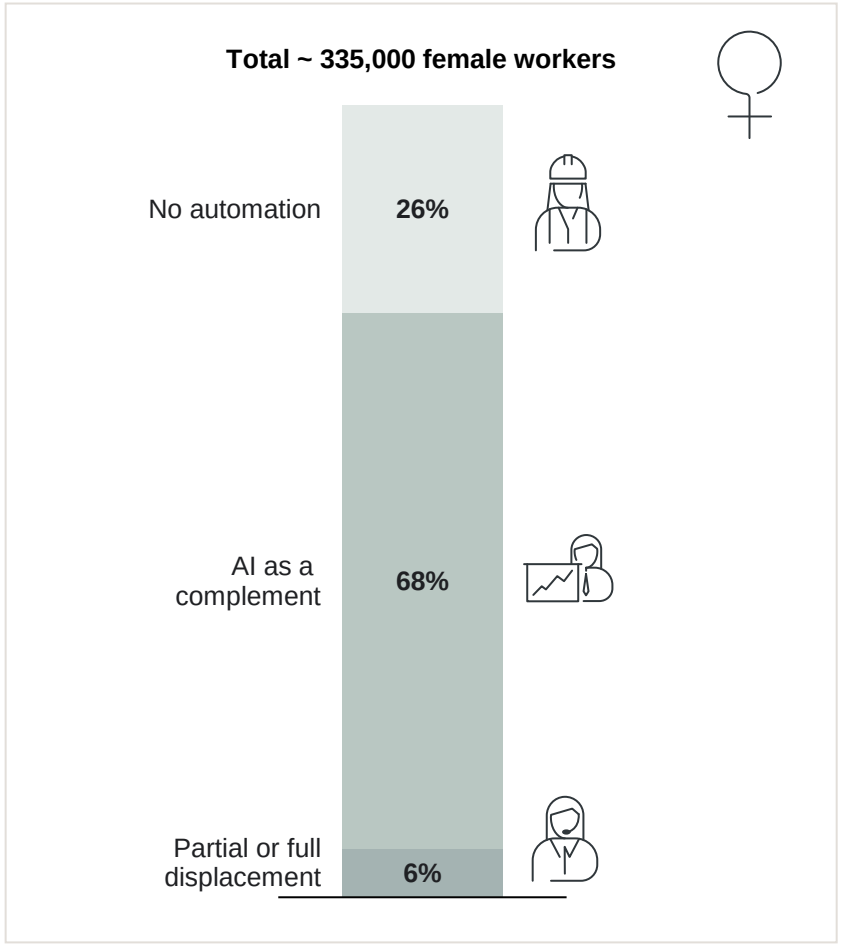


- Despite a number of new technologies since 2005, Estonia's net job openings have, on average, been positive in the period.
- The Estonian economy has created around 22,000 more jobs since 2005. This is a result of a much larger number of job openings and closures over the period.
- Historically, Estonia has around 45,000 job openings every year due to economic growth, technological advancements and structural changes.
- We estimate that the jobs highly exposed to generative AI can lead to around 2,000-4,000 annual job openings and closures over the coming ten years. This is less than 10% of the historical average number of job openings in Estonia.
- The labour market effects stemming from the impact of generative AI on highly exposed jobs are thus small compared to historical levels of job changes.
- To avoid underestimating the possible job impacts of generative AI, these estimates are in a compressed scenario with broader and more accelerated adoption of generative AI than in our estimates of the GDP impacts.

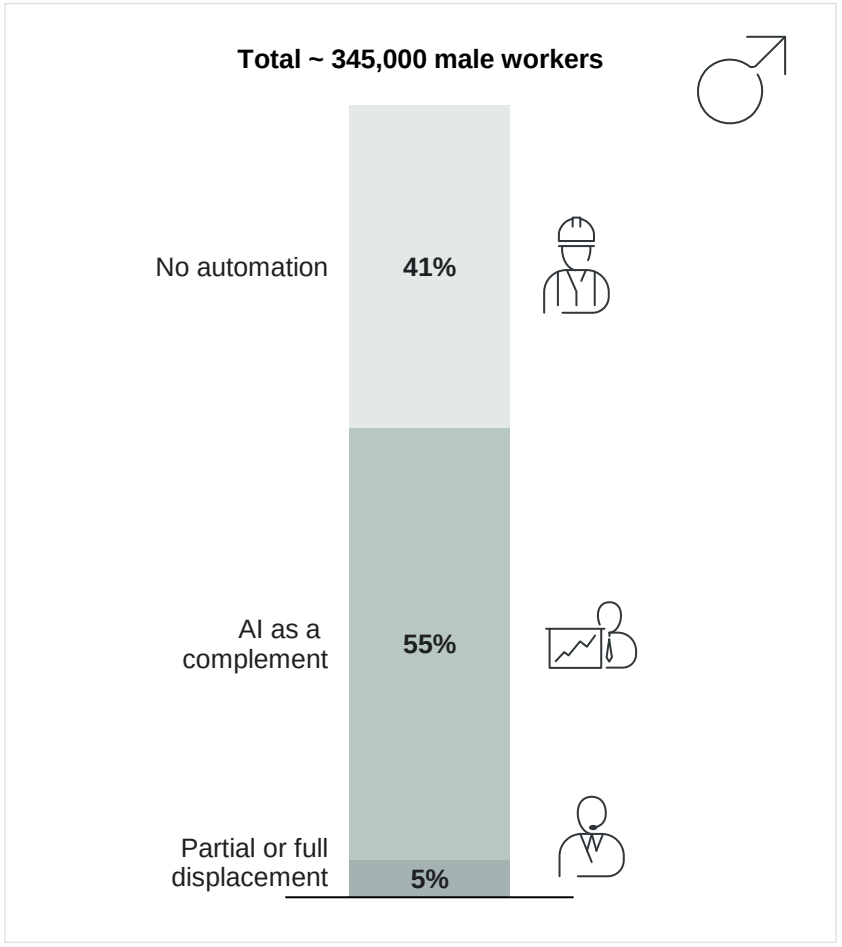
Note: Our GDP estimate makes conservative assumptions about the scope of tasks for generative AI and the speed of adoption as in the base scenario in Briggs-Kodnani (2023a). The compressed scenario used to gauge the potential job market implications assumes faster adoption (full adoption over ten years) and/or more broad application of generative AI (as in the Briggs-Kodnani scenario with "more labour displacement").
Source: Implement Economics based on Eurostat and Eesti Pank.

