GS4S Policy briefs (D2.3)

Policy brief no. 2

Global strategy for skills migration and development

Migration or Automation? Recommendations for How to Better Navigate Labour Shortages in the EU

This policy brief is part of the Horizon Europe project GS4S – Global Strategy for Skills, Migration and Development (gs4s.eu).

Project deliverable: D2.3 in T3.4

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Reviewers: Stefan Jestl and Ksenija Ivanović.
Language editor: Josh Ward

Suggested citation (APA): Ghodsi, M., Tverdostup, M., & de Lange, T. (2025). Migration or Automation? Recommendations for How to Better Navigate Labour Shortages in the EU. Global Strategy for Skills, Migration and Development (GS4S). https://doi.org/10.5281/zenodo.15114793

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Migration or Automation? Navigating Labour Shortages in Austria

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Executive Summary

This policy brief draws on the findings of Tverdostup et al. (2025) to examine Austrian firms' responses to labour shortages through automation and migration. Like many European nations, Austria has been grappling with labour shortages over the past decade. These shortages have been influenced by demographic shifts, economic cycles and evolving industry demands. Understanding these trends is crucial for formulating effective policy responses, particularly in the realms of migration, education and automation, three policy domains central to our Horizon Europe project formulating a Global Strategy for Skills, Migration and Development (GS4S). The referenced empirical evidence indicates that automation largely complements human labour, notably benefiting low-educated migrants who are not from the European Economic Area (EEA), but posing challenges for highly educated migrant workers. Policy recommendations include improving EU migration policies, streamlining the recognition of qualifications, developing targeted training initiatives, and incentivising responsible automation practices to foster inclusive labour market growth and resilience.

Keywords: automation, labour migration, skills, labour shortages, substitution, EU

JEL Code: F22, O15, K37

Acknowledgements: This policy brief is part of the Horizon Europe project GS4S - Global Strategy for Skills, Migration and Development (gs4s.eu). The broad line of inquiry in this paper had initially been suggested by Isilda Mara. The funding from the European Union is gratefully acknowledged. However, the views and opinions expressed herein are those of the authors only and do not necessarily reflect those of the European Union, Horizon Europe or the Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them. The authors thank Stefan Jestl and Ksenija Ivanović for their extensive feedback and suggestions to the early drafts of this policy brief.

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1. Introduction

Like many European nations, Austria has been grappling with labour shortages over the past decade. These shortages have been influenced by demographic shifts, economic cycles and evolving industry demands. Understanding these trends is crucial for formulating effective policy responses, particularly in the realms of migration, education and automation, three policy domains central to our Horizon Europe project formulating a Global Strategy for Skills, Migration and Development (GS4S).

The Austrian labour market experienced notable fluctuations between 2010 and 2023. A suitable and commonly used indicator to represent demographic change, particularly in the context of labour shortages, is the old-age dependency ratio (OADR). This ratio measures the proportion of elderly individuals (typically aged 65 and older) relative to the working-age population (usually aged 15-64). It effectively captures the pressures that ageing populations place on labour markets and social security systems. As observed in Figure 1, the OADR in Austria has been steadily rising, from 15.95% of the population in 1990 to 20.16% in 2023. Furthermore, labour force participation has increased from 55.44% of the population aged 15 and above in 1990 to 61.6% in 2023, indicating a booming economy capable of employing a larger proportion of the working-age population.

Furthermore, the unemployment rate, which is a key indicator of labour market health, has seen periods of both increase and decline. For instance, in 2010, the unemployment rate stood at approximately 4.4% (see Figure 1). This rate experienced an uptick during the European debt crisis, reaching around 5.7% in 2016. After 2016, there was a gradual decline, with the rate dropping to about 4.5% by 2019. However, the COVID-19 pandemic led to a sharp increase, with unemployment peaking at 5.4% in 2020. By 2023, the rate stabilised at approximately 5.3%.

Despite these unemployment trends, employers have consistently reported experiencing difficulties in filling vacancies, indicating a persistent mismatch between labour supply and demand. In 2023, the number of job vacancies remained high, with an annual average of 206,400, although this is slightly lower than the peak in 2022 (EURES 2023; Statistics Austria 2024). This persistent demand for labour underscores structural challenges in the Austrian labour market.

