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ISABEL

MINIMIZE COSTS AND MAXIMIZE BENEFITS IN THE TRANSITIONARY EUROPEAN REGIONAL LABOUR MARKETS

mInimize coSts and mAximize Benefits in the transitionary European regional Labour markets

Deliverable Nº 2.3

Report on existing policies to address JCD and skills shortages

WP2: Conceptualisation, Co-creation Methodology, and System Architecture

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Abstract

This deliverable explores recent policies planned and implemented to address labour market transformations. In particular, it reviews strategies at the national, regional and local level to mitigate job destruction and enable job creation, with a specific focus on these policies in the context of the green and digital transition. Furthermore, it examines strategies to mitigate skill shortages, i.e. policy tools to reskill and upskill workers who are affected by the transitions. The report offers recommendations for policy improvements, serving as a valuable resource for policymakers and stakeholders in developing effective responses to labour market challenges. The ultimate aim of this deliverable is to assess these policies and then highlight best practices, with these insights informing the place-based strategies that the ISABEL project will suggest.

Views and opinions expressed in this document are those of the author(s) and do not necessarily reflect those of the European Union or REA. Neither the European Commission nor the granting authority can be held responsible for them.

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Executive summary

The objective of this document is to review the literature on the strategies that can be developed to address the Job Creation and Destruction (JCD) associated with the energy transition and the full development of the digital economy and artificial intelligence technologies.

The research was conducted using an approach to take advantage of the main artificial intelligence applications and designed specifically for this review: the Prompt-based Automated Literature Extraction Tool (*PALET*). This procedure identified, after applying filters, 142 papers proposing economic policy recommendations related to the EU's 'twin challenges' of green and digital transition. These recommendations were analyzed and grouped into six blocks: (i) promoting the training of technicians and the continuous training of workers; (ii) measures to adapt to the changes that will occur in the workplace and the new models of spatial relations; (iii) immigration policies to act as an ally; (iv) prevent spatial gaps and correct inequalities between territories; (v) promote research and development; and (vi) take into account Europe's unique diversity by promoting smart specialization policies that adapt to it.

Following this general review, the document is completed with a more detailed analysis of active labour market policies (ALMP) related to the 'green transition' and decarbonization process, whose impacts are already visible, and against which more specific policies have been generated. The effectiveness of various active employment policies has been widely evaluated, finding that careful design, appropriate targeting, and supportive institutional frameworks are required, rather than simply increasing program expenditure.

Finally, the document is completed by reviewing other policy actions implemented throughout the European Union at both the national and regional levels in the six partner countries of ISABEL: Greece, Spain, Serbia, Poland, the UK and Denmark.

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1. Introduction

In a global context of instability and change, the European Union faces the challenges of green and digital transition as cornerstones of its medium and long-term strategy. Both challenges will have a significant impact on the labour market, eliminating jobs in many sectors and certain types of activities, but creating opportunities in others.

We review the literature on the strategies that can be developed to address this Job Creation and Destruction (JCD) associated with the energy transition and the full development of the digital economy and artificial intelligence technologies.

The research was conducted using a method to take advantage of the main artificial intelligence applications and designed specifically for this review: the Prompt-based Automated Literature Extraction Tool (*PALET*). This procedure identified, after applying filters, 142 papers proposing economic policy recommendations related to the EU's 'twin challenges' of green and digital transition. These recommendations were analysed and grouped into five blocks:

- First, education and lifelong learning are central pillars, as highlighted across numerous studies. It is critical to develop a highly skilled workforce capable of leveraging emerging technologies in clean energy, AI, and digital systems. This entails integrating digital and green competencies not only into higher education curricula, particularly in STEM disciplines, but also across vocational training and basic education levels. Moreover, continuous professional development is essential for the current workforce, emphasizing skills mapping and tailored upskilling programs to ensure adaptability and resilience in the face of rapid technological and environmental change.
- Second, the transformation of work, driven by digitalization, has led to widespread adoption of remote and flexible work models. While such models provide opportunities for healthier and more flexible working conditions, they also introduce regulatory, social, and spatial challenges. Remote work influences organizational structures, working relations, urban mobility, and urban form. Policymakers must ensure that remote work is not precarious and that the environmental benefits of reduced commuting are not offset by increased urban sprawl, which could generate negative environmental externalities.
- Third, migration policies also play a strategic role. The EU must align immigration and social integration policies to facilitate the inclusion of migrants into sectors pivotal for the green and digital transitions. This requires targeted training programs, language support, and flexible integration pathways tailored to labour market needs.
- Fourth, a significant concern is the emergence of territorial disparities and "green discontent," wherein regions bearing disproportionate costs of decarbonization perceive limited benefits from EU policies, fuelling political disaffection and populism. Digitalization similarly risks exacerbating regional inequalities despite infrastructure convergence, as gaps persist in digital skills and usage. This underscores the importance of developing policies that minimize the social and territorial impact of the green agenda. While progress is being made toward the environmental sustainability of the European economy, policies must be developed that minimize its impact and avoid sparking discontent that could hinder the objectives and backfire on the European Union itself.

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- Finally, Europe's territorial heterogeneity underscores the necessity of smart specialization strategies. Policies must be localized, leveraging regional strengths and sectoral interdependencies, to ensure an inclusive and balanced transition across diverse European territories.

Following this general review of the strategies against JCD, the document is completed with a more detailed analysis of active labour market policies (ALMP) related to the 'twin transitions', whose impacts are already visible and against which more specific policies have been generated. The literature on digital transition reveals striking parallels with green transition policy frameworks, particularly regarding the central role of training programs, employment services, and comprehensive support packages for displaced workers. Just as green transition policies emphasize the importance of upskilling workers from declining carbon-intensive sectors, digital transformation strategies prioritize reskilling programs for workers in automation-vulnerable occupations. Both contexts highlight the inadequacy of purely reactive approaches and underscore the necessity of proactive, anticipatory policy interventions that prepare workers before displacement occurs.

While the following analysis focuses specifically on ALMPs in the context of green transition, the policy mechanisms, design principles, and implementation strategies discussed are largely applicable to digital transformation challenges. The emphasis on comprehensive stakeholder engagement, place-based approaches, and coordinated policy packages reflects universal principles of effective labor market adjustment that transcend the specific nature of the underlying structural change. This convergence suggests that policy frameworks developed for one transition can inform and enhance responses to the other, supporting the integrated approach increasingly recognized as essential for managing the interrelated challenges of the twin transitions.

Based on an extensive literature review, encompassing meta studies, comparative studies and single-case reports, this analysis addresses two related policy questions:

- What should governments and other stakeholders do to facilitate the green transition, particularly the transition away from coal?, and
- What are the most suitable and efficient labour market policies to prevent long-term unemployment and income losses among workers affected by the green transition and support their re-employment?

The surveyed literature on this particular area was divided into 'macro' and 'micro' studies. Macro studies are methodologically and topically heterogeneous. They address the first question from various angles and use mostly qualitative and comparative methodology to describe the transition processes, to evaluate strategies and policies applied, to draw lessons learned and to suggest optimal policy choices. Micro studies are typically focused on 'scientific', or 'net impact' evaluations of active (and, very rarely, passive) labour market programmes. They are methodologically and topically more homogeneous, attempting to assess, using econometric and other statistical techniques, the 'net impact' of various programmes on labour market outcomes of beneficiaries of such programmes and to distil, in the context of the green transition, which programmes work best and for whom.

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The methodological asymmetry between the two types of studies reflects the asymmetry between the policy measures aimed specifically to alleviate the negative effects of job destruction on affected workers, and the broad set of measures aimed to maximise job creation and economic growth in a region, sector, and ultimately in an economy undergoing a green transition.

What transpires from the best experiences presented in 'macro' studies is that the green transition requires strategic cross-policy planning and extensive resources. Subnational governments and other relevant stakeholders should be actively engaged in both the design and implementation of measures (ILO, 2015). The green transition is a challenging endeavour, often causing disruptions to the economic, labour market and business and cultural identity of affected regions (Caldecott et al., 2017). To compensate for these disruptions and utilise their potential advantages by updating skills and upscaling businesses, extensive financial resources are needed to carry out investment strategies, with projects encompassing infrastructure, regeneration activities, education and R&D (Diliuso et al., 2021). Regional authorities and businesses should also be supported to pursue smart specialisation and economic diversification. Identifying skill needs at the local level and creating reskilling and upskilling programmes tailored to these needs is emphasised in many sources, including Cirillo et al. (2024). Reliance on ALMPs is important, but it is not enough (Keese & Marcolin, 2023). Effective transition strategies should prioritise early stakeholder involvement (Broughton &Wehnert, 2020; Vogl, 2019). That is, creating consensus, ideally through encompassing social dialogue, among regional authorities, industries, trade unions, and citizens about the sequencing and overall pace of the transition is found to be very beneficial (Galgóczi, 2019).

Compensating fully and early workers and citizens whose lives will be disrupted and who are about to suffer financial and other losses due to the green transition is crucial for the credibility, fairness and political success of the process. Studies emphasise the central role played by existing or enhanced social protection systems (Fretwell, 2017; Cunningham &Schmillen, 2021). Following the spirit of the optimal rate and speed of transition model (Aghion &Blanchard, 1994), adequate and careful sequencing and pacing of economic and labour market restructuring is needed to navigate between the negative spiral of unemployment, demand shock and political economy risks, if the pace of transition is too fast, and status quo, leading to further lagging behind, if the pace is too slow. In that vein, Nævdal and Wagner (2025) criticise politically set EU-wide milestones for emissions reductions because they are not optimally designed in individual countries.

Active labour market policies are interventions aimed at assisting workers in becoming employed or maintaining jobs. Using the Eurostat classification, ALMPs (named LMP measures by Eurostat) include Training; Employment incentives; Sheltered and supported employment and rehabilitation; Direct job creation and Start-up incentives. Typically, these programmes are evaluated using advanced econometric techniques, attempting to isolate ex- post net effects of the intervention, comparing the actual individual labour market outcomes of the intervention with the hypothetical (counterfactual) individual outcomes without the intervention.

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ALMPs are widely used instruments of economic and labour market policy. Their main advantage is that, by targeting the members of the labour force at risk, rather than the entire economy, they avoid the macroeconomic disruptions that can be potentially caused by generally expansionary fiscal or monetary policy. In the context of green transition, the role of most ALMPs increases as the large number of jobs, often crucial for the well-being of a population within a region, might be under elevated risk.

Regarding policy evaluation, the evidence from analysed studies reveals significant heterogeneity in ALMP effectiveness across intervention types, contexts, and implementation approaches. Entrepreneurship and self-employment programs consistently demonstrate the strongest positive effects across different settings, while public works programs[1] show limited or negative impacts. Training programs exhibit mixed results, highly dependent on design quality and economic conditions, with workplace-based training generally outperforming classroom instruction. Job search assistance shows moderate positive effects when properly implemented, while wage subsidies demonstrate conditional effectiveness depending on program design and economic context. Cross-country analyses suggest that implementation quality, institutional capacity, and targeting precision matter more than aggregate spending levels. Regional studies highlight the importance of local economic conditions and employer engagement in determining program success. The evidence emphasises that effective ALMPs require careful design, appropriate targeting, and supportive institutional frameworks, rather than simply increasing program expenditure. However, without adequate funding for the challenge at hand, the impact of ALMP is likely to remain limited.

Finally, across the ISABEL partner countries, significant policy reforms are underway to manage the social and economic impacts of the twin transition. Greece and Spain have developed robust national frameworks, with Greece focusing on phasing out lignite through its National Energy and Climate Plan (NECP) and territorial plans targeting economic diversification and reskilling in affected regions. Spain, meanwhile, has enacted the Just Transition Strategy and pioneering legislation like the Climate Change and Energy Transition Law, aiming for carbon neutrality and massive investments in renewables and green hydrogen, while ensuring social inclusion through retraining and regional development initiatives.

Poland's path remains complex, as coal still plays a dominant role despite commitments to phase-out, particularly in regions like Silesia. Policies such as the Social Agreement on Hard Coal Mining, the Programme for Silesia, and the Territorial Just Transition Plan reflect attempts to balance economic restructuring with social stability. However, inconsistencies between national energy strategies, political uncertainty, and limited vocational training funding hamper cohesive action. Denmark, by contrast, leverages its flexicurity model and strong social dialogue to manage labour market transitions, focusing on green and digital

[1] Public works are programmes designed to directly create new temporary jobs primarily for the most vulnerable unemployed, by specially designed projects which are typically financed by PES, but run by municipalities or private service providers. These projects typically employ a group of vulnerable (e.g. long-term) unemployed. Their primary goal is to reduce unemployment and poverty, while also helping participants maintain their motivation, work skills, and connection to the labour market. Governments may implement such projects directly or in cooperation with non-profit organisations or the private sector.

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skills development, though spatial disparities like those in Kalundborg reveal local mismatches between booming green industries and workforce availability, compounded by housing constraints.

The United Kingdom and Serbia also exemplify divergent experiences. The UK's transition policies are marked by industrial strategy shifts, skills initiatives, and region-specific interventions, though political shifts have introduced some uncertainty. Serbia, still aligning its frameworks with EU standards, faces early-stage challenges in coal-dependent areas, with limited institutional capacity and fragmented labour market interventions.