A higher share of female workers are estimated to be affected by generative AI – both in terms of potentially positive and negative impacts

Share of female jobs exposed to automation by generative AI
% of total employment among female workers



Share of male jobs exposed to automation by generative AI
% of total employment among male workers



No automation

- 26% of female workers and 41% of male Estonian workers are in jobs with limited exposure to generative AI. These are, for example, manual, outdoor and human-to-human jobs.

Complemented jobs

- 68% of female workers are expected to see generative AI complement their current job, whereas the share is only 55% for male workers. Female workers are, to a higher degree than men, employed in jobs such as teachers and lawyers, where generative AI is expected to augment human capabilities and make workers more productive.

Potentially displaced jobs

- 6% of female workers and 5% of male workers in Estonia are currently in jobs such as clerical work, call centre workers and technicians, which are likely to be highly exposed to automation by generative AI and hence more at risk of seeing their current job being fully or partially displaced by the new technology.

Note: Based on 2022 employment data. In accordance with Briggs and Kodnani (2023a), "No automation" are occupations with less than 10% exposure, "AI as a complement" are occupations with 10-49% exposure, "Partial or full displacement" are occupations with exposure of or above 50%. Note that percentages and absolute numbers are rounded.
Source: Implement Economics based on Eurostat, O*Net and Briggs and Kodnani (2023a)..

Workers need a broad set of skills to reap the benefits of generative AI

Skill needs in the age of AI (incl. both generative and traditional) OECD

Skills …	*Type of skills*	*Examples*
… for developing and maintaining AI systems.	Specialised AI skills	Machine learning capabilities and knowledge
	Data science skills	Data analysis and visualisation, cloud computing and programming
	Other cognitive skills	Create problem-solving
	Transversal skills	Social skills and management skills
… for adopting, using and interacting with AI applications.	Elementary AI knowledge	Principles of machine learning
	Digital skills	Ability to use computer/smartphone
	Other cognitive skills	Analytical skills, critical thinking and problem-solving
	Transversal skills	Creativity, communication, teamwork and multitasking

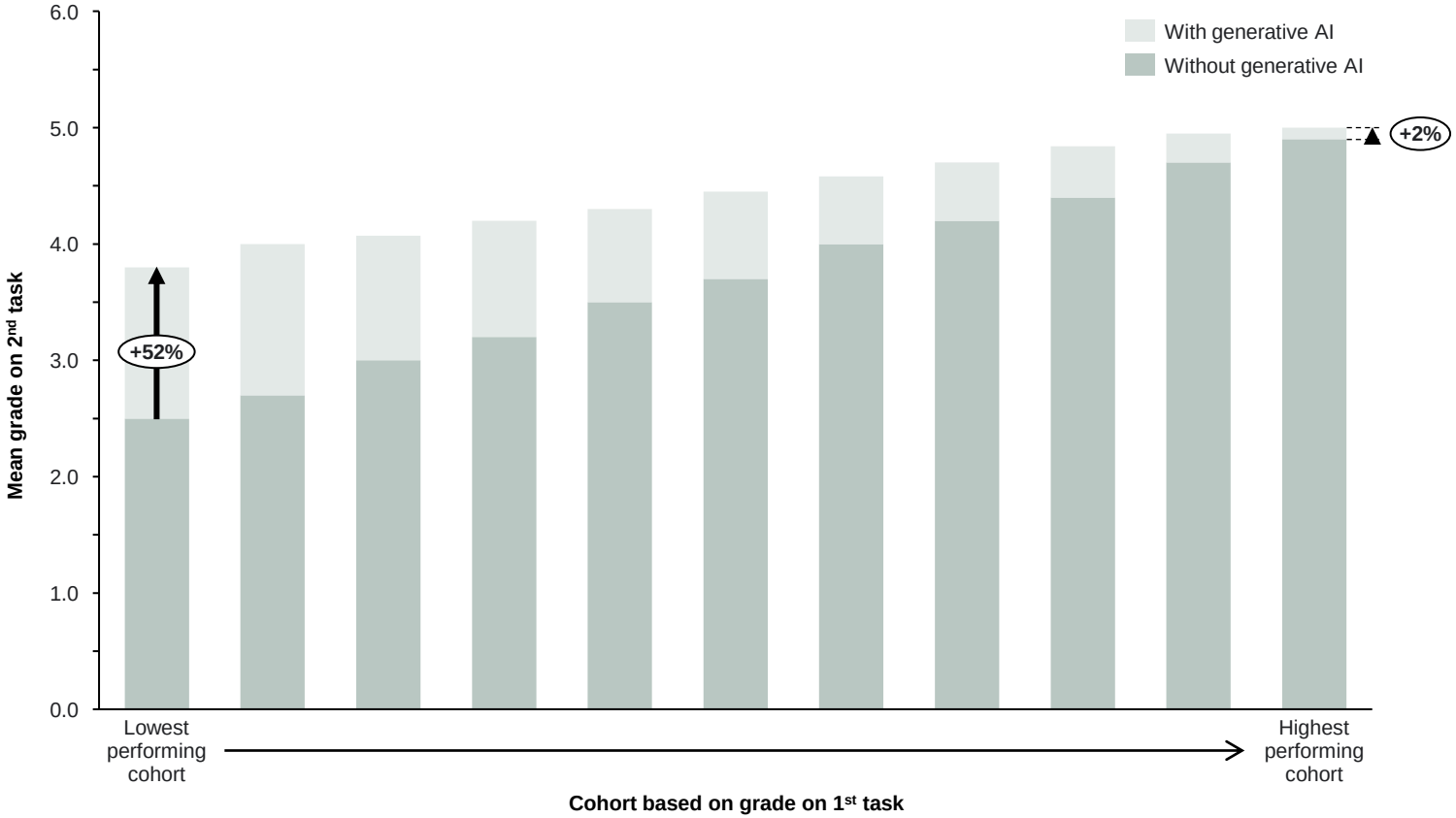
- Generative AI adoption and usage requires limited digital skills relative to earlier advancements in information and communication technology (ICT) due to its ease of use via normal language prompts.
- However, fully leveraging generative AI requires skills beyond basic digital skills, i.e. creative, managerial and analytical skills.
- Of the polled European workers indicating that AI will completely or slightly change their job, an average of 28% expect to have to re-skill or take some type of course within the next five years as a result of AI.
- In 2023, only 56% of Estonians aged 16-74 had basic digital skills, but it was required in 90% of professional roles.
- OECD studies based on companies in Estonia and the Netherlands suggest that companies that provide ICT training for their employees on average have 3-5% higher growth in their annual labour productivity.
- The literature highlights that companies that combine technology/ICT adoption with employee training have higher implementation and financial success.