Automation, particularly through the adoption of industrial robots, has been a significant trend in addressing labour shortages. Robot density, measured as the stock number of industrial robots per 10,000 employees in the manufacturing sector, serves as a key indicator of automation intensity. Globally, robot density has been on the rise. In 2022, South Korea led with 1,012 robots per 10,000 employees, followed by Singapore (730), Germany (415) and Japan (397). According to the data provided by the International Federation of Robotics (IFR), Austria has been proactive in adopting automation technologies. As Figure 2 shows, the robot intensity of Austrian firms has increased sixfold, from 0.529 installed robots per 1,000 employees in 1993 to 3.199 in 2021. The country's strong industrial base, particularly in sectors like automotive and electronics, suggests a robot density comparable to other advanced European economies. As Barišić et al. (2024) report, after Germany, Slovenia, Czechia, Italy and Slovakia, Austria had the largest intensity of robots per 1,000 employees in 2021 across the EU member states. The increasing integration of robots into manufacturing aims to boost productivity and mitigate the impacts of labour shortages. However, it also raises questions about the future of work, employment patterns, and the role of human labour in automated settings.

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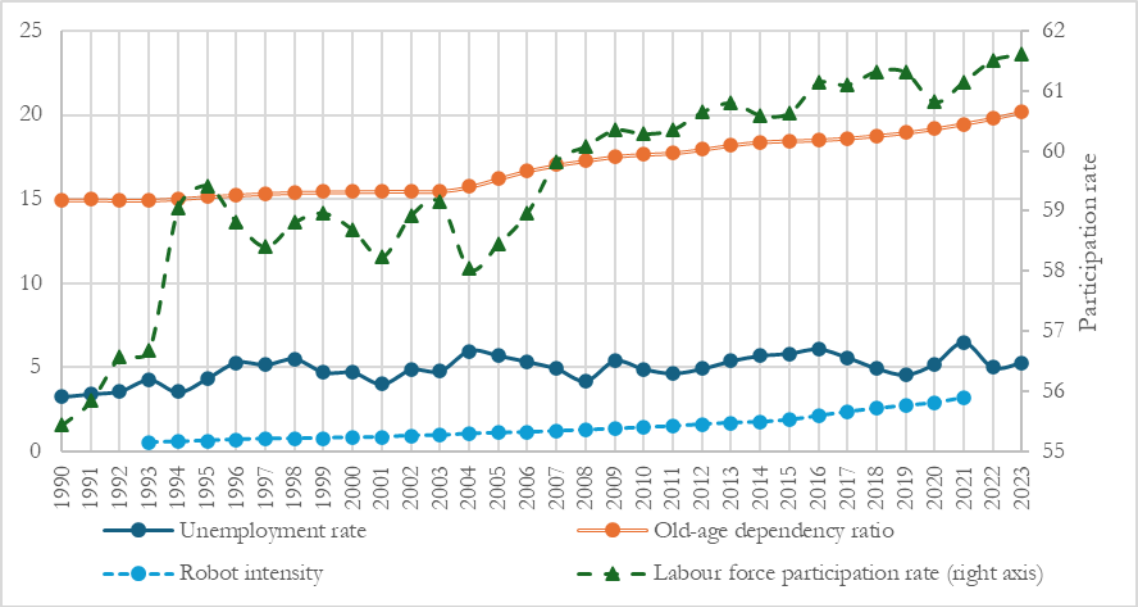
Figure 1 / Labour market development and robot intensity in Austria, 1990-2023



Sources: World Development Indicators of the World Bank, International Federation of Robotics; authors' calculations.

In the European Union (EU), automation is just one of several responses to labour shortages, as upskilling and migration are also playing increasingly significant roles. It is noteworthy that in its recent Action Plan for Affordable Energy, the EU acknowledges the need for 'a resilient supply chain with sufficient domestic manufacturing capacity and a skilled workforce, and technological developments' (European Union 2025a). Moreover, in its Union of Skills, the European Commission addresses the fragmented governance of skills policies as 'interlinked with education, labour, economic and financial policy, and social inclusion' (European Commission 2025b: 4). A key deliverable of the Union of Skills relates to making European education and training systems attractive, including for third-country nationals (ibid.: 15-16). The idea is to engage the Talent Partnerships to this end as well as to develop 'multipurpose legal gateway offices' to provide support for employers (ibid.: 16).