Across all countries, common threads include efforts to promote economic diversification, green and digital skills training, and social inclusion, yet practical implementation varies widely depending on governance capacity, regional contexts, and socio-economic legacies.

The 2030 Agenda: Europe's Main Challenges

The European integration project is facing one of the most complex periods since its foundation in the middle of the last century[2]. Since the 'Great Recession', triggered by the 2008 financial crisis and intensified in Europe by austerity policies and the subsequent debt crisis (Caporaso and Rhodes, 2016; Jones et al., 2016; Kapitsinis, 2023), the European Union (EU) has been hit more by consecutive crises, such as (i) the pandemic and their effects over the process of economic recovery (Krastev and Leonard, 2020; European Commission, 2022), (ii) the conflict in Ukraine and the resulting energy and raw materials crisis (Howorth, 2017; European Think Thanks Group, 2022), (iii) the increase of the refugee pressure (Buonanno, 2017) and, continuously since Brexit, (iv) the rise of a populist, anti-system and anti-EU political wave (Ansell et al., 2017; Rodríguez-Pose, 2018 and McCann and Ortega, 2021). To all this has recently been added the radical change in the international policy of the United States under the second Trump administration[3].

Aware that the way to move away from a future where the fall of the European integration project could be possible is to face global challenges with decisive policies. To face these challenges, all the EU member states assume as their own the objectives of the strategic document *Transforming our world: the 2030 Agenda for sustainable development (2030 Agenda)* (United Nations General Assembly, 2015). The *2030 Agenda* embraces five fundamental principles: (i) universality, which applies to all countries; (ii) leaving no one behind, which considers all people irrespective of status and location; (iii) interconnectedness and indivisibility, which needs to be implemented as a whole; (iv) inclusiveness, every contribution is valid; and (v) multi-stakeholder partnerships to support implementation. The *2030 Agenda* contains an implementation framework of 17 Sustainable Development Goals (SDGs), 169 targets and 244 indicators (93 of which are environment-related). These 17 SDGs aim to measure the world's most pressing issues, more specifically related to: no poverty (SDG 1); zero hunger (SDG 2); good health and well-being (SDG 3); quality education (SDG 4); gender equality (SDG 5); clean water and sanitation (SDG 6); affordable and clean energy (SDG

[2] For a comprehensive review of the current European crisis see, among others, Riddervold et al. (2021) and Vanhercke et al. (2023).

[3] On the historically growing weakness of transatlantic relations see Ikenberry (2008).

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7); decent work and economic growth (SDG 8); industry, innovation and infrastructure (SDG 9); reduced inequalities (SDG 10); sustainable cities and communities (SDG 11); sustainable consumption and production (SDG 12); climate action (SDG 13); life below water (SDG 14); life on land (SDG 15); peace, justice and strong institutions (SDG 16) and partnerships for the goals (SDG 17) (United Nations General Assembly, 2015).

Since the launch of the *2030 Agenda* strategy, the EU has been aligning its various policies to achieve the global objectives established by the United Nations. The increase in global uncertainty, especially following the succession of crises since the pandemic, has reinforced a double main challenge: the climate challenge and the challenge of digitalization. During the *United Nations High-Level Political Forum* in July 2022, it was stressed that the EU can provide a leadership role in accelerating the *2030 Agenda* for sustainable development. This priority was incorporated for the first time in the *European Green Deal* (European Commission, 2021a). Digitalization has been interpreted as an opportunity to boost the productivity and competitiveness of the European economy and even interact positively with other Union policies and objectives, such as the *Green Deal* (European Commission, 2021b). However, the explosion of artificial intelligence (AI) and the acceleration of digitalization have placed these aspects at the center of European policy and European challengers (Leal Filho et al., 2022).

Digitalization and the green economy are interconnected, with digital solutions enabling sustainable production while climate goals require structural shifts. The EU aims for a 55% emissions reduction by 2030 and carbon neutrality by 2050, posing challenges for fossil fuel-dependent regions (European Commission, 2024). Coal-reliant areas face significant job losses, with 54,000–112,000 EU coal jobs at risk by 2030 (Kapetaki et al., 2021). While green sectors create jobs—3.5 million in the EU by 2020—transition impacts are uneven across regions and demographics (Vandeplas et al., 2022). Low-skilled workers, women, and migrants struggle with re-employment, exacerbating inequality (Cárdenas-Rubio et al., 2022). Labour markets shift toward flexible but precarious work (Herod, 2017). Despite net job creation forecasts, working conditions and regional disparities are often overlooked (Laubinger et al., 2019). National-level studies neglect regional adaptation, masking uneven socio-economic effects (García-García et al., 2020).

The 'twin challenge' of the green and digital transition will determine the evolution of the EU over the next decade. In a context of growing global uncertainty and accelerating change, Europe must strengthen its integration and international position with a successful green and digital transition (Rodríguez-Pose and Bartalucci, 2023). This twin/dual transition requires enormous efforts to adapt production processes, public and private investments (Frondel et al., 2020; Cedefop, 2021a and 2021b) and, especially, professional skills (Lehr et al., 2012; Lewney et al., 2019 and Cedefop, 2023).

Objective of this literature review and structure of the document

The review of the growing literature on the effects of the 'twin challenge' of digitalization and decarbonization in terms of JCD seeks to generate a growing set of economic policy recommendations. The objective of this literature review, once the general context and the particular phenomenon to which we are paying attention have been established, is to synthesize and highlight the main economic policy recommendations that are emanating from the scientific contributions around the JCD debate on the changes derived from

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digitalization and decarbonization of economies.The document is structured as follows. The following section will explain the methodology used to carry out a synthetic and objective review. We try to provide a new procedure supported by the implementation of an AI review process guided by the expert knowledge of the authors. This allows us to have a selection of objectively delimited contributions, papers, reports and working papers, whose characteristics are described in a brief meta-analysis presented in the third section. The fourth section is the one that provides the greatest conceptual value by synthesizing the main economic policy measures/recommendations that can be deduced from this review. Following this general review, the document is completed with a more detailed analysis of active labour market policies (ALMP) related to the 'green transition'. Finally, the document is completed by reviewing other policy actions implemented throughout the EU at both the national and regional levels, among the ISABEL partner countries.

To enrich the research process and insights of D2.3, we organized a co-creation workshop on the 10th of July 2025. The exact and detailed procedure, participants and feedback of this first co-creation workshop of ISABEL are described in D2.4. Specificities about the feedback received and how we addressed can be found in the annex.

2. Methodological approach: a new approach of making a synthetic selection of references using AI tools

The* Prompt-based Automated Literature Extraction Tool *operating process

There is a growing academic literature, in addition to reports from public institutions and private organizations, that studies the impacts in terms of job creation/destruction arising from the challenges posed by climate change and the 'green deal', as well as those arising from digitalization and the increasing implementation of technologies based on AI. Each of these published papers generates pertinent economic policy recommendations, which we seek to identify, prioritize, and synthesize in this literature review. The problem is that there is an enormous breadth of work, from which very specific policy proposals are then derived. We need to implement a procedure that ensures a complete sweep of key references, even though the information we extract from each work is minimal. Therefore, we believed it appropriate to use a procedure that is objective, efficient, and automated.

We are going to propose an operating process that we called a *Prompt-based Automated Literature Extraction Tool* (PALET). This process consists of: (i) the synthesis of research questions and extraction of keywords, (ii) the generation of Boolean search strings adapted to specific scientific databases based on the research questions and keywords, (iii) the retrieval and export of relevant bibliographic records in CSV format, (iv) automated filtering based on PRISMA-ScR guidelines[4], and (v) contextualized synthesis of retrieved literature in relation to the original research questions, all conducted through an Agent (A) architecture powered by AI.

Wooldridge and Jennings (1995) distinguish two general uses of the term agent within the fields of AI and Computer Science: the so-called *Weak Notion and Strong Notion of Agency*.

[4] See: https://www.prisma-statement.org/scoping

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The former is used to refer to any software-based computer system that possesses the following properties: (i) autonomy, in the sense that it operates without direct human intervention and has control over its actions and internal state; (ii) social ability, it can communicate with other agents and humans; (iii) reactivity, it can perceive its environment and respond to changes occurring within it; and finally, (iv) proactivity, it can exhibit goal–directed behavior by taking the initiative.

The Strong Notion of Agency, on the other hand, complement the aforementioned properties by adding that agents are “conceptualized or implemented using notions that are more typically associated with humans”, i.e. capabilities, choices, and commitments (Shoham, 1993, pp. 5).

Green et al. (1997), on the other hand, formally define an agent as "a computational entity that acts on behalf of other entities autonomously, performs its actions with a certain level of proactivity and/or reactivity, exhibits a certain level of the key attributes of learning, cooperation, and mobility". In a more synthesized way, Wooldridge and Jennings (1995) defines them as "a computer system that is located in a given environment and that is capable of acting autonomously in that environment to meet its design objectives".

Although the system described here requires an initial seed (that is, a prompt from which the user's preferences regarding the research questions are communicated) this fact does not exclude it from the definition of agent under Wooldridge and Jennings (1995) Weak Notion. As Shoham (1993) posed, the autonomy is taken to mean that “the agents’ activities do not require constant human intervention”. In this sense, the system responds to the criteria of autonomy, proactivity, reactivity and social skills, by being able to interpret an initial input, transform it into complex search strategies, interact with different databases and return relevant results without continuous human assistance.

In the next section, the behavior and operational process followed by the Agent is described. Each phase includes a general description, the input data received, the expected output, a step-by-step account of the Agent’s behavior, the specific rules and constraints that delimit its behavior, an example of execution, and concluding remarks. Each part of the process has been given a name. The overall PALET workflow is illustrated in Figure 1.

Step-by-step* PALET *operational process and workflow

First step: Automated Research Query

In this first step, *PALET* receives the key research questions and extract relevant keywords for the bibliographic search. The generated keywords will serve as inputs for the subsequent steps in the automated process. This step, that we have named Automated Research Query (ARQ), is almost the only direct intervention required from the user; in the sense that it needs a seed prompt to start the process. The remainder is fully automated based on the information provided here as an input. Therefore, the quality, context, and precision of this input are critical to ensure accurate and relevant outcomes.

The user's seed prompt should provide a clear and structured description of the review topic and RQ, so that *PALET* can understand them and generate meaningful keywords and structured search strings. The key elements the researcher should, ideally, include in the

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prompt are summarized in Table 1. The CPC Framework (Context-Precision-Concision Framework) for prompt engineering (Perancho, 2025), is highly recommended for this step.

During the whole process, *PALET* uses the well-known Chain-of-Thought (COT)[5] to structure its behavior but always following some predefined steps. The COT method have proven to facilitate reasoning in LLMs when solving complex tasks (Wei et al., 2023; Zhang et al., 2022; Feng et al., 2023). The behavior of the agent regarding ARQ is as follows: (i) input analysis and segmentation into keywords through structured reasoning (COT); (ii) interactive refinement, presenting an initial proposal to the researcher and iteratively adjusting based on feedback and (iii) final validation and transfer, ensuring alignment between questions and keywords before passing the output to the Query Structuring Process (QSP).

PALET can request additional clarifications i.e. suggesting consolidating overlapping or redundant questions and discouraging the use of overly generic terms that may introduce noise in the literature search. The researcher may iterate this process until the final version of questions and keywords is validated. Once the researcher is satisfied with the selected keywords, by typing *Confirm*, *PALET* will start the next step

Table 1. Key elements to design a good seed prompt

Theme	Research Questions (RQ) to answer
Central theme of the Scoping Review	What phenomenon do you want to explore? What is the general focus of the study? What main concepts do you want to discuss?
Main objective of the review	What do I hope to get out of the review? Are you looking to map the state of the art, identify gaps in literature, or both?
Geographical scope	Are you interested in a specific country, area, or language? Do you want to make comparisons between regions, countries or languages?
Time period	Since what year do you want to review the literature? Are you looking for recent or historical studies?
Disciplines and theoretical approaches	From what areas of knowledge will the topic be addressed? Is one approach more interesting or predominant than another (i.e., economic, anthropological)?
Examples of previous studies or references	Is there a key item that you want to prioritize? Do you want to avoid certain types of studies or approaches?
Other clarifications or important aspects for the researcher	Is there anything you want to prioritize? Do you want to avoid certain types of studies or approaches? Are there any magazines, or journals, that should be prioritized? Are there any databases that should be prioritized?

Source: own.

Second step: Query Structuring Process

In the Query Structuring Process (QSP), *PALET* is responsible for generating optimized search strings for multiple academic databases (e.g., Scopus, JSTOR, Web of Science, Google Scholar). The main objective of this phase is to ensure a precise retrieval of literature relevant to the

[5] The Chain-of-Thought "consider one's own thought process when solving a complicated reasoning task. It is typical to break down the problem into intermediate steps and solve each before giving the final answer" (Wei et al., 2023).

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topic defined in the seed prompt. The quality of the results depends largely on the effectiveness of the previous prompt and the refinement process led by the researcher. Operating on the generated keywords, *PALET* translates this information into queries tailored to the syntactic requirements of various databases. Therefore, to maximize precision and reduce noise, and by the means of COT, *PALET* applies Boolean operator structuring, semantic term expansion, and structured filtering.