Source: Implement Economics based on OECD, Ipsos Survey, Eurostat, Mosiashvili and Pareliussen (2020), Borowiecki et al. (2021), Gal et al. (2019), Andrews et al. (2016), Jiang et al. (2020) and Ouyang et al. (2022).

Generative AI can help close the skills gap for those with the lowest skill levels

Grades with and without generative AI

Estimated mean grade on 2nd task



- AI requires a broad skill set to reap the benefits. However, AI as a tool can itself augment the performance of human skills.
- Furthermore, generative AI can help close the skills gap by increasing the performance of those with the lowest skill levels.
- An experimental study by Noy and Zhang (2023) tested candidates' writing skills with and without access to generative AI.
- The results showed that, on average, all candidates were able to boost their grades on a written task with the use of generative AI – in this case, a large language model.
- The AI augmentation effect was highest among those with the lowest performance on the first task.
- The lowest-performing group increased their average grade by more than 50% when allowed to interact with a large language model, whereas the best-performing group increased performance by 2%.
- This study is an early indication that generative AI has the potential to boost skills for everyone *and* reduce skill inequalities in the labour market.

Note: The graph shows mean estimates for cohorts.
Source: Implement Economics based on Noy and Zhang (2023), Brynjolfsson et al. (2023) and Dell'Acqua et al. (2023).

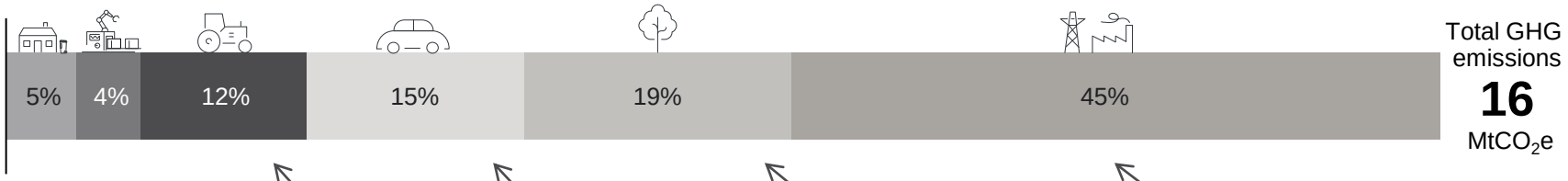
05

AI’s impact on societal challenges

AI can help with some of Europe’s most pressing societal challenges.

AI can play a key role in addressing climate change

Estonia's net greenhouse gas emissions, 2021
$MtCO_2e$



Decarbonisation initiatives enabled by AI and other digital technologies (non-exhaustive).

Agriculture

- Efficiency improvements from precision farming
- Reduced food waste
- Changes in land use

Domestic transport

- Electric cars, vans, busses and small trucks
- Efficient and eco-friendly driving
- Reduced travel by use of digital tools (working from home and video conferences)

Land use and forestry (LULUCF)

- Advanced satellite imagery
- Remote sensing technologies
- Digital mapping and inventory systems

Energy supply

- Expansion of renewable energy
- Electrification
- Smart grid
- Flexible electricity demand

- Artificial intelligence and other digital solutions are expected to play a key enabling role in reaching Estonia's climate goals of carbon neutrality by 2050.
- AI and other digital technologies can play a significant role in decarbonising the energy sector by supporting the transition to flexible energy utilisation and smart grids.
- Large gains also arise from facilitating the electrification of vehicles, where AI and other digital solutions are crucial to optimising the charging of EVs, providing a cleaner and cheaper solution for consumers.
- In manufacturing, AI and other digital solutions can help optimise energy efficiencies as well as reduce overproduction by more accurately forecasting demand.
- Agricultural emissions can also be reduced by AI and other digital solutions, where machine learning algorithms allow precision farming practices that are more eco-friendly and reduce consumption of, for example, fertilisers.

Note: Data on net greenhouse gas emissions and removals sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States). This data set reflects the GHG inventory data for 2021 as reported under the United Nations Framework Convention for Climate Change. CRF inventory categories: Energy supply: CRF 1A1 (energy industries) + 1B (fugitives); Industry and manufacturing: CRF 1A2 (manufacturing industries and construction) + CRF 2 (industrial processes and product use); Domestic transport: CRF 1.A.3; Residential and commercial: CRF 1A4a (commercial) + CRF 1A4b (residential); Agriculture: CRF 1A4c (agriculture, forestry and fishing) + CRF 3 (agriculture); Waste: CRF 5 (waste); LULUCF: CRF 4 (LULUCF); Other combustion (CRF1A5a + CRF1A5b + CRF indirect CO_2).
Source: Implement Economics based on the European Environment Agency (EEA).

AI can help improve accessibility to healthcare in Estonia

Estonia has seen significant improvements in health outcomes since 2000 and also in recent years. However, issues pertaining to healthcare accessibility persist with large inequalities between regions and socioeconomic groups.

In the **2030 Estonian health plan**, the government prioritises health accessibility and recognises the significant potential in leveraging Estonia's **advanced e-health ecosystem** to integrate services and enhance health-related decision-making.

Need for improved access

- In 2022, 9% of the Estonian population – the highest proportion in the EU – reported unmet medical care needs.
- This is largely an effect of long wait times and high out-of-pocket expenditures, which amounted to roughly 22% of all Estonian health spending in 2021.
- Estonia has fewer healthcare practitioners per 100,000 inhabitants than the EU average, and the number of graduating healthcare practitioners is insufficient, putting pressure on wait times.

AI can help free up and optimise critical resources by …

- Automating tasks in healthcare administration, such as appointment scheduling.
- Recording and synthesis of appointment notes, referral information and care plans.
- Faster and more accurate screening and decisions by physicians.
- Enabling physicians to undertake remote consultations.

Showcase initiative: National Clinical Decision Support tool

- Since May 2020, healthcare practitioners have been able to use the decision support system to make faster and better patient-based recommendations.
- The tool is integrated with the Estonian health information system, and it analyses individual health data to assist healthcare practitioners make knowledge-based treatment decisions and avoid treatment mistakes.