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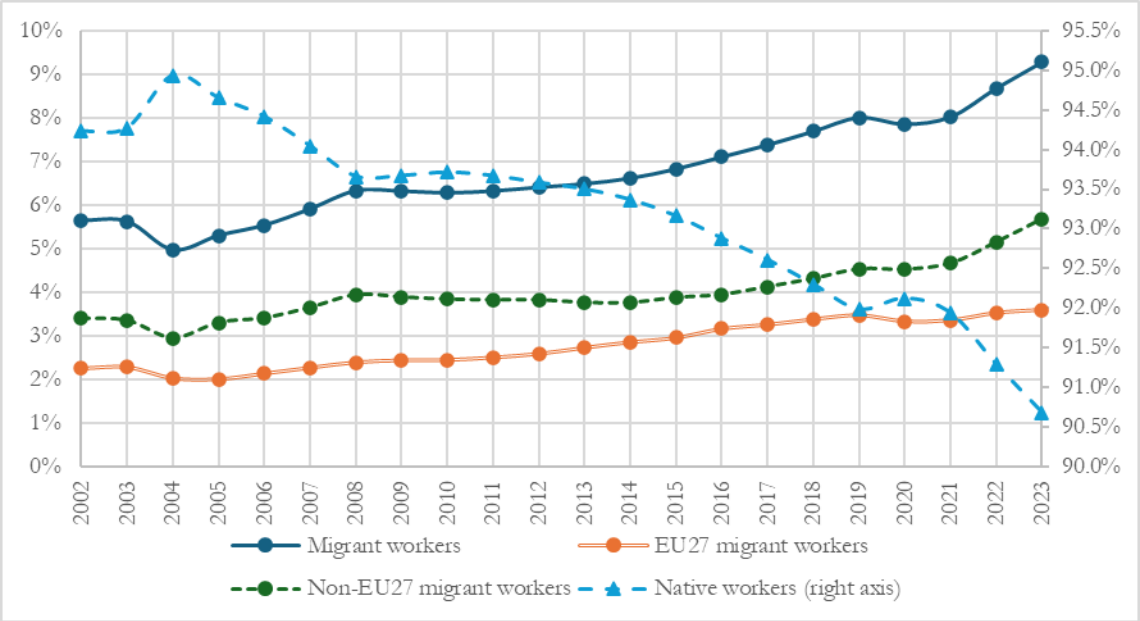
Figure 2 / Development of the share of migrant workers in total employment in the EU27, 2002-2023



Source: Labour Force Survey of the Eurostat, [lfsa_egan__custom_15917270]; authors' elaboration.

Previously, the 2025-2027 agenda of the EU's Centre for the Development of Vocational Training (Cedefop) had called for 'new evidence on the implications of digital technologies and working methods for task automation, skill formation and mismatch' (Cedefop 2024: 53). Our working paper accompanying this policy brief provides such information, and we elaborate on it in the next section. Moreover, Cedefop's skills research and intelligence work aims to help 'European economies [...] accelerate up- and reskilling of the EU workforce and better [inform] migration management approaches' (ibid.: 72). Employers in many European countries have been actively recruiting migrants to address critical skill gaps by engaging various business-to-business models (Poeschel et al. 2025). Attracting migrant talent has become a strategic priority, with individuals increasingly drawn through targeted talent-attraction schemes tailored for high-demand occupations. As Figure 2 shows, the share of migrant workers in total employment across the EU27 rose from approximately 5.64% in 2002 to more than 9.3% in 2023, thus, the share of native workers decreased from 94.9% in 2004 to 90.7% in 2023. Several EU countries have also introduced specialised talent programmes explicitly designed to attract migrant workers to occupations experiencing severe shortages (Hooper & Slootjes 2025). According to Ghodsi et al. (2024), this trend is particularly prominent in sectors facing persistent labour shortages. On the other hand, the political climate in some EU member states has politicians calling for less migration, thereby putting pressure on automation (and innovation, for which international highly qualified workers are probably just as needed). In line with these broader EU trends, Austria has been actively promoting international recruitment initiatives, as it recognises that migration is a practical solution to demographic pressures and workforce scarcity. The newly formed government aims to accelerate processing times and to identify target countries for the recruitment of skilled workers (Migration Partnership Facility 2024).