As aforementioned, the researcher can incorporate, in the seed prompt, additional parameters (i.e. language, time frame, document type, country of publication, among others), to refine the search and enhance result relevance. Since each database has its own syntactic requirements, in the QSP step, *PALET* automatically adapts each search equation to the preferred platform, if specified.

The behaviour of *PALET* regarding the QSP is as follows: (i) reception and validation of ARQ output; (ii) keywords structuring; (iii) generation of advanced Boolean search strings, optimized for the syntactic requirements of each academic database; (iv) heuristic refinement, reducing redundancies and enhancing precision and thematic coverage and (v) delivery of finalized search strings.

Third step: Search Execution

In the Search Execution (SE) step, *PALET* is responsible for executing the refined search strings across the academic databases specified in the seed prompt. After the search, *PALET* retrieves and exports the bibliographic data associated with the results into structured CSV files; these contain information regarding authors, title, year, source title, volume, issue, page range, citations, DOI, affiliations, abstract, keywords, document type, publisher[6].

Once the retrieval is completed, *PALET* informs the researcher of the total number of items (i.e., academic publications, reports) collected. If the researcher considers the number to be excessive, the process returns to the previous step to refine the search string and increase specificity. If no results are retrieved, *PALET* autonomously repeat the previous step, modifying the search strings.

Within this step, *PALET* act as follows: (i) execution of search strings across the selected databases; (ii) automated retrieval and export of bibliographic metadata in structured CSV format; (iii) inform the researcher of the total number of items retrieved; (iv) conditional adjustment: If results seem excessive to the researcher will return to last step for refinement, If no results are found *PALET* autonomously modifies the search string and re-executes the search and (v) storage, preparation and duplicates removal of retrieved data.

[6] This list may vary depending on the database.

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Fourth step: Matching and Assignment Process

During the Matching and Assignment Process (MAP) step, *PALET* analyses the abstracts of the retrieved items and aligns them with the RQ provided by the researcher; therefore, it provides the user with a structured synthesis of which articles respond to which RQ. Using the unified CSV generated during the SE phase, *PALET* performs a semantic matching process, using the RQ as anchors– and determines which article answers which question.

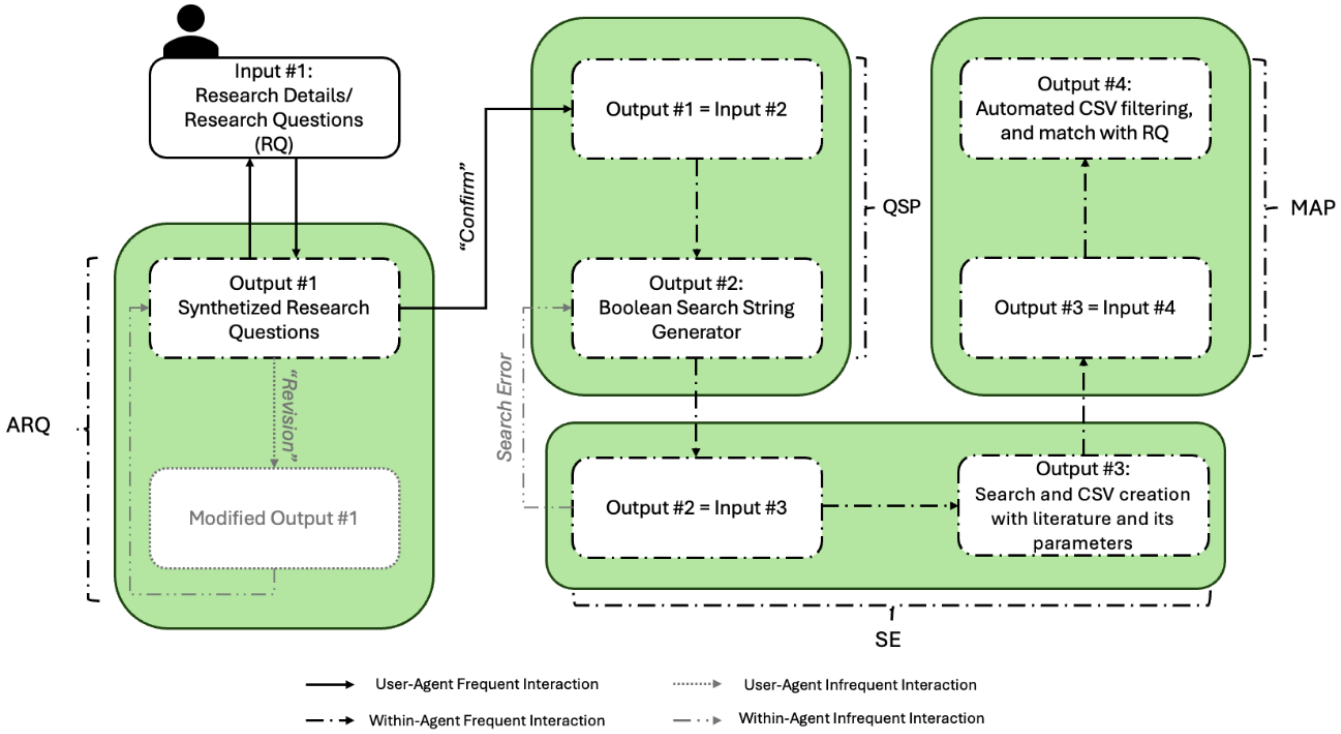
The outcome of this step is a report that links each RQ with a list of articles whose abstract content is considered to answer that particular RQ. Items that do not clearly correspond to any specific question, but may contain valuable insights, are grouped separately.

The behaviour of *PALET* here is as follows: (i) abstract analysis of all retrieved items; (ii) semantic matching between RQ and abstracts; (iii) assignment of articles to each question; (iv) identification of unmatched but potentially valuable articles and (v) generation of a structured PDF matching questions and literature.

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Figure 1. Step-by-step *PALET* workflow



Source: own.

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3. Application of PALET: main results and statistics

In this section, we present a summary of the results obtained from the *PALET* review process described in the previous section, summarized in Figure 1.

The specific research questions used to apply the procedure are presented in Table 2.

Table 2. Specific Research Questions (RQ) used in the application of the *PALET* procedure

	Research Questions (RQ)
RQ1.-	What economic-policy recommendations does the literature formulate to mitigate job destruction and boost job creation associated with the green transition in the EU?
RQ2.-	What recommendations does the literature provide regarding the impact of digitalisation and artificial intelligence on JCD in the EU?
RQ3.-	What cohesion or smart-specialisation policies does the evidence suggest?
RQ4.-	Which initial-education and lifelong-learning models are most effective for adapting green and digital skills?
RQ5.-	What role do immigration and labour mobility play in filling skill gaps during the transition?
RQ6.-	How should just-transition policies be designed to prevent green and digital discontent in territories that depend on fossil fuels or have low levels of digitalisation?
RQ7.-	What knowledge gaps persist regarding the measurement and forecasting of JCD and the effectiveness of the cited policies?

Source: own.

The result, after applying the appropriate filters in the interaction process between the AI and the researchers, was a total of 142 papers connected with the seven research questions as shown in Table 3.

Additionally, Figures 2 and 3 summarize some basic statistics of the selected papers. Figure 2 presents the distribution of citations by research question, and Figure 3 presents the temporal distribution of the papers classified by research questions. All references are incorporated in the final section of this document.

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Table 3. Summary of the papers selected related with each Research Questions (RQ) (Table 2) after applying *PALET*

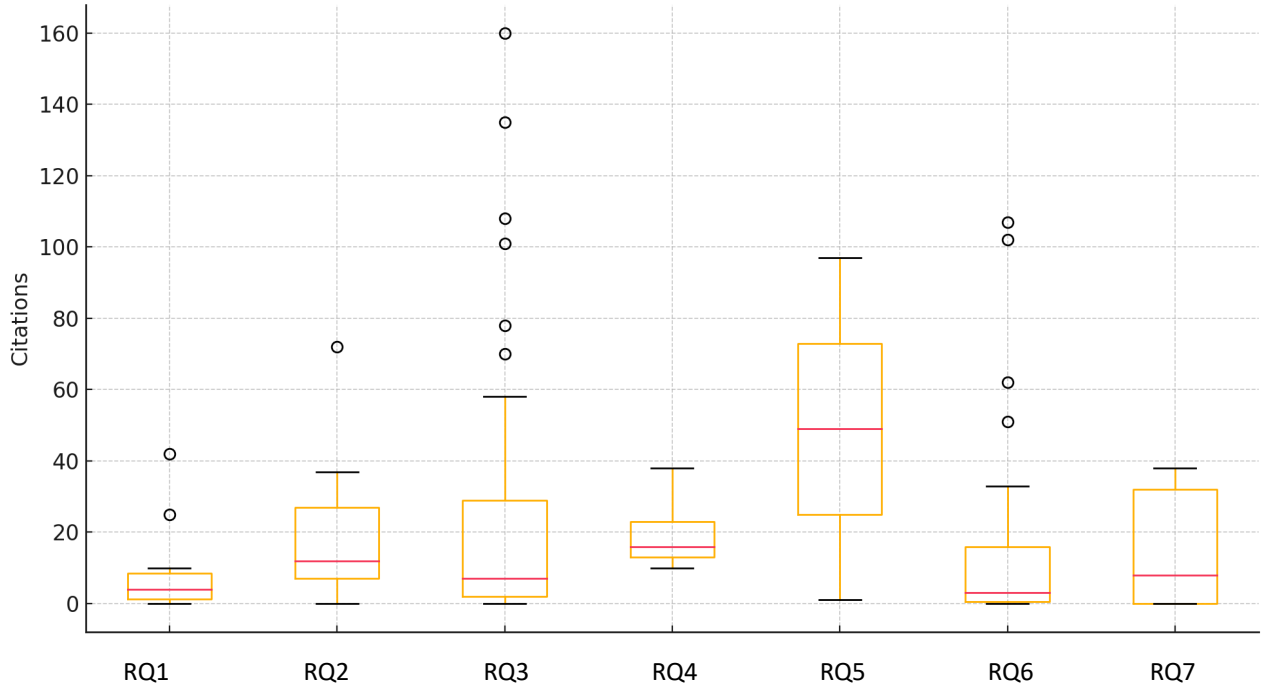
	Research Questions (RQ)
RQ1.-	Bohnenberger (2022a), Bohnenberger (2022b), Carrera et al. (2021), Doran et al. (2017), Dzemydaite (2021), Frankowski et al. (2023), Furceri et al. (2022), Galgóczi and Pochet (2023), Jones and Munday (2020), Mach et al. (2023), Markowska et al. (2016), Méda and Benegiamo (2023), Murphy et al. (2019), Orsatti and Dinale (2024), Pollin (2023), Señoret et al. (2022), Tolosa et al. (2017) and Winchester et al. (2025).
RQ2.-	Barzotto et al. (2020), Benegiamo et al. (2023), Dziembaa and Talar (2021), Guarascio et al. (2025), Kleibrink et al. (2015), Lepore and Spigarelli (2020), Pinzaru et al. (2022), Shevtsova et al. (2020), Spandagos et al. (2023), Stryabkova et al. (2021), Talavera (2025), Wang et al. (2022) and Wigger (2023).
RQ3.-	Abad-Segura et al. (2024), Agnello et al. (2016), Albanese et al. (2023), Ali et al. (2023), Bailey et al. (2018), Barzotto et al. (2019), D.-Bell (2017), Benner et al. (2024), Biagi et al. (2021), Bonanno (2019), Butkus et al. (2019), Camagni et al. (2020), Capello and Caragliu (2016), Capello and Dellisanti (2024), Castillo-Díaz et al. (2024), Chapman and Meliciani (2018), Coaquira et al. (2022), Cörvers and Mayhew (2021), Cousins (2021), Crowley (2017), Cruz and Rossi-Hansberg (2024), Cutrini and Mendez (2023), Dev (2024), Di et al. (2022), Diebolt and Hippe (2019), Ezcurra (2019), Faggian et al. (2024), Foray (2018a), Gavurova et al. (2017), Gergics (2023), Han et al. (2025), Hildreth and Bailey (2014), Hunady et al. (2017), Jedelhauser and Binder (2015), Kruse and Wedemeier (2022), Lago-Peñas et al. (2015), Li et al. (2022), Lourenco et al. (2025), McCann and Ortega-Argilés (2013), McCann and Ortega-Argilés (2014), Meili and Mayer (2024), Melnikova (2019), Melnikova (2022), Mogila et al. (2021), Mutra et al. (2023), Nurlanova et al. (2018), Peck et al. (2013), Pobedin (2024), Pycroft et al. (2016), Qureshi et al. (2025), Rodríguez-Pose and Bartalucci (2024), Savoia (2024), Solly (2016), Stawicki and Wojewódzka-Wiewiórska (2023), Sud, 2025, Velásquez et al. (2023), Ye et al. (2014), Yuan et al. (2024), Zemtsov et al. (2022), Zhu and Zhu (2023) and Zlati et al. (2024).
RQ4.-	Bartlett et al. (2019), Bei and Varc (2015), Nieth (2019) and Radtke and Ohlhorst (2021).
RQ5.-	Huang et al. (2023) and Lee and Rodríguez-Pose (2013).
RQ6.-	Abdul-Salam et al. (2022), Bastos, (2022), Bell and Katz-Rosene (2024), Boncheva (2022), Cappelli and Di (2025), Eadson and Van (2023), Foray (2018b), Fridman et al. (2023), Ftiti et al. (2025), Galanis et al. (2025), Girón and Ivanova (2023), Godin et al. (2022), Goods (2022), Gupta and Arts (2018), Halonen et al. (2022), Iacobucci and Ruggeri (2023), Jonek-Kowalska (2024), Karadag et al. (2025), Kozowska-Woszczycka et al. (2025), Kucharska (2023), Mandelli (2023), McCauley et al. (2023), Mc-Gowan and Geobey (2022), Measham et al. (2024), Monaco (2023), Moon et al. (2025), Percebois and Solier (2024), Popescu et al. (2022), Rachidi et al. (2021), Sarkki et al. (2022), Sefa-Nyarko et al. (2025), Slevin and Barry (2024), Snell (2018), Stilwell (2021), Sweeney (2017), Van et al. (2025), Winkler et al. (2023), Wong et al. (2022) and Zajdler (2023).
RQ7.-	Benner (2017), Gerlitz et al. (2020), Kruse and Wedemeier (2023), Lopes and Franco (2019) and Mazzola and Pellegrini (2021).