AI solutions can also advance patient care, offering smarter and higher quality treatment to patients by …

- Analysing and enhancing medical images, detecting diseases and injuries earlier and faster.
- Improving detection of complex and rare diseases with training data sets and smarter diagnostic tools.
- Predicting individual treatment response by analysing different patient data.
- Enabling the development of targeted therapies.
- Tracking health issues and accidents through wearable devices and sensors.

As a European leader in commercial AI efforts, Estonia can leverage e-health AI solutions from its own backyard.

Showcase initiative: Nora AI

- Nora AI is a startup looking to accelerate anti-viral drug discovery.
- The Nora platform integrates data from different sources and proposes high-potential drug candidates to scientists – shaving off years, risks and costs of typical drug development.

Source: Implement Economics based on The Estonian 2030 Health Plan, European Observatory on Health Systems and Policies and e-Estonia.

06

AI readiness in Estonia

Estonia’s capacity to leverage the potential of AI can be evaluated based on several factors and compared to European and global frontrunners.

In assessing Estonia's AI readiness, we compare with other small digital frontrunner countries in Northern Europe

- In assessing Estonia's AI readiness, we can compare Estonia to a comparable group of small, digitally advanced and open European economies.
- Big economies, such as the United States, have an advantage when it comes to scale, i.e. absolute AI capacity, including the amount of commercial activity, availability of funding and volume of R&D.
- Common indicators, such as the Tortoise Global AI Index, compound both **scale** and **intensity** (AI capacity relative to population or GDP).
- As a small country, Estonia cannot compete on scale on, for example, the absolute amount of AI-related R&D investment. Estonia will be dependent on EU-wide initiatives. Therefore, Estonia should work for initiatives at EU level, especially in the areas of R&D investment, regulation and digital infrastructure.

The digital frontrunners of Northern Europe

Finland
#1 in DESI in 2022

Denmark
#2 in DESI in 2022

The Netherlands
#3 in DESI in 2022

Sweden
#4 in DESI in 2022

Norway
#5* in DESI in 2022

Ireland
#5 in DESI in 2022

Luxembourg
#8 in DESI in 2022

Estonia
#9 in DESI in 2022

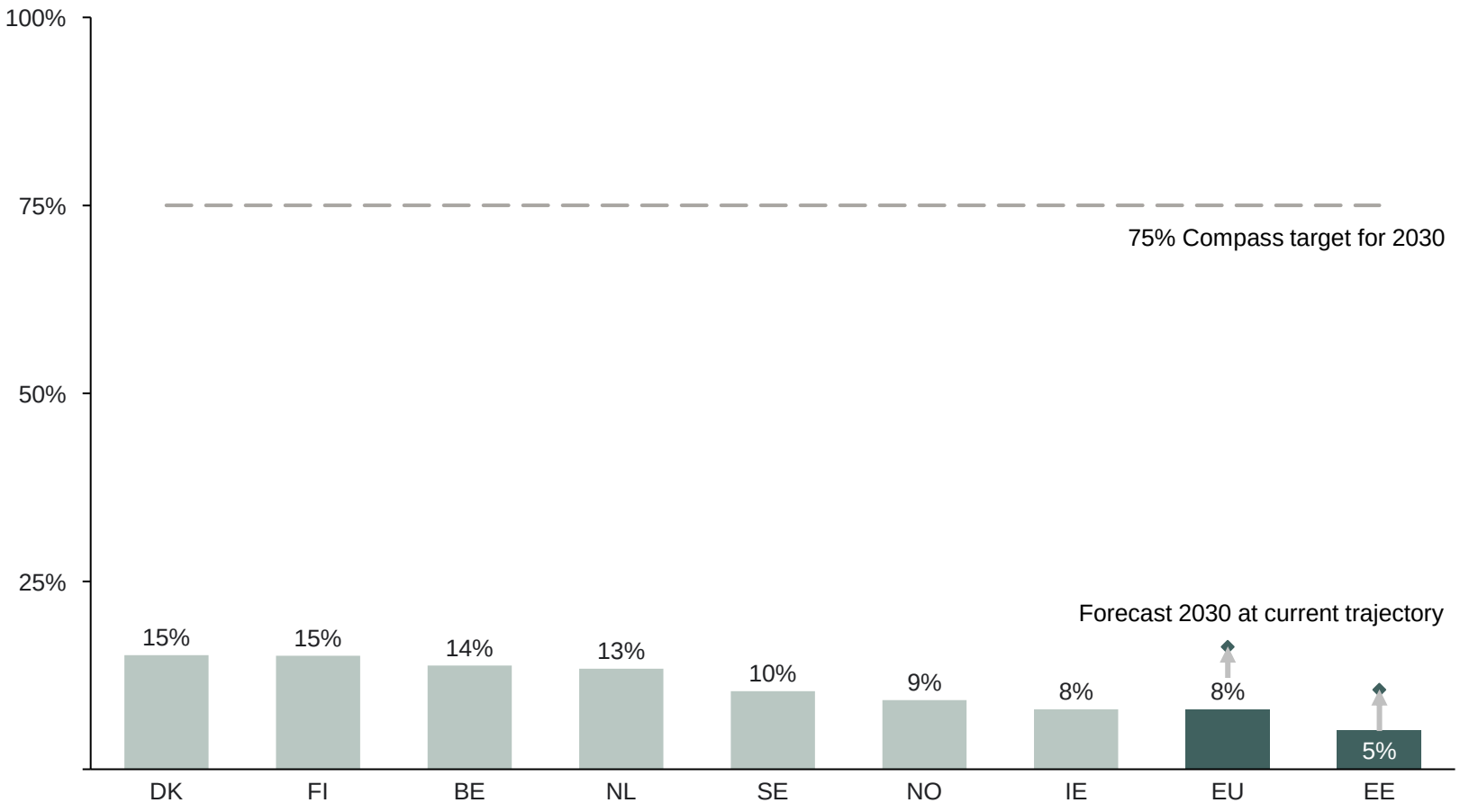
Belgium
#16 in DESI in 2022

Note: Ranking within the EU is shown. *) When we include Norway, it ranks #5 in DESI in the region.