Our findings show that Austria has sought to address labour shortages through both automation and immigration. A recent working paper by Tverdostup et al. (2025) provides empirical evidence

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on how Austrian firms have employed these strategies. The next section of this policy brief summarises the key findings of that paper, highlighting the relationship between robot adoption and the employment of migrant workers. The third section outlines policy recommendations derived from these findings with a focus on the EU context, while the final section offers a summary and concluding remarks.

2. Key research findings

The findings presented in this policy brief are derived from a comprehensive econometric analysis performed by Tverdostup et al. (2025) in the context of the Horizon Europe project Global Strategy for Skills, Migration and Development (GS4S). The analysis utilises a novel, firm-level dataset specifically created for Austria by combining two primary sources: the information and communication technologies usage (IKTU[1]) surveys of Statistics Austria (waves 2018, 2020 and 2022) and detailed registry-based employer-employee records provided by the Austrian Micro Data Center (AMDC).

The merged dataset uniquely captures firm-level decisions on robot adoption (i.e. a binary variable indicating whether firms adopted robots differentiated by industrial and service robots) and detailed employment information, including workers' education levels (low, medium, high) and regions of origin (native (i.e. Austian-born), EU/EEA migrants and non-EU/non-EEA migrants). However, a limitation of the data is that we cannot analyse employment by occupation and skill level to test whether automation replaces jobs involving routine tasks. To analyse employment effects, the authors employed Poisson pseudo maximum likelihood (PPML) regression methods while controlling for crucial firm-specific characteristics, such as firm productivity, profits, investments, and sectoral and regional factors. Moreover, an individual-level analysis was conducted using multinomial logit models to assess transitions into and out of employment, exploring differences between robot-adopting and non-adopting firms.

This robust analytical framework allowed the authors to comprehensively examine the relationship between automation and migration and to thereby gain key insights into whether automation technologies serve as substitutes for or complements to migrant labour across different education levels and sectors. The analysis uncovered four significant insights into how automation technologies interact with employment patterns in Austrian firms:

1. Complementarity between automation and employment

Firms that adopt robots tend to employ a greater number of workers overall after the years of survey, indicating a potential causal relation between robot adoption and employment growth. This effect is stronger particularly for those with low and medium education levels. This indicates that, rather than broadly substituting for workers, robot adoption generally complements human labour, helping firms to mitigate labour shortages but not lessoning their dependency on low- and medium-educated migrant workers. As adopting firms tend to increase employment of workers with lower levels of education rather than those with higher levels, this may reflect a shift towards optimising labour costs.

[1] In German: Einsatz von Informations- und Kommunikationstechnologien in Unternehmen (IKTU).

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However, in the services sector, robot-adopting firms – especially those using service robots – tend to employ fewer highly educated workers than non-adopting firms. This suggests a substitution of highly educated labour with service robots. The negative effect appears to be more pronounced for non-EEA migrant workers in service firms adopting such robots.

2. **Differential effects by workers' origin and education level**

Automation notably changes the composition of labour, as it increases the employment share of low-educated non-EEA migrants, suggesting a strong complementarity between robots and this group. Non-EEA migrants appear to be more adaptable to roles alongside automation compared to their native or EEA-born counterparts. Conversely, highly educated migrants (both non-EEA and EEA) face relative disadvantages in robot-adopting firms compared to natives, indicating potential integration challenges or barriers to fully utilising their qualifications.

3. **Stronger impact of service robots**

Service robots exhibit a more pronounced positive association with employment growth than industrial robots. These effects are particularly significant in manufacturing sectors, highlighting sector-specific automation dynamics.

4. **Employment stability and labour market dynamics**

Low-educated workers generally experience greater employment stability in robot-adopting firms. However, highly educated migrant workers in robot-adopting firms face a higher likelihood of unemployment, possibly due to mismatches or restructuring processes induced by technological advancements. Additionally, workers exiting robot-adopting firms typically have higher wages than those leaving non-adopting firms, indicating a strategic labour-cost optimisation by firms through automation.

These findings underscore the complex interaction between automation and migration, revealing nuanced effects that vary significantly across sectors as well as the education levels and origins of workers.