Source: own.

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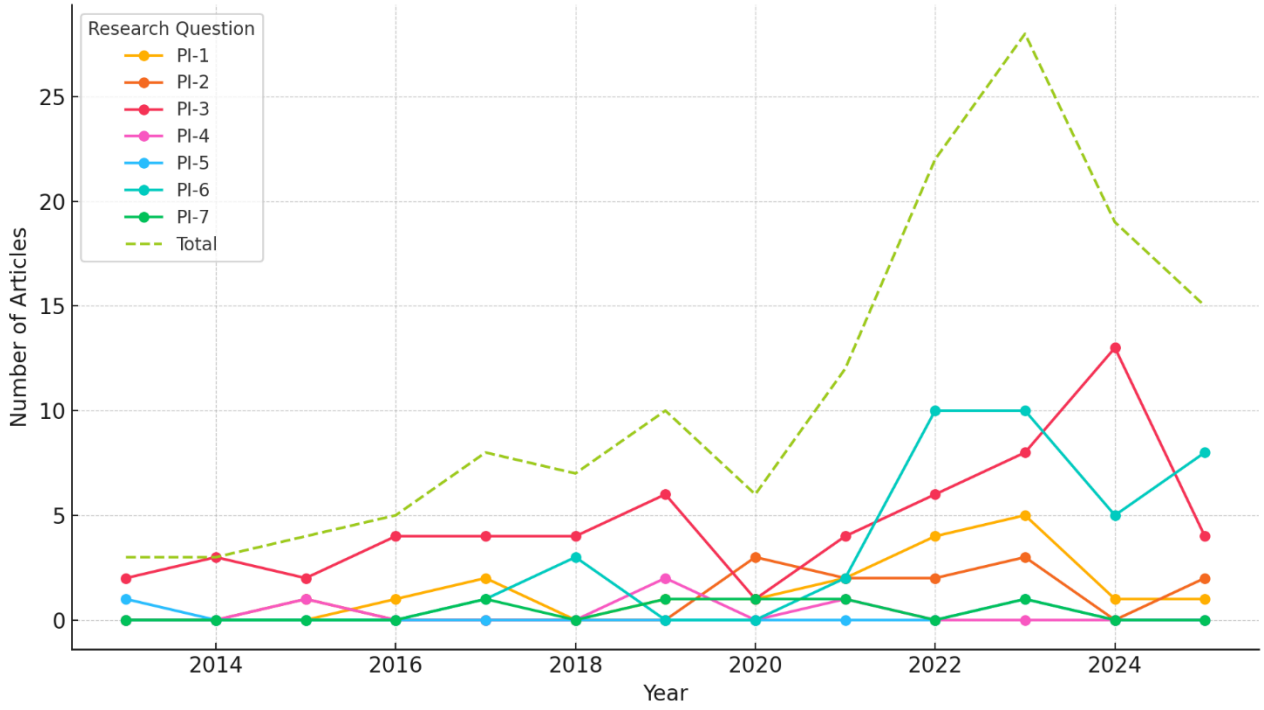
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Figure 2. Citation distribution by Research Question (RQ) (extracted from Table 2 and 3)



Source: own.

Figure 3. Annual publication by Research Question (RQ) (extracted from Table 2 and 3)



Source: own.

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4. Main policy recommendations derived from the literature review

By summarizing the main conclusions that we can draw from the various works identified and analysed, six main blocks of possible policies were identified, acknowledging the limitation of possibly overlooking some insights when summarising.

Fundamental relevance of education at all levels and continuous training

One of the key aspects is the importance of education and continuing training for citizens. Training that renews or adapts skills will fundamentally help workers prepare for changes that will become increasingly intense, unpredictable, and frequent.

First, multiple documents and papers (see papers selected in RQ1 and RQ2, Table 3, but in particular for this issue the papers selected for RQ3) emphasize the importance of having highly qualified workers to take full advantage of the potential of digitalization and the green transition in the coming decades. This implies promoting higher education related to clean energy generation, the implementation of new technologies, the design and use of AI algorithms, and other aspects related to both the energy and digital transition. This particularly affects STEM (Science, Technology, Engineering, and Mathematics) studies. But it is also essential to incorporate new knowledge related to green and digital challenges, especially those related to the professional revolution that AI will bring, into all studies so that the new professionals of the future are fully familiar with the use of digital technologies.

An example of how this cross-disciplinary training can be essential is found in the German Federal Government's strategy (Germany Federal Government, 2022), which emphasizes the importance of training healthcare personnel in the use of new digital and AI-related technologies to improve patient diagnosis and triage procedures. In particular, a notable increase in the need for intermediate healthcare personnel is identified, which will require both efforts in training these new personnel and efforts in seeking maximum efficiency in their work through new medical technologies.

However, beyond the importance of having highly qualified professionals trained in new technologies, the importance of training extends beyond university studies. It is essential to implement changes in the levels of vocational training, as well as in elementary education. Some documents even highlight the importance of focusing on these levels of training more than on higher education (Bartlett et al., 2019; Bei and Varc, 2015; Nieth, 2019 and Radtke and Ohlhorst, 2021). The priority in this context is the continuous modernization of training and advanced training regulations, especially with a view to including the skills required to manage the ecological and digital transformation.

Finally, many papers remark the importance of strengthening continuing training. Most workers who will face the major transformations derived from the green deal, digitalization, and AI in the 2030s and 40s are already working today. Any reinforcement of university, vocational, or basic training would only affect a small portion of the workforce. Only a reinforcement of continuing training can prepare most employees for the new skills and capabilities that will be needed. To implement continuing employee training, it is important to identify their real skills. That is, understanding what each employee knows how to do and, from that starting point, promoting continuing training processes that adapt these current

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specific skills to the renovated skills that may emerge within the framework of the development of green or digital transformation challenges. Employees would not be grouped by type of contract or organizational position but rather by their specific functional skills. Companies must design continuing training programs that allow them to adapt their employees' skills by training qualified employees in specific and multifaceted skills, which will provide both these employees and their companies with greater resilience.

Transforming the workplace and the spatial relationships

In response to changes in the working world and the preferences of employees and companies, it is necessary to develop legislative improvements to facilitate flexible working models available (see Lepore and Spigarelli, 2020; Li et al., 2022 or Kleibrink et al., 2015). The push for remote work may end up completely changing the way workers' organizations operate, so it is important to anticipate the legal and social challenges that these transformations may entail. Several documents propose shifting the responsibility for anticipating new labor complexity by placing greater emphasis on collective agreements to allow employees greater flexibility in the organization of their working hours, subject to certain conditions and strictly for a fixed period (German Federal Government, 2022).

The digital transformation of the working world is a huge opportunity to establish a better and more comprehensive framework to promote good, healthy working conditions and in this way to help to secure the skilled labor pool. Adaptive assistance systems and robots are today already taking on tasks which are physically demanding, hazardous to health and monotonous. Thanks to digital technology, flexibility on working time and location is beneficial for both employees and companies, and is possible on a larger scale than was long believed. This has been shown not least by the Covid-19 pandemic: working from home has since doubled and seems to be stabilizing at this high level (Kapitsinis, 2025). However, digital working options must be designed to be accessible, so that all employees can make use of them. The digital transformation is also increasing the proportion of activities requiring information skills and social skills in almost all occupations. A shift is taking place from previously physical to primarily cognitive requirements, and this is changing the demands on workers. Finally, the platform economy offers low-threshold access to employment in many cases. Appropriate working and operating conditions remain a vital element in securing employability and thus the supply of skilled labor, even in these new, data-based business models and forms of activity. Modern regulations protecting workers in flexible remote work environments from precarization are crucial.

All of these transformations have consequences for urban mobility and the shape of our cities. These consequences can be considered side effects from a digital perspective, but they become central from an energy efficiency perspective. To the extent that urban mobility can be significantly reduced in new work models with greater remote-work, significant improvements can be achieved in the environmental quality of cities and their environmental impact. However, the possibility of working more from home and traveling less to the workplace can affect urban form by developing more dispersed city models, as families face greater pressure to have larger homes and less pressure to live close to the center of their metropolitan area, where they will need to travel less (Lasarte et al., 2028; Rubiera and Garrido, 2020 and Koprowska et al., 2020). It is very important that local governments take

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into account this important transformation in urban mobility and residential preferences so that the environmental benefits of digitalization through the reduction of mobility and associated pollution are not offset by extensive land use and greater urban dispersion with its relevant environmental consequences (Rubiera and Garrido, 2020 and Koprowska et al., 2020).

Modern immigration policies: making the immigrants allies of transformations

The twin challenge of decarbonization and digitalization is accompanied by many other challenges that the EU must face. One of these is the challenge of immigration. In general, the EU still needs to improve its immigration and immigrant integration policy (Lee and Rodríguez-Pose, 2013). In this regard, the EU is not promoting selective immigration models that favour immigrants with specific skills or training suited to adapting to the changes and challenges associated with the 'green deal' and the use of digital technologies (Huang et al., 2023). Within the framework of practical immigration policies, it is possible to develop training courses for immigrants as a preliminary step to granting residence permits that help align their work capabilities with the needs generated by the challenges.

The Germany Federal Government (2022) proposed to ensure that people with a right of residence or the prospect of a right of residence are even better equipped for the EU labor market. For example, all adults coming to the EU are to be offered tailored integration courses from the outset; the conditions for course providers, teachers and participants are to be enhanced; and greater support is to be provided for job-related language courses, and their funding is to be made permanent. This will also usher in a significant expansion in access to language courses. A wide range of integration and job-related language courses are already available, tailored to different needs. For example, specific job-related language courses prepare people for language tests in the context of the recognition of foreign professional qualifications or help apprentices to complete their program successfully. Childcare provision during integration courses enables migrant parents to attend an integration course even if they do not yet have a childcare place at a regular childcare centre. While, in principle, flexible course formats (e.g. virtual, in the workplace, part-time) already allow people to work or engage in skills development while taking part in courses, uptake of these formats remains low to date.

'Green discontent': the importance of supporting those territories that 'left behind' in the green and digital transition

The phenomenon of discontent associated with the dual green and digital transition is not a consequence on the labor market, which was our focus when linking this review to the JCD processes. However, we include it in this review given that the presence of a high level of discontent can lead to populist reactions that end up dramatically affecting both environmental sustainability policies and the very approach to International Competitive Economy on which the need to drive the digital revolution is based.

One common thread across most of the work analysing the special dimension of the JCD associated with the green transition, digital push, or AI is that it suggests that strong spatial inequalities will arise in the positive or negative impacts on the labor market (Walker, 2011; Eriksson and Hane-Weijman, 2017; Balsmeier and Woerter, 2019; Santos et al., 2023). This

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may reinforce existing gaps between territories and fuel discontent across Europe. Throughout the last decade, we have witnessed a general feeling of disaffection with the system and institutions, a climate of political discontent. This idea of discontent expresses different types of reactions that can be grouped into categories such as: (i) the rise of populist parties and movements with an anti-European stance in many EU countries (Algan et al., 2017; Vasilopoulou, 2018); (ii) reduced trust in the EU and national institutions, which has been referred to as a trust crisis (European Commission, 2015); (iii) reduced support for the European project in general, as well as reduced levels of identification with the EU (Flesher, 2017); and (iv) a reduction in social engagement and participation among the citizens of EU countries (Magni, 2017). Furthermore, as noted in the literature, these dimensions are localized in the sense that they are more prevalent in some places than in others. More boldly speaking, there is a *geography of discontent* (McCann, 2016; Los et al., 2017) such that the rise of populist movements, Euroscepticism, the loss of trust in the EU and national institutions and the reduction of social engagement exhibit spatial patterns (Georgiadou et al., 2018; Oesch, 2008).

Rodríguez-Pose (2018) summarizes this literature on the *geography of discontent* in the following way. EU policies produce results in prosperous places. Many spaces are 'left behind' and do not benefit, or their inhabitants feel they do not benefit, from the development strategies of governments and institutions. Thus, the concept of 'left behind places' was born, which basically draws attention to the existence of places that cannot take advantage of the general dynamics of growth and development (MacKinnon et al. 2022). In these places, a strong resentment against the economic and political system is generated, which ends up translating into anti-system voting, studied in multiple works (see references quoted in Table 3 related with RQ6 and, in addition, Gutiérrez-Posada et al., 2021; Díaz-Dapena et al., 2021; Houlden et al., 2022; or, among others, Fernandez et al., 2025).