While Estonia leads on commercial ventures and startups, Estonian companies generally lag behind the EU average on AI adoption

Adoption of AI 2023

% of enterprises using at least one type of AI technology



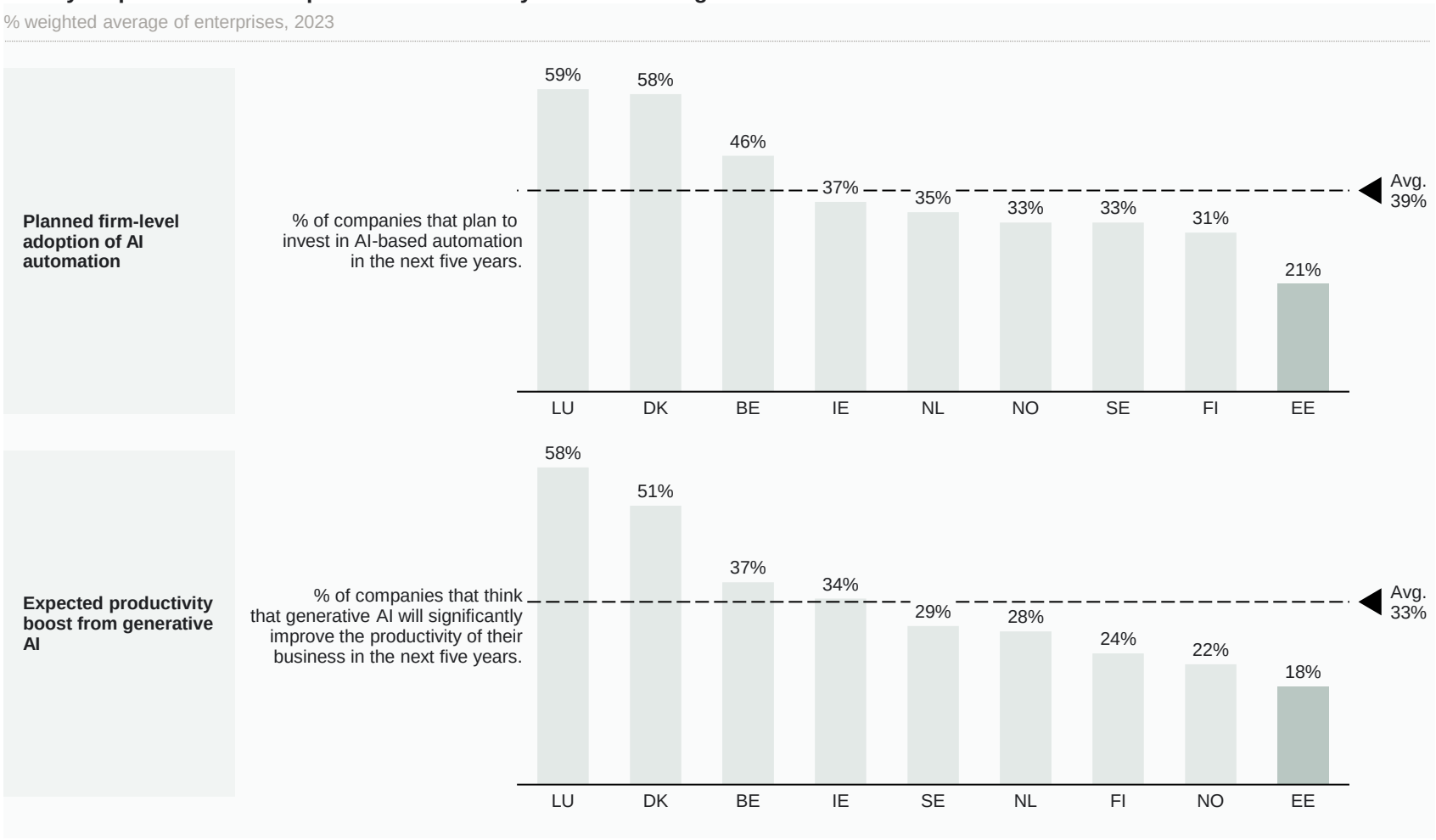
- Estonia lags behind the EU on AI adoption by companies. Only 5% of Estonian companies had adopted at least one type of AI technology in 2023.
- In its most recent assessment, the European Commission concludes that the EU is set to fall significantly short of its target on AI adoption for 2030.
- If we assume the same pace of adoption as the EU average, there is a risk that Estonia will fall significantly short of the 2030 target.
- Firm-level adoption data underestimates actual use in business settings (see page 7) as many instances of individual-level AI use are not captured.
- The Estonian government launched initiatives as part of their national AI strategy, Kratt Strategy 2022-2023, to facilitate the uptake of AI technologies in companies, likely further accelerating the pace of adoption.

Note: Current adoption is from 2023 and includes enterprises with ten or more employees, excluding financial services. Forecast for 2030 is based on European Commission-forecasted AI adoption.
Source: Implement Economics based on Eurostat and the European Commission.

New survey data points to accelerated adoption but lower than peers and not enough to reach full potential