3. What are the policy options for addressing skills shortages?

There is abundant research in the literature showing that automation increases productivity, improves competitiveness and fosters sustainable development (Graetz and Michaels 2018; Eder et al. 2024; Acemoglu and Restrepo 2020). Furthermore, Austrian firms adopt robots and employ migrant workers to circumvent labour shortages resulting from demographic changes. The findings of Tverdostup et al. (2025) suggest complementarity between robots and employment across all education levels. Thus, firms will continue automating without much negative impacts on employment and, in fact, employment tends to increase alongside automation. Consequently, we emphasise that continued robot adoption could support Austria's development, especially if it enhances the living conditions of all societal groups.

Our findings specifically indicate a greater need for low-educated labour when automation is adopted, with robot-adopting firms employing relatively more low-educated migrant workers than those with a medium or high level of education. If there is labour shortage for low-educated

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workers, firms automatically increase their employment of non-EEA candidates. For this reason, facilitating the immigration of such workers appears to be a sensible policy recommendation to address labour shortages resulting from increased automation.

The GS4S project emphasises that an integrated policy approach is necessary to develop a global strategy for skills, migration and development. In light of our findings, we present policy recommendations that are primarily aimed at EU policy makers and cover the policy fields of automation, education/integration and immigration. Although we acknowledge and support the recognition of these interconnected policy fields by the European Commissions' Union of Skills (European Commission 2025b), we nevertheless believe that the Commission must go a step further to truly engage with innovation, green technologies, automation and skilled labour migration. Indeed, we cannot stress enough the importance of industrial policies that **facilitate further automation and innovation**, as these technologies could improve the competitiveness of firms in global markets**.**

In this vein, we outline the following nine concrete recommendations to the European Commission and the EU member states:

1. **Adopt sector-specific strategies to facilitate automation, especially with service robots**

Various sector-specific measures can be taken as part of the integrated policy approach to facilitating automation. Tverdostup et al. (2024) find that both industrial and service robots increase employment at the firm level. However, the magnitude of the effect is stronger for service robots. Service robots in the manufacturing sector differ from industrial robots in that they typically support humans or systems by performing auxiliary tasks rather than being directly involved in core manufacturing processes, such as welding or assembly.

For instance, Autonomous Mobile Robots (AMRs) for internal logistics transport raw materials, parts or tools between storage areas, production lines and quality control departments. A car manufacturing plant may use AMRs (e.g. from Mobile Industrial Robots – MiR) to autonomously carry components across large factory floors, optimising intra-logistics and reducing the need for human labour. As another example, inspection drones monitor infrastructure (e.g. roofs, pipelines, storage tanks), safety conditions and emissions. A chemical manufacturing firm may deploy aerial drones equipped with cameras and sensors to regularly inspect hard-to-reach areas, minimising the need for scaffolding or human intervention. Similarly, cleaning robots help maintain hygiene in production areas, especially in cleanrooms or food manufacturing. A pharmaceutical company might use autonomous floor-scrubbing robots (e.g. from Brain Corp) to maintain sterile conditions, reducing contamination risks and labour costs. These service robots have been shown to increase employment, as they require operational technicians and maintenance staff, while significantly improving productivity in the execution of such tasks.

Therefore, in manufacturing, policy makers at the EU and member-state levels can incentivise the adoption of service robots, which have shown positive employment effects while also improving productivity and competitiveness. In the services industry, recommendations could promote inclusive innovation practices to prevent the potential displacement of highly educated workers as robots replace them.

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Furthermore, various sector-specific measures can be taken as part of the integrated policy approach to facilitating automation. For example, in manufacturing, policy makers at the EU and member-state levels can incentivise the adoption of service robots, which have shown positive employment effects. In the services industry, recommendations could promote inclusive innovation practices to prevent the potential displacement of workers with high level of education.

2. **Increase funding for the skilling of already present migrants and refugees**

We welcome EU funding and EU and national integration policies that stimulate business in engaging the already available migrant workforce, including employer subsidies to offer training to refugees already present in the EU member states. Such funding could especially target automation- and green technology-related jobs. We note that advocacy for such funding of these initiatives should be taken on by various stakeholders – from the EU level to grassroots civil society – bringing visibility to underutilised skills throughout the member states.