Green transition policies are particularly sensitive to fuelling this sense of discontent in the 'left-behind' places. The places that will face the greatest costs from decarbonization are precisely those accumulating the most problems and generating the greatest discontent (Bolet et al., 2024). Multiple studies draw attention to the importance of carrying out a fair transition that compensates the territories that face the costs of decarbonization by promoting development policies in those areas (Mark et al., 2024; Pacca et al., 2021; or, among others, O'Sullivan et al., 2020). Again, Rodríguez-Pose and Bartalucci (2023) summarize this line of literature very well by speaking of 'green discontent'. Without policies to address this gap between territories, the EU's 'green deal' strategy is deeply compromised.

Although the digital transition does not produce the same level of rejection, it also presents significant spatial inequalities (Evangelista et al., 2014). Several authors highlight that, despite the significant development of digital infrastructure in Europe, the significant gaps between regions in the use of digital resources remain or are even increasing. Several recent works, such as Crespo and Uljas (2021), Apostol and Hernández (2024), or Hernández de Rojas et al. (2024), have begun to use these data for spatial studies of digital development in Europe. Most studies find that, although there is a convergence in the development of digital infrastructure, differences in the intensity of use and in the development of a digital culture in society remain. For example, Crespo and Uljas (2021) econometrically model the digital development trends of 99 European NUTS-2 regions, finding that gaps in infrastructure

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development will narrow, but gaps in the assimilation and exploitation of digital potential will widen. Digital development must also address these gaps and prevent them from acting against the long-term strategy in the form of discontent with EU policies and institutions.

More research: what we know and what we need to understand better

The EU's research and development efforts are remarkable (European Commission, 2020). However, there are still significant spatial inequalities in the advancement of investment in science and innovation in Europe (Rubiera and Fernández, 2023). The development of new technologies linked to the climate challenge, and even more so to the challenges of digitalization and AI, requires strong efforts in research, development, and innovation (RDI). It is also important that these efforts are spread across space so that the potential associated with these challenges can be harnessed in all regions (Crescenzi, 2005; Rodríguez-Pose and Crescenzi, R. (2008). In general, the literature highlights the degree of precise ignorance of the spatial dimension, potential inequalities, and adjustments that the dual challenge of decarbonization and digitalization will generate (Benner, 2017 and Gerlitz et al., 2020). The implementation of specific policies requires a better understanding of these aspects, which underscores the need to promote both global and local studies (Kruse and Wedemeier, 2023 and Mazzola and Pellegrini, 2021). Some works (see references related with RQ7) highlight the need to better coordinate European policies so that the objectives of each of them are more integrated, which also requires greater knowledge of the interrelationships between sectors and activities. In short, there is a general recommendation to increase knowledge regarding the effects that the climate and digital challenges may have in Europe.

Territorial heterogeneity in Europe: the necessary smart specialization strategy

Finally, a key issue is understanding the heterogeneity that exists across Europe. This strong heterogeneity has driven the idea of implementing a regional policy based on smart specialization (Ramajo et al., 2008). The smart specialization strategy (S3) consists of identifying the specific reality of each territory, thoroughly understanding sectoral interrelationships and differential aspects, and designing actions and policies that build on this diversity and leverage these specificities to their advantage (Foray, 2016). This general principle is even more important in the field of digitalization and decarbonization. The potential of each location, the pace at which policies should be implemented, the aspects that should be enhanced and those that should be minimized, and so on depend drastically on the diverse reality of each territory (see papers quoted in Table 3 related with RQ3). Therefore, it is important to complement this general reflection with local analyses where the general ideas and recommendations emanating from the international literature are translated into concrete actions intelligently adapted to the specialization and specificity of each location (see references of Table 3, RQ3).

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5. A detailed literature review on active labor market policies against 'twin transition' labour consequences

Both digital transformation and green transition represent fundamental structural shifts that profoundly reshape labor markets, creating numerous policy challenges despite their distinct technological and sectoral characteristics. While digital transformation primarily drives automation-induced displacement and skills obsolescence across routine-intensive occupations, and green transition involves the phase-out of carbon-intensive industries alongside the emergence of sustainable sectors, both transitions generate labor market disruptions: job displacement, skills mismatches, and the need for workforce reallocation. The policy instruments developed to address these challenges—particularly active labor market policies (ALMPs)—demonstrate to certain extent transferability across both contexts, as they target the fundamental mechanisms of labor market adjustment.

ALMPs against digital transition effects on employment

Digital transformation necessitates a comprehensive and coordinated labour market policy response to address automation's substantial impact on the workforce across multiple economic sectors. On one side, automation leads to loss of jobs for a certain number of workers, while on the other side, even when workers stay in the same job/occupation, the nature of work (i.e. the way the job is done) is changed with introduction of the new technologies, which also calls for adoption of new skills. In the context of digital transition, a possible skills mismatch is an important issue for policymakers, having in mind that potential skill gaps could hamper economic growth and competitiveness (Favero, 2022). Labour market policies and institutions are regarded as crucial in this process, as they provide both income support in case of dismissal (through the unemployment benefit system, i.e. passive labour market policies) and different forms of help through ALMPs.

Bürgisser (2023) summarises three types of policy responses to technological change, as shown in Table 4.

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Table 4. Policy responses to technological change – place of active and passive labour market policies

	Investment Policies	**Steering Policies**	**Compensation Policies**
Goal	Prepare and upskill workers ex-ante to cope with structural changes at the workplace and to match the demands of new technologies	Steer the pace and direction of technological change by shaping firms' employment, investment, and innovation decisions	Buffer the negative effects of technological change ex-post to cope with frictional unemployment
Idea	Social investment and predistribution	Economic interventionism	Social insurance and redistribution
Target	Individuals	Firms	Individuals
Policies	• Education • Training • Active labour market policy • Early childhood education and care	• Capital tax deductions • Robot and digital tax • Research & development • Employment protection • Work time (reduction) • Minimum wage • Collective bargaining • Work councils	• Passive labour market policy • Early retirement • Wage insurance • Job guarantee • Negative income tax • Universal basic income

Source: Bürgisser (2023), p. 4.

Although passive labour market policy has positive sides, such as providing income security and possibly providing an individual with more time to adapt, invest in human capital and find a better matching job, it is generally recommended that it should be accompanied by some active labour market measures. In the context of digital transition, Bessen et al. (2025) analyse the impact of automation on individual workers in the Netherlands and find that wage income losses are only partially offset by various benefits systems, while older workers are generally more likely to enter early retirement. The results of this study also show that income losses are larger for older workers, workers with medium levels of education, and workers employed at smaller firms. Even in this case, where workers generally had good access to benefits and the social protection system, workers displaced by automation still shouldered most of the financial burden themselves.

Concerning the group of "investment policies", ALMPs can have an important role in addressing the problem of skills mismatch. However, some empirical findings show that workers in jobs vulnerable to automation invest relatively little in training – Koster and Brunori (2021) find that throughout the 23 European countries covered in the study, workers in jobs that have a relatively high probability of being affected by automation receive less training than those in low-risk jobs (after correcting for composition effects including age, educational level and sector). Ehlert (2020) also states that workers engaged in performing routine tasks are more likely both to be replaced and to receive less training. Some of the possible explanations may be connected to the possibility that companies do not have

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incentives to invest in workers that may soon become obsolete, while routine workers might also not be fully aware of the impact of automation on their jobs and therefore underinvest in training (Bürgisser, 2023).

To tackle this issue, alongside with specific labour market policies, a broader set of educational and labour market institutions seem to be important – according to Ehlert (2020): "inclusiveness of lifelong learning is already influenced by the initial educational system, while strong unions and dynamic labour markets further enhance access to further training among vulnerable workers" (p. 1). Koster and Brunori (2021) emphasise the role of a proactive government approach and the importance of labour market policies in this regard, as they are seen as a boosting instrument for a life-long learning culture, in comparison to the approach where training is left more to the market. Other authors, such as Ioannidou & Parma (2021), also emphasise the need for strategic implementation of education and social policy tools — including upskilling and reskilling focused ALMPs, open and flexible education and training systems, skills recognition programs, and targeted support for vulnerable groups in order to significantly enhance training opportunities for workers facing automation risks.

Van Doorn & Van Vliet (2024) provide evidence that training and job creation schemes may mitigate the negative impact of automation of routine-intensive labour on employment possibilities in this segment of the labour market, with the restriction that possible complementarities between different ALMPs and benefit conditions and eligibility rules were not taken into account in the analysis. Schmidpeter and Winter-Ebner (2021) present similar results – they analyse an active labour market policy program that provides extensive training to unemployed workers in Austria, and show that provided training counteracts the negative impact of automation on the job finding probability, while younger workers and those with higher levels of education profit most from these measures. Their results also show that programs are more effective in bringing workers faster back to work than improving job quality.

The literature provides some specific recommendations for ALMPs in the context of the digital transition. According to OECD (2019), training provision requires lifelong accessibility with targeted incentives for vulnerable populations, particularly low-skilled workers. In order to address barriers to adult learning, different policies are suggested: innovative pedagogical approaches such as remote learning platforms, strengthened lifelong learning financing mechanisms, and formalised skills validation frameworks. Ribiero et al. (2025) also emphasise that solutions such as hybrid learning models, mobile training units, and regionally adapted curricula may be helpful in improving accessibility and inclusivity. One of their recommendations also points out that the "career coaching, job placement services, and employer-matching platforms should be systematically integrated into training initiatives to support participants in securing sustainable employment" (p. 15), while it is essential to adapt training formats in order to remove mobility, scheduling, infrastructure and economic constraints in order to include rural and NEET populations. The OECD (2025) report emphasises that, especially in the context of digital transition, integration of ALMPs with broader policy objectives can amplify their impact. The example of ICT training programmes in Greece is cited as an illustration of how training programmes can not only enable "younger workers to access higher-paying jobs in emerging sectors which supported individual career advancement, but also contributed to the country's digital transition through investment in

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ICT skills" (p. 15). On the other hand, it is crucial to align ALMPs to national and labour market needs, through linking training to skills anticipation systems, particularly within an environment where some sectors may be undergoing swift changes driven by digital transformation or green transition (OECD, 2025).

Digital transition and innovations in this domain also have a strong influence on PES and the way they deliver their services. For example, by automating some routine tasks through digital tools, coaches can invest greater time and attention in cultivating meaningful connections with both job seekers and employers (Ingold, 2025). According to the European Commission (2019), there are large disparities between the PES across the EU – with some leveraging on advanced analytics, whereas others are still in the process of building basic unified IT systems. As Scarano & Colfer (2022) state, digitalisation has significantly transformed PES operations and ALMPs delivery through two main technological domains: "remotisation" and "automatisation." Among different ALMP types, employment assistance emerges as the most sensitive to digitalisation, having in mind its main forms of interventions: career guidance, profiling and job-matching tools. While career guidance aligns more closely with remotisation technologies that enable remote service delivery, profiling and matching tools are better suited to automatisation processes. Big-data analysis and inference techniques enable the creation of detailed user profiles that facilitate highly tailored and personalised service delivery, though these capabilities simultaneously present significant challenges regarding privacy protection and individual autonomy.

The inclusion of digital technologies and digital transformation in national employment policies varies across countries. Chacaltana et al. (2024) analyse 75 national employment policies available in the ILO Employment Policy Gateway and find that 62 reference digital strategies in specific policy areas, while the most frequent were digital employment services and digital skills development and training. Regarding digital skills and training, it mostly included "training programmes on digital literacy for ICT-enabled jobs, revising curricula with a digital perspective, integrating digital literacy within formal and informal systems or developing high-value digital skills to prepare graduates for innovative areas, such as AI and data science" (p. 22). In most cases, these measures were targeted to specific groups. However, the focus on the supply side without parallel efforts to boost job creation may not lead to an optimal solution, as it might lead to a scenario with insufficient labour demand (Chacaltana et al, 2024; Favero, 2022).

ALMPs against green transition impacts on work

The next section provides a comprehensive policy analysis and recommendations encompassing both passive labour market policies (such as unemployment benefits and various forms of income support and compensation) and active labour market policies. While the analysis demonstrates a particular emphasis on green transition contexts—reflecting the geographically concentrated nature of sectoral decline and the consequent need for place-based policies that extend beyond labour market interventions to include broader regional development strategies—the fundamental principles and mechanisms underlying ALMP design and implementation exhibit considerable transferability across both digital and green transitions. With this regard, at the end of this section we provide an overview of general

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evaluations of different ALMPs, which may offer important insights for policymakers, not only in general, but also in the context of the twin transition.