Survey responses from companies on their five-year outlook on generative AI

% weighted average of enterprises, 2023



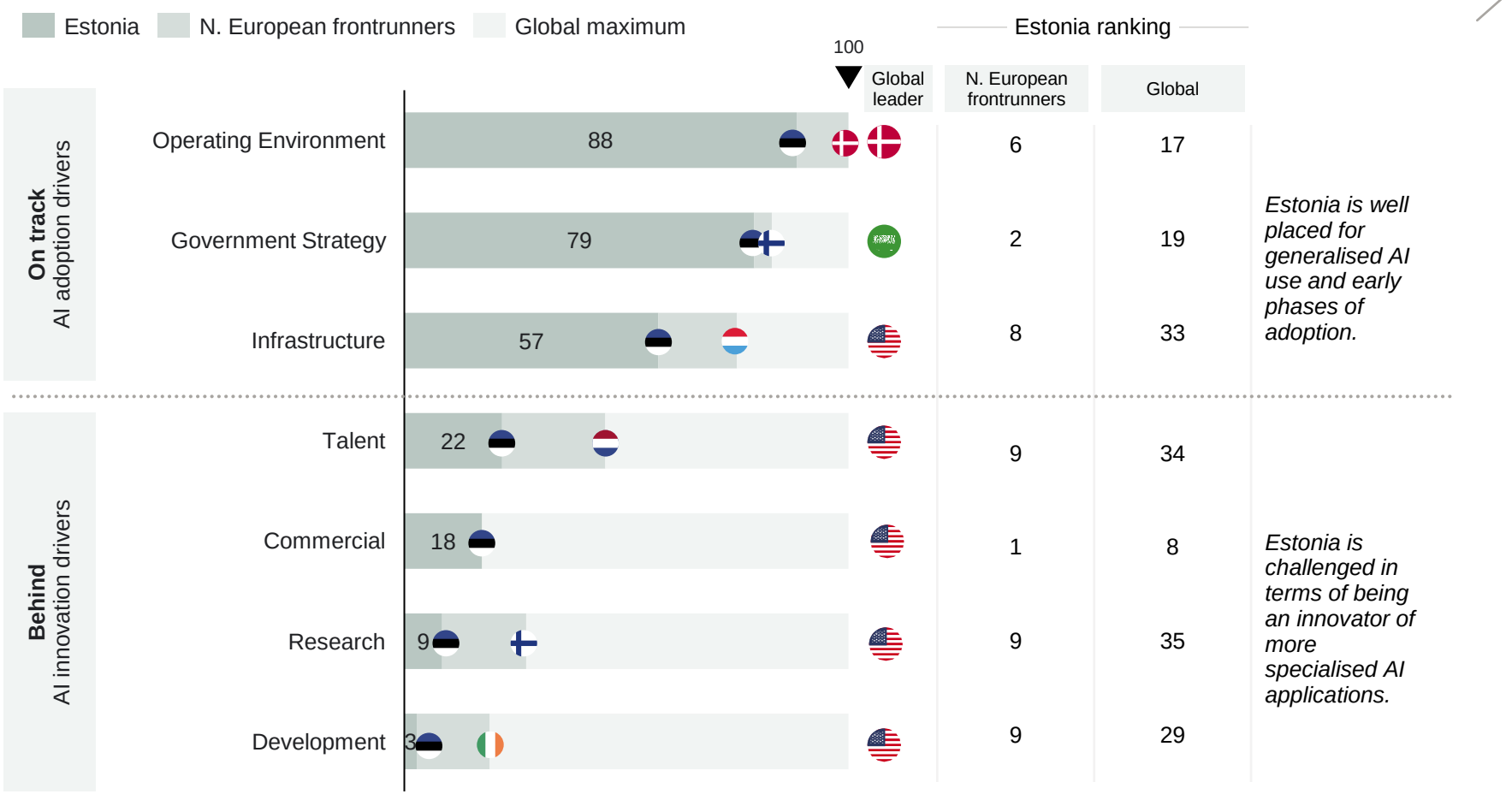
- According to polling by Public First, 21% of companies in Estonia claim that they plan to invest in AI-based automation in the next five years. This is lower than the Northern European frontrunner average of 39%.
- 18% of Estonian companies anticipate significant productivity impacts from generative AI on their business in the next five years, which again is lower than the Northern European frontrunner average of 33%.
- While this generally suggests a fast pace of adoption, AI adoption is still in an early phase, and more complementary innovations, investments and commercial ventures in AI are needed to capture its full economic potential.

Note: Public First survey conducted in summer 2023 and Q1 2024 for Estonia and Ireland. Nationally representative consumer and business polling. Respondents of the survey include Estonia (EE), Sweden (SE), Denmark (DK), the Netherlands (NL), Belgium (BE), Luxemburg (LU), Finland (FI), Norway (NO), and Ireland (IE). Averages across countries are computed as arithmetic means.
Source: Implement Economics based on Public First country surveys.

Despite its active commercial environment, Estonia lacks AI-related talent and R&D capacity, potentially hindering its ability to capture the full benefits of AI

Estonia's AI capacity according to the Tortoise Global AI Index

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



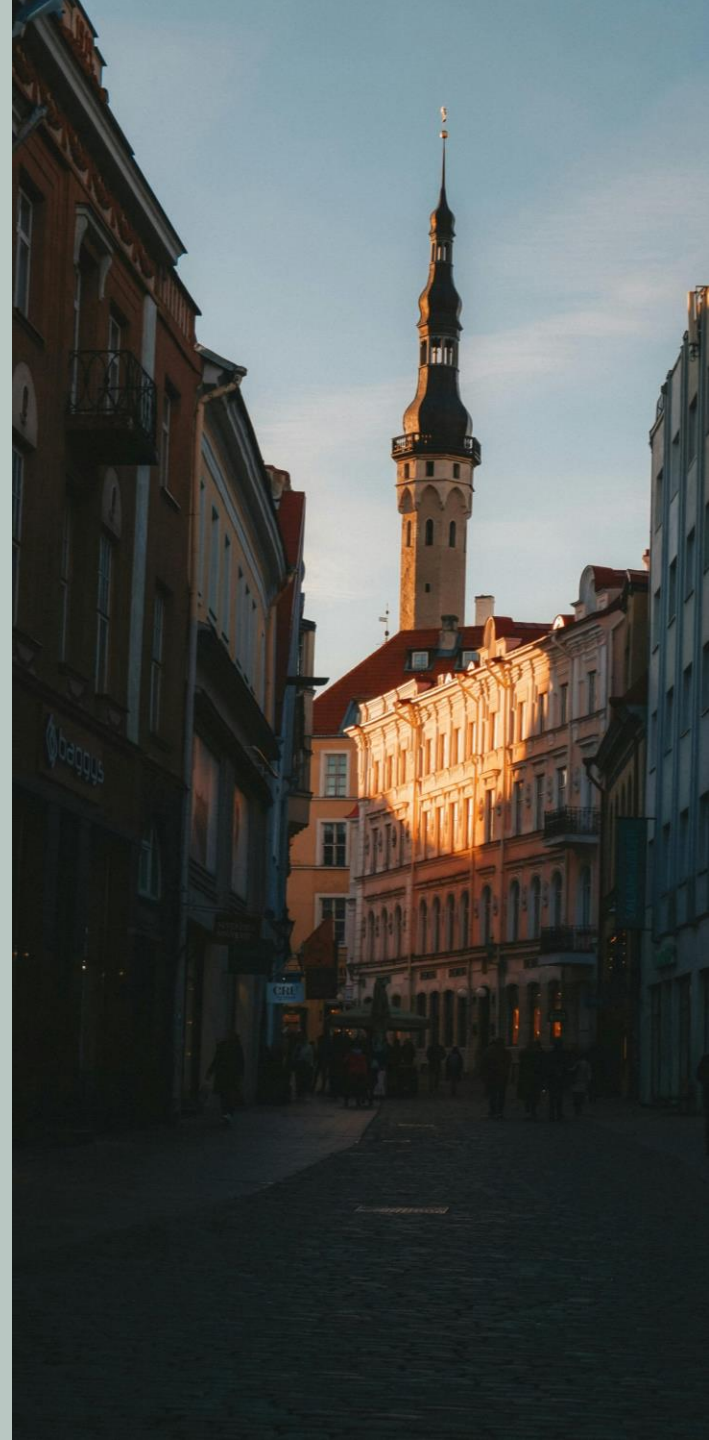
- Estonia leads Europe when it comes to commercial AI capacity and ranks 8th globally – though this is still significantly below the level of the United States.
- Estonia is best positioned on the early foundational drivers of AI adoption that ensure a safe and reliable AI-ready environment: operating environment, government strategy and infrastructure.
- However, more specialised AI applications and the realisation of full productivity gains will require a cohesive and competitive innovation ecosystem that is conducive to development and commercial uptake.
- Estonia lags behind other Northern European frontrunners on complementary innovations, investments and AI-related skills.
- It is estimated that 18,000 more ICT specialists will be needed in Estonia by 2027 to sustain the rapid development of the sector.
- Current gaps suggest that Estonia, like other Northern European frontrunners, may be able to step into a superuser role in the future rather than emerging as a lead innovator.