3. **Add a 'Skills and Migration Omnibus' to existing labour migration directives**

To attract, train and integrate skilled third-country nationals, we propose a multistep solution that could be legislatively added to existing labour migration directives through what we call a 'Skills & Migration Omnibus'. This is inspired by the Commission's proposals to streamline corporate social responsibility (CSR) rules. The proposal would go beyond the Union of Skills, which solely facilitates skilled migration (European Commission 2025b). We believe new legislation is required to adequately address the skills shortages related to automation. For example, not all skilled workers will be eligible for a Blue Card permit under its current state, due to the high qualification requirements and income thresholds. Such omnibus legislation should thus instruct the EU member states to develop entry policies for shortage occupations at different skill levels defined in each national context (see, e.g., the Austrian government's 2025 shortage occupation statistics in Government of Austria 2025) or at the EU level (e.g. with data on shortage occupations available through enhanced skills intelligence announced by the Union of Skills).

In terms of migration policy, we encourage EU legislators to see to it that the EU member states improve their national-level procedures so as to facilitate (automation- and green technology-related) job-seeking permits and thereby transitioning to the job market. The omnibus legislation could implement such a job-seeking permit and facilitate transitions from one permit to the other, including in the case of circular mobility in the directives on students and researchers (2016/801/EU), the Blue Card (2021/1223/EU) and the single permit (2024/1233/EU).

4. **Establish a standardised EU framework for recognising foreign qualifications and work experience**

A major barrier to employment for immigrants, particularly those from third-countries, is the lack of a harmonised and swift process for recognising their education credentials and professional experience. To address this, the EU should go beyond its 2023 recommendation (European Commission 2023) and implement a unified procedure for evaluating foreign degrees, vocational training and work histories. This process must be standardised across all member states so as to ensure fairness, transparency and adherence to common recognition standards. Additional

validation measures (e.g. competency assessments and qualification equivalency exams) should be introduced to facilitate smooth labour market entry.

5. **Offer temporary 'internship' permits to train migrants for automation-complementing jobs**

To achieve the outlined policy-integration aims, we propose the introduction of a residence permit for temporary skilling 'internships'. These permits could offer a maximum of two years to allow their holders to hone their automation, digital and technical skills, and they could be made accessible to both in-country applicants and applicants from outside the EEA. Importantly, one's educational level should not be a barrier to participating in this scheme, and the emphasis should instead be placed on the specific targeting of (shortage) occupations. To achieve such a pathway, a chapter could be added to the EU's directive on students and researchers (2016/801/EU). At present, this instrument is only available to the highly qualified, but the level of qualifications should not be an obstacle to finding and training workers with skills complementary to automation technologies (again, regardless of degrees or certifications).

In tandem with such a legal pathway, to ensure that migrants and beneficiaries can fully utilise their potential, skill gaps identified during the profiling process should be addressed through targeted training and education. These programs should be tailored to individual needs and developed in collaboration with local employers so as to enhance job readiness. A two-way communication strategy is essential for encouraging participation and designing courses that effectively align with labour market needs.

6. **Have the Talent Partnerships focus more on automation and green technologies**

The pilots and further iterations of the Talent Partnerships could benefit from a focus on automation and green technologies. The Talent Partnerships, launched in 2021, constitute mobility schemes for work and training combined with investment for capacity-building in partner countries. While some have focused on green skills, the fact that participation is limited to the 'skilled' is a barrier to the optimal use of such partnerships. Moreover, improved promotion of cooperation with 'Talent Partnership countries' on universal technical training is essential. The multipurpose legal gateway offices proposed in the Union of Skills could perform this role as part of their remit to provide additional support to employers in addition to focusing more on automation and green technologies (European Commission 2025b).

7. **Have public employment systems monitor and assist immigrants seeking jobs in shortage occupations**

The public employment systems of the EU member states should monitor and assist job-seeking permit holders in their efforts to find a job in shortage occupations. As informed by their context-specific data on labour shortages, these systems can place a focus on providing skills and jobs in targeted automation, digital and technical sectors. Given the high employment instability among immigrants (e.g. part-time or temporary contracts), continuous support is crucial. Public employment services and integration agencies should provide continuous mentoring, career counselling and job-search assistance until individuals secure stable employment. In addition to the targeted sector skills, immigrants should receive training in essential skills – including language proficiency and knowledge of the host country's legal and labour market systems – to foster their long-term success.