Specific emphasis is given to active labor market policies (ALMPs) for several reasons. Unlike passive policies, such as unemployment benefits and unemployment assistance, (and in some frameworks severance payments and early retirement schemes), which primarily provide temporary income support without addressing underlying structural challenges, ALMPs, through various types of measures (including training, job creation subsidies, entrepreneurship grants for self-employment, etc.), can actively facilitate the reallocation of human capital from declining, carbon-intensive industries to emerging green sectors. While passive labour market policies are socially important for maintaining living standards and preventing a demand shock, ALMPs can have a transformational impact. For instance, they can directly address the skills mismatch that occurs during green transitions through various measures such as training programmes for upskilling and reskilling. ALMPs can generally increase workers' productivity and employability and positively affect the reallocation process and job search efficiency. Consequently, they serve as essential catalysts for the fundamental economic and social transformation required during the shift to sustainable economies. ALMPs can also take a preventive approach by preparing workers before job displacement occurs. This proactive approach is particularly important during green transitions because the pace of technological and sectoral change often outpaces workers' ability to adapt independently, creating skills mismatches that can only be resolved through deliberate intervention.

Before providing an overview of evaluations of specific ALMPs, we first provide a broader policy view perspective in the context of the green transition, given its potential profound regional impact. Historically, according to Diluiso (2021)[7], concerning interventions aimed at socioeconomic policies, investment strategies played an important role, encompassing infrastructure, education technology, R&D, regeneration activities, and even nuclear programs (Greenpeace, 2016; Sheldon et al., 2018; Turnheim & Geels, 2012). Policies aimed at economic diversification are also emphasised as important. Other documented policies included financial support directed at affected regions (e.g., business support), workers (e.g., retirement incentives, lump sum financial aid), or directly to the coal industry (e.g., grants, subsidies). Authors find that “financial compensations to workers are among the most reported policies” (p. 24), among other measures that provide new employment opportunities and training programs.

Although ALMPs in the context of the green transition have been implemented in many countries, rigorous evaluations of their effectiveness in this particular context remain relatively limited. Frequently, the implemented measures are not dedicated specifically to green transition, as noted in a recent study by Lauringson et al. (2025): during 2023-2024, half of the OECD member states (19 countries) provided ALMPs aimed at facilitating the transition to greener jobs. However, around 40% of these ALMPs were specifically dedicated to

[7] The paper by Diluiso et al. (2021) presents a systematic review of previous studies dedicated to the coal transition, based on 278 case studies from 44 countries. It examines transition events primarily from the late 19th century to 2021, documenting a wide range of policies and measures implemented during this period.

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supporting the green transition, while the remainder pursued multiple objectives simultaneously, most commonly those associated with the digital transition.

The same study reveals that the design of these ALMP programmes, aimed at facilitating a smoother labour market green transition, typically involves integrated packages of support that combine several complementary interventions. Training, job search counselling and brokerage services, and employment incentives, such as recruitment subsidies and wage support, are among the most frequently deployed measures. Given the specific skill requirements associated with green jobs, training emerges as the most prevalent intervention within green transition-focused ALMP packages. Empirical evidence also supports the importance of adequate human capital adjustment. Results from the study by Bluedorn et al. (2022), which examines how the green transition and environmental policies affect employment and labour markets, show that workers previously employed in pollution-intensive or neutral occupations face greater difficulty transitioning to green-intensive employment. However, higher skill levels facilitate movement into green-intensive roles, underscoring the critical role of human capital in enabling successful labour market transitions. Strategic training initiatives designed to enhance the human capital of lower-skilled workers currently in pollution-intensive or neutral occupations could facilitate their reallocation to green-intensive occupations.

Lauringson et al. (2025) also emphasise that targeting is a central feature of these ALMPs. Commonly targeted groups include individuals with low or obsolete skills, job seekers with limited or outdated work experience, and displaced workers from specific sectors or regions. Strategies for targeted support to displaced workers are also present in non-OECD countries. Some population groups, such as low-skilled youth and women, may face increased barriers to labour market integration due to the skill-intensive nature of green jobs.

Beyond individual ALMPs, the study emphasises that the effective response to green transition challenges requires coherent cross-policy strategies, as already stated in ILO Guidelines for a just transition towards environmentally sustainable economies and for all (ILO, 2015), and other studies, such as Keese & Marcolin (2023), Chmiel et al. (2023), Cirillo et al. (2024), Broughton & Wehnert (2020). ALMPs explicitly focused on the green economy should be complemented by other services, benefits, and measures to ensure a holistic and coordinated policy approach. Subnational governments and other relevant stakeholders should be actively engaged in both the design and implementation of measures.

Finally, well-developed labour market information systems are needed for monitoring changes and improving forecasting capacity, as well as evidence-based planning. Such systems are vital not only for long-term planning but also for the timely implementation of ALMPs. In the context of rapid transitions—such as mass layoffs—public employment services (PES) must be equipped to respond proactively and intervene before unemployment materialises. Additionally, an enhanced institutional capacity of PES may be needed to respond adequately to all labour market challenges related to the green transition.

Similar conclusions are found in other studies. A key insight from OECD research on labour market responses to the green transition, authored by Keese and Marcolin (2023), is that policy support for workers affected by structural economic changes must be implemented promptly, as delays increase the economic and social costs borne by displaced individuals.

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Moreover, these interventions must adopt a whole-of-government approach, encompassing not only direct employment and training measures but also local economic development and mobility-enhancing policies.

Some studies point to the importance of labour mobility: the research note from Mandala (2023) analyses different scenarios of a coal mine in New England, New South Wales, and tests employment outcomes with varying geographic mobility (local, state-wide, national). The results of this study indicate that geographic mobility is crucial, as willingness to relocate dramatically increases job placement rates, with nationwide mobility offering the best outcomes. However, one should be cautious when implementing policies aimed at improving geographical mobility, as the loss of human capital can further hinder the economic development of the affected region.

Keese and Marcolin (2023) also note that the transition to a green economy requires robust and agile public employment services (PES) and well-designed ALMPs. Key functions of PES in this context include skills profiling, guidance provision, and identifying transferable competencies. Advanced profiling tools should be deployed as early as possible in the unemployment spell, if feasible, even during the notice period, to enable timely and tailored support. The digitalisation of PES functions is also critical, as it enhances service delivery efficiency and enables resources to be reallocated to clients in greater need (OECD, 2022).

In parallel, ALMPs must be evidence-based and regionally responsive, which calls for robust evaluation mechanisms. In this regard, the recruitment of PES staff who can acquire strong local labour market expertise is vital for effective placement strategies.

Training programmes, with upskilling and reskilling initiatives, are seen as one of the crucial components in supporting the transition of workers from declining to expanding sectors as the economy becomes greener. While targeted training programs have proven more effective than the generic ones, the authors state that explicit strategies focused on green skills and employment still remain rare.

Concerning other ALMPs, authors state that hiring subsidies directed at employers have demonstrated relatively strong positive effects on participants' long-term employment outcomes, particularly when they are well-targeted. One should keep in mind that there are some caveats to this positive impact, such as the possible deadweight, substitution, and displacement effects. Direct job creation and public works with ecological objectives programmes can be used to support the labour market integration of disadvantaged groups. However, evaluations show that public sector employment programs often yield negligible or even adverse outcomes, underlining the importance of context-specific design and rigorous assessment (Card, Kluve, & Weber, 2017).

It is also stated that the current portfolio of ALMPs often lacks a green orientation. Defining green and greening occupations is thus critical for job matching, guidance, and career services, along with targeting and planning training and retraining programmes. Across multiple EU Member States, PES have been active in identifying green and greening occupations and developing corresponding occupational profiles. Such improvements require collaboration with social partners and other stakeholders to identify portable skills and emerging job opportunities.

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Finally, high-quality labour market information systems are also seen as essential for monitoring evolving skill demands. . These systems underpin effective planning and implementation of training and employment strategies that align with green transition objectives.

These broader messages are largely supported in analyses of different case studies and measures implemented aiming at the labour market green transition. For instance, the paper authored by Cirillo et al. (2024) examines JTF-supported upskilling and reskilling policies in Germany, Italy and Spain in territories transitioning from coal-dependent industries.. The authors state that inadequate identification of skill needs at the local level seems to be the primary constraint in designing effective ALMPs. Qualitative evidence suggests that comprehensive strategic planning is essential to assess labour demand across skill levels better. Beyond active labour market interventions, incorporating social protection mechanisms into the JTF framework is considered crucial, with the establishment of EU-wide minimum standards. Such comprehensive safety nets could be vital for workers who are unable to adapt to transition-related economic disruptions. The analysis also reveals that effective policy implementation requires integrating ALMPs with broader development strategies, including industrial policy, sectoral diversification, investment attraction, education, and R&D initiatives. This integrated approach must account for local/regional specifics. Authors also argue that the quality of employment in the newly created (green) jobs should be monitored, as there may be a danger that workers affected by the green transition could get new low-quality jobs, despite the presumption that jobs in new industries will be of high quality. Additionally, a just transition should address cultural and social factors, particularly workers' identification with traditional industries that have provided intergenerational employment. This calls for EU-level regional and local rebranding policies to support the transition processes.

According to the Chmiel et al. (2023) study, which analyses experiences of three lignite regions, Wielkopolska in Poland, Lusatia in Germany, and Upper Nitra in Slovakia, "there is no one-size-fits-all recipe for a just transition that could benefit every region," (p. 84)[8] making comparative analysis essential for understanding practical approaches. Key recommendations are the following:

- Effective ALMPs in coal transition contexts require coordinated action across multiple dimensions. Policy alignment across governance levels is essential, ensuring local, regional, national, and EU strategies work coherently rather than in isolation.
- Long-term planning perspectives are essential, developing transition strategies for decades rather than years, with mechanisms that ensure continuity beyond electoral cycles. Coordination across regional boundaries is necessary, as coal regions often extend beyond administrative borders, necessitating inter-regional cooperation.
- Local institutional capacity must be strengthened to enable effective program delivery through enhanced regional administrative capabilities and partnerships.
- Adequate and stable funding mechanisms are critical, requiring the establishment of long-term financial frameworks.

[8] This is often stated in the literature, e.g. Mey et al. (2019), Chun (2024), ILO (2015).

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- Stakeholder involvement must be transparent and comprehensive, engaging trade unions, employers, government, and civil society in well-designed processes. Coordinated social dialogue is critical.
- Although dispersed ad-hoc interventions can be helpful in the absence of other actions (p. 88), they act more like an emergency, rather than a strategic response. For successful coping with the challenges of upskilling and reskilling workers, a comprehensive and coordinated policy approach should be implemented.
- Other policy instruments, besides labour market support measures (e.g. retraining, skills upgrading, skills transferability), include "social insurance programmes, temporary income support, unemployment support, community care programmes, environmental rehabilitation and repurposing strategies" (p. 88).
- Skills development, training and retraining form the foundation of successful transitions. These should be coupled with the creation of decent jobs offering competitive salaries.
- Miners' identity and cultural factors should also be addressed.
- Programme design should implement age-specific measures, providing flexible solutions such as early retirement and adjustment allowances for older workers. Generally, the demographic picture of the region should be taken into account when designing ALMPs.
- Regular evaluation combined with program flexibility enables responsive frameworks that adapt to changing transition dynamics rather than being constrained by rigid requirements.

Caldecott et al. (2017) focus on coal transitions in the Netherlands, United Kingdom, Poland, Czech Republic, Spain, and the United States, and provide some important lessons for managing this process. They identify key factors that make coal transitions particularly challenging: mining activities are geographically concentrated in dependent regions, strong cultural identity is tied to coal production, labour mobility is limited, and miners face skills shortages that restrict their competitiveness in alternative employment sectors[9].

The case studies reveal different outcomes and timelines, as they are in various phases and face different scales of challenges in terms of workforce and the share of economic activity affected. The most significant finding is that anticipation and proactive management are essential for achieving successful outcomes (see also Caldecott et al., 2017 on China's transition challenges). The Netherlands' Limburg region stands out as a primary success story, achieving consensus among workers, companies, and the government through the early acceptance of change and the provision of alternative employment for all workers who desired it. Collaborative approaches that systematically engage government, local community, trade unions, workers and employers in a structured transition process have generally achieved positive outcomes. At the same time, they have benefited from substantial stakeholder agreement regarding the necessity of closure from the outset.

Worker support programs showed mixed effectiveness; generous redundancy payments alone proved insufficient and sometimes counterproductive. Workers receiving lower payments, but better retraining and relocation support achieved superior long-term outcomes. Effective workforce management involves staged approaches, including natural turnover, early retirement, voluntary redundancy, and internal mobility within companies.

[9] Similar factors are also identified by Mey et al. (2019).

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However, such comprehensive workforce transitions require sufficient time and a manageable balance between workers and solutions. Relocation packages for miners and their families offer opportunities in areas with better employment prospects, although workers may face the dual loss of professional identity and social networks.

According to this study, among the analysed case studies, the Netherlands represents the most successful example, employing three key strategies that yielded positive results. The government invested in creating new alternative sources of economic demand for the region. while developing industrial clusters. Worker retraining focused on actual labour market needs through on-the-job learning rather than classroom training. Additionally, investing in the education of the next generation helped prevent intergenerational economic disadvantage among mining families by supporting the development of local educational institutions and improving access to higher education.