Note: The Global AI Index looks at seven sub-pillars for AI capacity: talent (availability of skilled practitioners in AI solutions, including IT and STEM 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, adoption of AI technologies by companies etc.).
Source: Implement Economics based on Tortoise Media and OSKA 2022.

07

The way forward to capture the benefits of AI

Estonia can consider several policy initiatives to improve its position on AI readiness.



Potentials, pitfalls and paradoxes

Artificial intelligence (AI) has the potential to be the most powerful technology in decades

- AI enables us to do things better and work more efficiently. It also enables us to do better things. With AI, we can focus on the best parts of our jobs and leave the rest to AI. Yet, AI is still in its infancy and how it is applied is highly uncertain.
- To make AI benefit humans and society as a whole will require pursuing the potentials, avoiding the pitfalls and navigating the paradoxes.
- The future of AI should *not* be reduced to a simple one-dimensional question: Should we have more AI or less AI — or even ban AI?
- AI is not a fixed thing with a predetermined future that can come quickly or slowly. AI is new, **uncertain** and malleable and will require wise choices by all stakeholders across business, governments and civil society.

Potentials

- The estimated economic potential assumes **widespread adoption** of generative AI within ten years.
- The estimate includes both narrow **labour-saving** impacts and broader **value-creating** impacts that enable workers to do something novel or powerful.
- It assumes that AI lives up to its promise of being the most radical **technological breakthrough** in decades.
- Moreover, we estimate that AI will **complement the majority of workers** and free up time to spend on non-routine, creative and inventive tasks.
- The result is an economy not simply at a higher level of productivity, but at a **permanently higher growth rate**.

Pitfalls

- Displaced workers might end up in **less productive jobs** (than already assumed).
- AI may end up being **less promising** or less ready to bring to market than initially hoped.
- Time to market may be **challenged by a legal regime** not designed for AI.
- Companies may **miss out on the benefits** of AI due to a lack of competences or failure to change organisations and habits.
- National regulators, driven by any number of concerns, may **impose strict regulations** that slow the speed of AI development.
- **Regulatory uncertainty** and lack of clarity on future rules may delay the uptake.

Paradoxes

- How can policies encourage the types of AI that complement human labour and best prepare those at risk of losing a job to AI?
- What choices will encourage the development of AI that companies of all sizes can access instead of just the largest ones?
- What kind of investment in AI research and development might unleash the most interesting new ideas, innovations and applications in support of overall societal value?
- What kind of high-performance computer infrastructure is needed to power the new technology, and how is that best provided?

Unlocking the AI opportunity by creating trust and preserving the incentive to invest

The benefits of new waves of technology do not come automatically. As with past waves of technology, it takes time for people to trust the technology. Regulators across the world are set to ensure the safety of the technology while achieving its benefits. The EU's AI Act aims to lead on this. In the urgent efforts to achieve broad-based trust, regulators may create fragmentation, misalignment and uncertainty about future rules, which can hamper investment and adoption.

Developers and early technology adopters will need clarity on future rules. Clarity is needed regarding, for example, the requirements for transparency in the functioning of the generative AI models, the data used to train them, issues of bias and fairness, potential intellectual property issues, possible privacy violations as well as security concerns.

To navigate these choices, this report offers five perspectives:

Enable **innovation** and invest in AI **research and development**

- Invest in long-term public AI research and encourage private investment in basic and applied research at national and EU level.
- Foster industry, government and university innovation partnerships to undertake pre-commercial AI research projects.
- Support innovation on top of already developed foundational models and findings, e.g. by leveraging the new EU AI innovation package.
- Make AI tools available to entrepreneurs and scientists so they can use AI in support of other discoveries and innovations.
- Support international research collaboration, technology transfer and international movement of researchers.

Create a conducive and aligned AI **regulation**

- Avoid siloed approaches to AI regulation to minimise the risk of misalignment and fragmentation by increased international co-operation.
- Ensure copyright rules that support innovation and creativity and preserve the incentive to generate new content.
- Adopt a risk-based approach to AI regulation to provide clarity to developers, adopters and users about which uses are disallowed.
- Encourage privacy and security principles so that individuals' personal data is safeguarded.

Promote widespread **adoption** and universal accessibility

- Promote widespread adoption and universal accessibility by helping governments, small businesses and all sectors of the economy adopt and use AI.
- Lead with the public sector adoption of AI solutions, which may require overcoming procurement roadblocks that often appear when public entities aim to adopt new technologies.
- Create a national strategy to spur AI adoption across all industries and all sizes of businesses.
- Give small businesses an "AI jumpstart" through technical assistance, training and guidance to help them understand and leverage AI for their businesses.

Build **human capital** and an AI-empowered workforce

- Build an AI-empowered workforce by investing in human capital, education and training systems. This means treating AI as a core component of the education system.
- Focus training and upskilling on areas where AI enhances and augments the capabilities of workers so that workers are trained to work together with the new technology. The aim should be to improve the marginal productivity of workers rather than replace them.
- In those selected types of jobs where AI risks displacing workers, efforts should be devoted to re-skilling workers for other jobs.
- Ensure a flexible labour market and continuous lifelong training enabling new opportunities in the labour market.