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8. **Take active measures against wage discrimination faced by migrants**

In light of the research findings on wage discrimination, further safeguarding of rights could mitigate these patterns. Leveraging the equal treatment principle under the single permit directive (2024/1233/EU) should help to lower the amount of wage discrimination faced by third-country nationals.

9. **Reinforce social safety nets in case of worker displacement**

As part of this integrated and sustainable approach, reinforcing social safety nets in welfare regimes among the EU member states remains key. This can be accomplished by: enhancing social protection measures for workers vulnerable to displacement due to automation; ensuring the equitable distribution of productivity gains; offering employer subsidies for vocational education and training (VET) as positive incentives; and including negative incentives for industry, with social conditionality in manufacturing in case of VET non-compliance (e.g. via withdrawing EU subsidies).

4. Summary and concluding remarks

This policy brief summarises and discusses key insights from the comprehensive firm-level analysis by Tverdostup et al. (2025), which investigates the relationship between robot adoption and the employment of migrant workers differentiated by their education levels and regions of origin. Their empirical analysis employs econometric methods and detailed Austrian firm-level data, providing essential evidence on how automation interacts with migrant employment amid persistent labour shortages.

The findings reported by Tverdostup et al. (2025) highlight a persistent mismatch between labour supply and demand as well as a notable complementarity between automation technologies and overall employment, especially among workers with low and medium levels of education. Firms adopting robots tend to employ larger workforces, suggesting that automation primarily complements rather than replaces human labour. In particular, low-educated non-EEA migrants appear notably adaptable to automated environments, significantly benefiting from the introduction of automation technologies. Conversely, highly educated migrants, regardless of their origins, tend to face employment disadvantages in robot-adopting firms, likely reflecting challenges related to skills mismatches or integration barriers. Austrian firms thus strategically combine robot adoption and migrant employment to address labour shortages resulting from demographic changes. Although firms pursue these strategies to optimise their profits, policy makers should introduce measures to support both robot adoption and the availability of migrant workers, who are essential for automation.

Based on these findings, several strategic policy actions are recommended to effectively navigate labour shortages while also ensuring equitable outcomes for workers:

1. **Adopt sector-specific strategies to facilitate automation, especially with service robots**: Supporting service robots in manufacturing given their positive employment effects.
2. **Increase funding for the skilling of already present migrants and refugees**: Leveraging existing migrant populations through targeted training and skilling initiatives.

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3. **Add a 'Skills and Migration Omnibus' to existing labour migration directives**: Enhancing EU-level policy coordination to streamline migration processes specifically targeting occupations facing skill shortages.
4. **Establish a standardised EU framework for recognising foreign qualifications and experience**: Introducing uniform credential-evaluation processes to facilitate labour market access for third-country nationals.
5. **Offer temporary 'internship' permits to train migrants for automation-complementing jobs**: Facilitating temporary skill-building opportunities in automation technologies accessible to migrants regardless of their educational background.
6. **Have the Talent Partnerships focus more on automation and green technologies**: Expanding Talent Partnerships to explicitly include skills relevant to automation and green technology sectors.
7. **Have public employment services monitor and assist immigrants seeking jobs in shortage occupations**: Enhancing targeted employment support in key automation-sensitive sectors.
8. **Take active measures against wage discrimination faced by migrants**: Strengthening legal protections to enforce equal pay and mitigate wage disparities for migrants.
9. **Reinforce social safety nets in case of worker displacement**: Strengthening social protection mechanisms for workers potentially displaced by automation.

These recommendations collectively advocate for an integrated approach addressing the complex dynamics between migration, automation and employment in order to promote inclusive, sustainable growth across the Austrian and broader European labour markets.

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GS4S Policy brief series (D2.3)

Policy brief no. 2

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About GS4S

GS4S seeks to better understand global skills shortages in selected sectors (Digital, Care and Construction) and strengthens evidence-based and multi-level policies on labour migration governance. The project provides new knowledge on alternative and equitable ways for addressing skills shortages in six regions (EU, EEA, Western Balkan, Middle East and Northern Africa, West Africa, and South/South-East Asia).

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