Some of the general recommendations from this study are the following:

- Future coal transitions should prioritise early stakeholder engagement and comprehensive planning over reactive crisis management.
- Implementing more incremental reductions in mining activity and employment facilitates better matching between the supply of displaced workers and available economic opportunities, while allowing workers to exit the workforce at appropriate retirement ages. Progressive declines also enable supporting industries to adjust and downsize with reduced disruption, providing regions with necessary time to cultivate alternative investment opportunities and economic activities.
- Local circumstances are critical factors that significantly influence transition outcomes. Key considerations include the geographic concentration of mining activities, the relative economic importance of mining and associated services, as well as proximity to regional economic centres. Effective restructuring requires comprehensive regional revitalisation encompassing transport infrastructure, environmental remediation, health services, and social protection systems. Optimal regional revitalisation operates as a community-driven process, guided by local stakeholders and leaders who possess a detailed understanding of regional specificities.
- Supporting vulnerable workers presents a fundamental challenge that requires targeted interventions. Assisting workers with health issues, advanced age, and limited educational backgrounds in securing employment is essential, as miners frequently face all three disadvantages simultaneously, thereby reducing their labour market competitiveness. The Limburg case provides an instructive example of a situation where the government essentially promised “no transition without new jobs for all workers that wanted them” (p. 10). At the same time, the company DCM committed to retraining and retaining a substantial portion (approximately one-third of the workforce) in new positions within the company. It limited separations from the workforce, as well as the risk of long-term unemployment.
- The analysed case studies reveal significant challenges with retraining programs due to skills-employment possibilities mismatches, while poorly managed transitions often force workers into early retirement, increasing social security costs. However, evidence demonstrates that failing to support transitions proves far more expensive than investing in proper transition management.

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- Regional economic regeneration strategies showed limited success across most case studies. The Dutch approach demonstrated effectiveness through government investment in providing new alternative sources of economic demand for the region, developing industrial clusters, supporting on-the-job training over classroom-based retraining, and prioritising next-generation education to prevent intergenerational economic disadvantage in former mining communities.

Wong, Röser, and Maxwell (2022) synthesise several case studies of countries and regions that underwent coal phase-out processes, examining the Ruhr area and Lusatia in Germany, the United Kingdom's coalfields, and Spain's coal mining regions. Their findings on the effectiveness of different transition measures are summarised below:

- Transfer to open mines: Success factors included closures were phased gradually, nearby mines were available for transfer, good transport infrastructure eased workers' commutes to their new locations.
- Wage subsidies: Succeeded in limiting the rate of unemployment increase.
- Compensation programmes: These measures supported recently unemployed miners and their families by limiting increases in poverty levels. However, they can contribute to a culture of joblessness that could lead to long-term regional deprivation and reduced workers' incentives to re-enter the labour market. Since workers require reskilling and reorientation to new industries, narrow compensation policies like severance pay and unemployment benefits alone are insufficient for addressing workforce transition needs.

Regarding unemployment benefits, Bischler et al. (2024) argue that in some cases, it may be necessary to adjust the eligibility conditions of the unemployment benefit system to encompass all affected workers who need temporary income support. Hanson (2023) points out that a second pitfall of unemployment benefits can be inadequate benefit generosity. A sharp drop in income upon benefit exhaustion can impede investment in training, job search, or relocation, particularly in depressed local labour markets. A possible solution could be targeted income support and workforce services for workers facing a risk of poverty or adverse long-term unemployment consequences, as well as tuning unemployment insurance to local economic conditions (Hanson, 2023, p. 187).

- Early retirement: This was one of the primary measures, and it generally limited the increase in unemployment figures. It is most suitable for workers who are within 5-10 years from retirement age. According to Bischler et al. (2024), in recent years, there has been a tendency to reduce early retirement availability.
- Career services (including retraining, career advice, and job search assistance): In the Ruhr, Lusatia, and UK cases, they were unable to improve employment prospects. They may lead to a reorientation toward low-wage jobs that are vulnerable to automation. However, comprehensive programmes can be successful in reintegrating workers into the labour force. The success factors of the programme were: the provision of a comprehensive service, including apprenticeships, application support, and workshops; regular assessment of regional skills supply and demand; and longer-term support. Failure factors were typically connected with a poor alignment of skills development with labour demand and a short duration of services. It is also important that workers are immediately eligible for retraining. Additionally, courses in literacy and numeracy can be beneficial. A similar approach concerning basic skills is also emphasised in other studies: Cirillo et al. (2024) state that reinforcing “general and basic skills can provide a more solid foundation for the upskilling and

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reskilling initiatives" (p. 36). Other reports, such as the United Nations Framework Convention on Climate Change, support this. The UNFCCC (2016) also state that core skills prove more valuable for enhancing employability than highly specialised, occupation-specific skills. Fundamental abilities in literacy, numeracy, decision-making, teamwork, and communication serve as crucial building blocks that can enhance individual adaptability and enable career mobility.

From a broader perspective, several policies were highlighted as beneficial, including: investment in transport infrastructure, education and research institutions, good coordination of education and skills development policies aligned with regional development objectives, repurposing former coal mines and power plants which can create short-term temporary jobs suitable for ex-miners, creation of innovation centres, and investment in culture and heritage. The authors conclude that economic regeneration in former coal regions fundamentally depends on attracting new businesses while retaining young people and skilled workers, a challenge that becomes particularly acute in rural areas lacking adequate transportation and educational infrastructure. It is also emphasised that the coal transitions are highly dependent on local circumstances that significantly influence their outcomes. Therefore, the transferability of transition strategies requires thorough consideration of regional differences and similarities to ensure that lessons learned can be effectively adapted to new contexts.

According to Galgóczi (2019), who analyses case studies from Germany, Australia and Italy as illustrative examples of different coal transition approaches, policy design should adopt a forward-looking approach, incorporating pre-layoff planning and worker preparation strategies, with comprehensive stakeholder coordination through social dialogue and the involvement of multiple levels of government. For effective implementation of measures, well-funded transition agencies capable of multi-year management may prove useful, as demonstrated by successful cases in the Ruhr region and the Hazelwood plant closure. Also, labour market interventions should provide differentiated support, targeting specific worker demographics and vulnerable groups, while individualised ALMPs ensure effective employment transitions throughout the structural adjustment process.

The OECD (2025) policy brief draws some conclusions on various measures based on findings from two OECD policy questionnaires distributed at the end of 2023, which are summarised in Table 5.

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Table 5. Summary of OECD (2025) recommendations for policy measures against green transition implications for the labour market

Policy/Measure	Comment
Training	Workers in emission-intensive occupations participate in training programs less frequently compared to those in other occupations (p. 3); Eight of 26 OECD countries provide subsidies or tax deductions for employers offering green training to employees, while other countries offer financial incentives to workers (p. 3); Nineteen countries provide funding support for training providers to develop new programmes or apprenticeships, including curriculum updates to incorporate skills and competences for green jobs (p. 3). Training alone may be insufficient – additional targeted and timely interventions are required for workers facing redundancy risk or dismissal notices, alongside measures addressing collective layoffs (p. 4).
Job retention schemes	Risk of postponing necessary transition – these programmes must be linked to business activity reorientation and training for workers (p. 4).
German "transfer companies" (*Transfergesellschaften*)	Workers are temporarily (up to 12 months) transferred to an independent business unit, typically managed by an external specialist, through a tripartite contract between the former employer, the transfer company, and the employee (who terminates their existing employment status). During this time, workers receive a special short-time allowance funded by the PES and are engaged in various qualification and training measures designed to help them find new employment (e.g., professional training, career counselling, skills assessments, and job placement services tailored specifically to the green sectors) (p. 4).
Severance pay / Notice periods	Extended notice periods may prove more beneficial than increased severance payments (p. 4).
Early retirement schemes	They can be expensive and reduce motivation for early adaptation and occupational reorientation, which is particularly problematic with ageing population and a labour supply shortage. Usage should be restricted to workers close to retirement, while other re-employment options are available for other workers (p. 4).
Wage insurance schemes	They cover the differences between pre-displacement and re-employment wages. Implementation remains limited to a few countries. They can serve as an efficient support mechanism for displaced workers during the net-zero transition, although they raise concerns about equity (p. 5).
Job search assistance	Effective in increasing the re-employment probability; leads to more stable jobs in re-employment; often used to steer vulnerable job seekers towards green and in-demand jobs (p. 5). PES must be adequately staffed, with appropriately skilled personnel. (p. 5).

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Policy/Measure	Comment
Complementary geographical mobility policies	May be needed in regions where short-term provision of adequate quality employment opportunities remains constrained (p. 6).
Place-based policies (e.g. green subsidies; investments targeted at the most vulnerable areas)	Needed to foster regional economic development.
Other	Some countries implement employment incentives targeting green jobs. A clear definition of a "green job" and a better understanding of the sectors that are contracting or expanding would assist PES in refining their strategies (p. 6).

Source: OECD, 2025.

A tailored approach is recommended both when analysing local/regional context, as well as when considering the adequacy of specific measures for individual groups of workers. In this regard, the European Commission (2021) gives an overview of measures for a specific greening labour market context (Table 6).

Beyond the previously discussed policy recommendations regarding stakeholder engagement, comprehensive planning, PES capacity building, income support mechanisms, and targeted training for disadvantaged groups, including taking into account specifics of local/regional economic situation and prospects, the European Commission (2021) study contributes several additional specific insights:

- PES should prioritise improving job matching through technology and developing better skills taxonomies. At the European level, strengthening cooperation with ESCO is essential for enhancing knowledge sharing on green taxonomies and occupational classifications across member states.

  PES should implement preventive policies by supporting upskilling for green skills acquisition in the most impacted sector, particularly targeting low-to-medium skilled workers in precarious employment situations. Supporting skills development efforts, it is also important to further develop systems for validating prior learning, certifying competencies after upskilling, and establishing an overview of certificates related to the acquisition of green skills.

- For workers unable to undergo reskilling or upskilling, PES need to implement additional and complementary active labour market programs. These encompass job creation schemes and public works initiatives that serve dual social and environmental purposes, helping integrate disadvantaged groups while specifically addressing the needs of older workers who are overrepresented in carbon-intensive sectors.

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Table 6. Typology – Typologies of greening labour markets and policy implications for PES

Typology – Main Driver of Changes	Key Policy Implications (for PES in particular)
Technology-intensive greening labour markets	• Skills adaptation, upskilling; flexible training programmes for workers • Cross-sector and occupational mobility support; identification of transferable skills • Cooperation with companies to increase mobility and to identify new and transferable skills.
Labour-intensive greening labour markets	• Counselling for occupational and cross-sector mobility; identification of transferable skills; short training modules for occupations that require awareness raising; on-the-job training. • Other ALMPs, e.g., to support regional mobility, entrepreneurship development; • Cooperation with local stakeholders; • Adapt PES capacity (staff and funds); financial support for the unemployed.
Disruptive greening labour markets: shifting rapidly from polluting to green industries	• ALMP and social protection schemes for the unemployed; • Networking with training institutions to provide the necessary training programmes in due time; • Counselling to avoid long-term unemployment and to ease job/sector transitions; post-placement support; • Cooperation with other regional stakeholders on identifying potential sectors of growth, identifying and training the unemployed with upskilling and reskilling potentials for jobs in local demand; • ALMPs to support regional mobility; cooperation with local stakeholders to provide social infrastructure/accompanying measures (child-care, quality schools, housing, etc.).
The repair and preserve greening labour markets	• Upskilling; small upskilling modules for ecological awareness raising; • Job creation for absorbing the unemployed who don't have easily transferable skills; other ALMPs – e.g., entrepreneurship development; • Cooperation with local stakeholders; provision of other types of support for small/family businesses and retaining a skilled labour force in regions.
Evolutionary greening labour markets: hybridisation and deep transformation over time	• Adaptation of skills, reskilling, upskilling; • Intensive counselling, career guidance to support job/sector transitions; • Cooperation with companies to support internal transitions, including through training and retraining.

Source: Adapted from: European Commission (2021).

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A Toolkit developed by Broughton & Wehnert (2020) to assist practitioners in coal regions across Europe also gives important insights. General recommendations are largely in line with previous findings. First, a successful green transition requires policy coherence, integrating short-term worker support with longer-term economic development strategies. Effective transition strategies should prioritise early stakeholder involvement. This approach is supported in findings from a qualitative case studies, e.g. Vogl et al. (2019) analyse the intended shift from coal to hydrogen-based steelmaking in Sweden and reach conclusions which emphasize the critical importance of early stakeholder engagement throughout the transition process, proactive integration of social and political considerations into planning frameworks, as well as systematic recognition and mitigation of conflicting interests among different stakeholders to ensure a socially sustainable transformation. The process of comprehensive skills audits aimed at mapping current skills against future requirements should enable targeted support for workers to acquire missing competencies. Particular attention should be paid to the transferability of skills across sectors. Besides promoting economic diversification, regions should focus on linking labour supply and demand through three key strategies: 1) attracting investment from new green industries, 2) connecting local labour markets to broader regional opportunities, and 3) fostering local job creation through entrepreneurship support.

Additionally, the Toolkit provides specific recommendations, taking into account the fact that different demographic groups require tailored approaches. It is emphasised that older workers often need programmes focusing on income replacement and early retirement options, while younger workers could benefit more from measures like active engagement in seeking employment or travel cost support. Special attention must be given to particularly vulnerable populations:

- Long-term unemployed individuals generally require skills mapping, targeted training, and practical job search assistance;
- Young people may more often need internships, training and upskilling opportunities;
- Older workers would often benefit from training and upskilling support, help in health issues management, or advice on early retirement and bridging period options10.