Invest in AI **infrastructure** and compute power

- Ensure the right incentive and regulation for public and private entities to invest in AI infrastructure and compute capacity such as graphics processing and supercomputers needed to drive the powerful AI models.
- Enable trusted cross-border data flows in trade agreements and ensure regulatory interoperability and non-discrimination in the EU.
- Support the building of cross-border AI infrastructure and subsea cables through initiatives such as the G7 partnership for global infrastructure and investment.
- Reduce electricity emissions from data centres by promoting ambitious decarbonisation strategies such as 24/7 Carbon-Free Energy.

Note: For more details on policies, see OECD AI principles, OECD AI Observatory, EU's ethic guidelines for trustworthy AI, EU's AI innovation package, Google's AI principles and paper on "An Opportunity Agenda for AI". For more details on carbon-free energy and digital decarbonisation, see the European perspective and global perspective.

Estonia can draw on policy choices of other frontrunners

While Estonia is a frontrunner in many aspects of digitalisation, other European frontrunners lead in separate fields.

Estonia can learn from them and can collaborate on a regional level where it makes sense. Small countries such as Estonia cannot achieve everything on a national level. Individual EU countries are dependent on what happens at the EU level to succeed with AI. Estonia should leverage the possibilities at the EU level, including the EU AI package.

Estonia leads on commercial AI activity … **… and can draw on best practice initiatives from other Northern European frontrunners**

Indicator	Commercial	Operating environment	Infrastructure	Talent	Research	Development
Northern European leaders						
Best practice	Estonia recognises itself as an **implementation leader** for startups and AI applications. The national AI strategy (2019) outlines 12 initiatives to accelerate AI uptake in companies, including different funding measures and 9 initiatives to increase R&D. **Example:** AI & Robotics Estonia (AIRE) • Supports Estonian industrial companies in adopting smart digital solutions in the field of AI and robotics.	Denmark is a **pioneer in enforcing transparency and ethical use of AI** and has introduced principles and tools to ensure responsible AI deployment. The tools are aimed at building trust in AI technologies. **Example**: Guide for responsible use of generative AI • Formal ethics and safety guidelines for using and implementing AI publicly and privately. • *Datavejviseren:* A platform that provides access to all public data sources. • *Sprogteknologi:* Supports the development of AI solutions in Danish.	Finland is home to one of the **fastest supercomputers** in the world called LUMI. Up to 20% of the LUMI supercomputer's capacity has been reserved for European industry and SMEs, including access to the LUMI user support team, enabling companies to take advantage of high-performance computing for innovation and development activities. **Example:** Poro LLMs • A family of open LLMs built and trained on the LUMI supercomputer. • With its advanced capabilities with low-resource languages, Poro will be built to handle all 24 languages of the EU.	The Netherlands is nurturing and growing AI **talent through targeted and joint undertakings by industry and research institutions.** **Example:** Kickstart AI • Host AI superchallenges to solve societal issues and promote talent globally. • Create joint industry-academia appointments, adding 25 new positions to enhance education and training. • Promote a national AI course, aiming to reach 170,000 people.	Finland's long track record in AI research is a testament to its **world-renowned universities** offering a variety of AI courses/programmes, active industry-academic collaboration and innovative startups with roots in universities and research. **Example:** AI for Business programme (2018-2021) • Funding targeted for all-sized companies and research institutions for AI R&D projects. • Aimed to increase AI expertise and build global ecosystems and research collaborations.	Ireland attracts global tech companies for its **competitive, pro-business environment and strong industry-academic research credentials**, ensuring that innovative researchers, companies and entrepreneurs that are developing and using AI are connected to each other. **Example**: Lero, The SFI Research Centre for Software • Brings together 200 researchers in Ireland, covering a wide range of software development related to AI.

Estonia can capture the AI potential with a balanced set of choices

Grow R&D by local innovators

Enable **innovation** and invest in AI **research and development**

Dilemma

Ensuring performance of AI technology in a local context

AND

Driving application of leading global AI technology

Recommendation

- As a small economy, Estonia will need to leverage research and development internationally and facilitate the application of AI research in R&D initiatives by local innovators.
- With the Kratt strategy aiming to have at least 130 AI applications in the public sector by the end of 2023, the next step could be to grow R&D by local innovators. Estonia can boost this by taking inspiration from **Finnish** industry-academia partnerships and building on its successes in the public sector and startups.

Accelerate commercial uptake

Promote widespread **adoption** and universal accessibility

Dilemma

Encouraging AI-based business models in tech-focused startups

AND

Facilitating AI adoption in traditional, established companies

Recommendation

- **Estonia** excels in fostering a dynamic AI start-up scene, while more traditional companies are still hesitant to adopt AI.
- Estonia could support collaborative projects that enable startups to pilot AI technologies in established companies, thereby catalysing a wider integration of AI innovations into the broader economy. **Ireland** has programmes that connect researchers, companies and entrepreneurs using AI.

Retrain and upskill workforce

Build **human capital** and an AI-empowered workforce

Dilemma

General AI upskilling across population

AND

Targeted reskilling of groups affected by AI

Recommendation

- Estonia is advancing the upskilling of its population in AI but now needs to focus on ensuring a supply of AI specialists to address the tech sector's talent gap.
- Learning from **the Netherlands**' "Kickstart AI" initiative, Estonia could establish partnerships that connect academia's theoretical knowledge with the practical needs of the industry, fostering an ecosystem conducive to nurturing and retaining AI talent locally.

Note: For more details on policies, see Kratt Strategy (2019), OECD AI Observatory and Google's policy paper on "AI Opportunity".

08

Annex

Modelling the impacts of generative AI in Estonia.

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Modelling the economic opportunity for Estonia

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 of 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 an 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 in ten European industry aggregates in two sub-steps. First, the 39 work activities for 900 US occupations are mapped using importance-average activities for each occupation, providing 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 complement" work activities experience a productivity boost from automation. "Likely replacement" is the share of work activities 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 adoption peaks.

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 ten-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 Briggs and Kodnani (2023a) in "The Potentially Large Effects of Artificial Intelligence on Economic Growth".

Note: Methodology is based on Briggs and Kodnani (2023a).
Source: Implement Economics based on the European Commission, Eurostat, O*Net and Briggs and Kodnani (2023a).

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Disclaimer

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