[10] Also, workers with **different employment contracts** often need different approaches. As Christiaensen and Ferré (2020) emphasize for the case of Western Macedonia, salaried workers are expected to be less vulnerable due to severance and unemployment insurance coverage, in comparison with younger workers with term contracts who may require comprehensive support packages.

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Box 1. Gender aspect in green transition.

Due to the impact of coal transition on the whole value chain, women's employment vulnerability extends beyond direct mining operations. Female workers tend to exhibit a higher concentration in spillover sectors that service mining operations and worker households. Consequently, analytical frameworks focusing solely on direct mining employment may systematically underestimate women's exposure to sector-specific economic shocks (Cunningham & Schmillen, 2021). Besides employment losses, other effects related to the restructuring process are documented, such as: intensified domestic labour burdens resulting from male unemployment, increased intra-household conflicts, and adverse effects due to induced migration (Walk et al, 2021).

Green transition policies should address women through various measures, including comprehensive care infrastructure (such as childcare services), skills development for well-paid green economy jobs, early-stage training programs, and meaningful participation in decision-making processes (Walk et al., 2021). According to Cunningham & Schmillen (2021), women demonstrate greater occupational flexibility, accepting employment across broader sectoral categories, while men typically restrict their job search to occupation-specific positions. Additionally, empirical evidence from ALMP evaluations suggests superior female responsiveness across certain intervention types, such as post-training employment probabilities and wage gains, which exceed those of men, as well as a higher incidence of employment service usage (Cunningham & Schmillen, 2021; for more details on gender difference in ALMP impact, see section on general ALMP evaluations).

Empirical evidence (Causa, 2024) demonstrates that education constitutes the primary individual-level determinant of transitions from nonemployment to green employment, with education in scientific disciplines exhibiting particularly pronounced effects for labour market entrants. Gender disparities are evident, with women demonstrating significantly lower propensities than men to transition from nonemployment to green jobs. These findings suggest policy interventions should prioritise enhancing access to quality education, training and skills, particularly addressing structural barriers limiting women's participation in STEM disciplines.

The report suggests that, since the literature provides evidence that programmes integrating multiple interventions tend to yield better results than stand-alone measures (e.g., Kluve, 2016; for youth employment programmes), job-placement focused programs that combine employment opportunities with targeted retraining may prove more effective than stand-alone retraining programmes (p. 16). This Toolkit also provides a summary of the types of actions that could support individual workers in the transition, depending on the main aim of the action (Table 7).

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Table 7. Tailored support for the workers in the green transition

Aim	Action	Suitable type of worker	Time-scale
Move to an alternative role within the company	Support workers who have appropriate skills and/or are willing to retrain to take on alternative roles.	All with relevant skills and disposition	Short/medium-term
Move to alternative coal-based sites in the company	Practical support to transfer to another site.	Those who may find it hard to find work in other roles or sectors	Short-term
Move to an alternative local job	Regional worker transfer programmes. On-the-job training.	All with relevant skills and the ability to move to an alternative local job	Long-term
Move to another sector	Targeted training.	Workers likely to succeed in other sectors, particularly young people and those with post-secondary education	Long-term
Move to another sector in another region	Targeted training. Practical and financial support for relocation.	Those likely to succeed in other sectors and who are willing and able to relocate geographically	Long-term
Voluntary redundancy	Support package, including reconversion plan.	All	Short-term
Retirement	Early retirement. Providing a bridge to pension.	Older workers	Short-term

Source: Broughton, A., & Wehnert, T. (2020), p. 14.

Cunningham and Schmillen (2021) emphasise the timing of measures, with a specific phase of transition in mind, as well as the interplay between local economic context, the speed of transitions, and the social security system when choosing an adequate mix of measures. Besides, targeting specific groups is also important, since particular measures can have different impacts across socio-economic groups. Authors, following Fretwell (2017), define 3 key phases in effective coal transition:

- Pre-layoff planning involves identifying affected workers and auxiliary service impacts, reviewing labour regulations and social protection systems, and establishing institutional partnerships with communications initiatives. In this phase, the first step is to determine which workers will face job loss, accompanied by an assessment of the skills and competencies of the existing personnel. Additionally, spillover job losses should be considered, for example, in companies within the coal mining value chain. Some of the necessary steps are: a) gathering information about the general characteristics of the workers who are going to be laid off (e.g. age, gender, education, skill level, occupation, etc.), b) evaluation of potential reassignment opportunities within the same company or industry, c) evaluation of the broader employment circumstances and patterns in local, national, and international labour markets d) identifying where social service availability gaps may develop. Assessment of the relevant social protection system is also one of the important steps, since the authors state that “the most successful transition support often takes place via existing social protection systems” (p. 10.).

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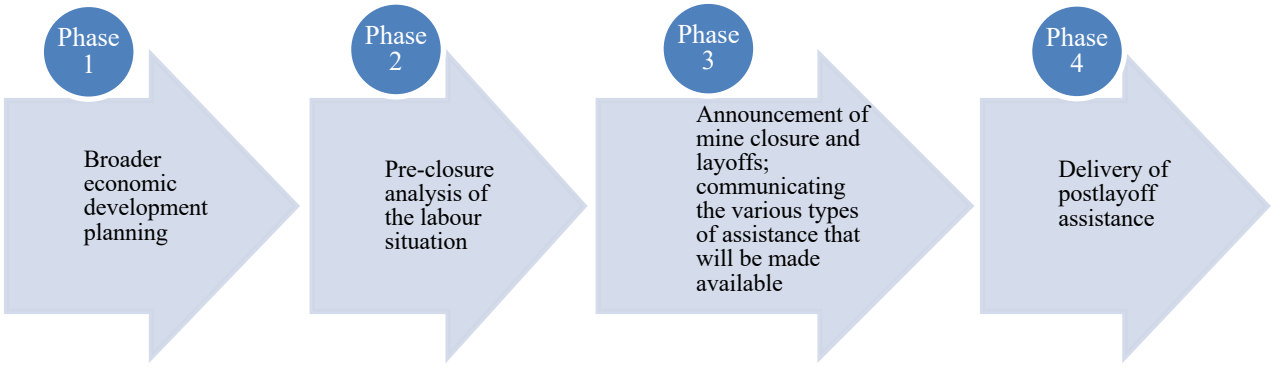
Engagement of key stakeholders in the early stages is one of the key prerequisites for successful transition.

- The pre-layoff assistance phase involves providing dismissal notices, informing workers of available assistance options, and initiating certain service provisions. The notice period must be aligned with the specific legal framework, with more extended periods of notice being preferable to shorter ones. Workers must be adequately informed about the options and services that may be available to them, and particular services should begin before layoffs occur, including: “establishing eligibility for and assessing interest in temporary income support and ALMPs; worker profiling and skill audits to provide each worker with a clear understanding of their skills and assistance needs and provision of initial in-plant jobs counselling and placement services” (p. 12).
- Post-layoff assistance includes providing temporary income support (through severance payments, unemployment benefits/assistance, social assistance and early retirement schemes), implementing ALMPs, and considering auxiliary services.

These phases should ideally be addressed sequentially, but may overlap in practice, particularly when coal mine closures occur rapidly without advance planning.

A similar framework for transition phases is provided by Ruppert Bulmer et al. (2021), as shown in Figure 4.

Figure 4. Policy framework and the phases of the labour transition



Source: Authors, based on Ruppert Bulmer et al. (2021)

According to Cunningham and Schmillen (2021), policy success depends on the broader economic climate, the existing capacity of the social protection system, transition dynamics, and the local context. The authors emphasise that "post-layoff assistance programs, in and of themselves, do not create jobs" (p. 24). While ALMPs combined with income support can address frictional unemployment and build human capital, actual employment creation requires private sector investment and economic development. For geographically concentrated job displacements, local economic development grants may be important, but their effectiveness depends on specific local circumstances. They show greatest promise where "the local context provides a solid foundation for an economic rebound, e.g. due to a strong human capital base and easy access to markets" (p. 24-25). Besides, some auxiliary services are often necessary and they encompass social programmes which ensure that displaced workers and their families continue to have proper access to health, education, and comparable services they deserve, as well as pension benefits.

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Concerning ALMPs, authors recommend sequencing them by starting with lower-cost services (such as employment services) for broader populations and progressing to higher-cost interventions (such as education and training) for those requiring additional support or facing significant re-employment barriers. This sequencing should be coordinated with income support programs to avoid duplication and capitalise on synergies.

Coordination between ALMP and social protection systems is emphasised in other studies (e.g., Bischler et al., 2024), who point out that the effectiveness of ALMP may depend on their sequencing, but also that the impact of ALMP can be more sustainable and inclusive when coupled with temporary income support measures. It is also argued that "existing coverage, adequacy and capacity of social protection systems and supply of ALMPs should be regularly monitored" (p. 191) in order to check whether these systems can adequately respond to new challenges imposed by the green transition. Authors highlight that the design of both ALMP and social protection should be shaped in line with the results of estimations and modelling the expected impact of green transformation. Similarly to Cunningham and Schmillen (2021), this study point out that the adequate policy mix depends on a lot of circumstances, such as: social protection system, legislation, labour market polices and institutions, but also on "the level and structure of informality, and the number, location and profile of workers affected" (p. 175).

Causa et al. (2024) provide some empirical results, using a large sample of European countries across the 2011-2019 period, the cross-country econometric analysis delivers several relevant insights on the ALMPs in the green transition context, which may be summarised as follows:

- The impact of the transition and policies is uneven across different groups, but also across places, which calls for a place-based policy approach;
- Formal education, competencies and access to training facilitate labour market transitions;
- Well-designed ALMPs can help workers cope with both cyclical and structural changes;
- ALMPs should be combined with "balanced and adequate income support" (p. 22);
- Policy results for transitions from non-employment to green employment:
- Transitions from non-employment to green jobs are more probable in countries with higher levels of adults' proficiency in numeracy and literacy, i.e. higher tertiary education attainment shares;
- Countries with higher rates of adult participation in formal and non-formal educational programs and greater availability of employer-provided training demonstrate higher probabilities of successful transitions from unemployment to employment and from education to employment.
- The association between ALMPs and transitions from non-employment to green jobs is weakly significant overall. This relationship also differs across socioeconomic groups and spending categories;
- Spending on training, PES and employment incentives can be effective, especially among highly educated workers. ALMPs significantly increase the (first-stage) probability of moving from jobless to a job;
- The impact of unemployment benefits on the conditional probability of transitioning from nonemployment to green jobs is weakly statistically significant and positive.

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An appropriate response requires well-targeted ALMPs in the areas of training, job-search, and profiling services, in combination with adequate income support for the unemployed. Anticipating the skills needed for the transition, both for young people entering the labour market and more widely for workers' mobility and requalification, is crucial for the success of the green transition.

The evaluation of ALMPs, implemented in different contexts, can give valuable insights for policymakers in the green transition. We present the summary of these evaluations in the next section.

Evaluation of the ALMPs - Key Findings from the Literature

The literature reveals mixed but generally positive outcomes for ALMPs, with effectiveness heavily dependent on program design, implementation context, and target populations (Spahiu, 2023). Job search assistance and monitoring consistently demonstrate the most positive results across European countries (Caliendo and Schmidl, 2016) This approach proves particularly cost-effective when combining counselling with activation measures, though excessive activation intensity can yield zero or negative effects.

Training programs yield heterogeneous results. Classroom-based training generally outperforms mixed practical approaches, though effectiveness varies significantly by economic conditions and can crowd out formal education participation among youth (Caliendo and Schmidl, 2016). Similarly, Scandurra et al. (2024) found that employability programs in higher education show generally positive outcomes for students through competitive advantage in employment and smoother school-to-work transitions, though their systematic review revealed concerning methodology limitations.

Wage subsidies demonstrate promise under favourable economic conditions, showing positive effects when targeted to specific groups. Albania's programs showed 33.8% increased employment probability for unemployed jobseekers in difficulty (Spahiu, 2023)

Public sector work programs consistently underperform, with Caliendo and Schmidl (2016) finding predominantly negative outcomes (5 negative, 8 insignificant, 1 positive effect). These programs often create lock-in or stigmatization effects rather than serving as stepping stones to regular employment.

Notably, ALMPs demonstrate greater effectiveness for low-skilled workers and adults compared to youth (Spahiu, 2023; Caliendo & Schmidl, 2016), challenging assumptions about program universality and emphasizing the need for targeted, context-specific approaches rather than "one-size-fits-all" solutions.

Meta-analyses

Multiple large-scale meta-analyses provide robust evidence on ALMP effectiveness across diverse contexts. While ALMPs can be effective tools for labor market policy, their success depends critically on matching program types to target populations, economic contexts, and implementation quality, with employment services and wage subsidies showing the most robust positive impacts.

Vooren et al. (2019) conducted meta-analysis of 654 causal impact estimates from 57 experimental and quasi-experimental studies across 17 countries, using standardized effect sizes and controlling for publication bias through FAT-PET and PEESE procedures. Levy Yeyati

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et al. (2025) exclusively examined randomized controlled trials, analysing 668 impact estimates from 102 interventions globally, with approximately half implemented in lower-income or lower-middle-income economies across Africa (30.4%), North America (24.5%), and Latin America (19.6%). The EU-focused analysis by Ismeri Europa (2022) synthesized 94 counterfactual impact evaluations across 23 member states, providing 882 estimates on employment outcomes from ESF and Youth Employment Initiative programs.

Program Type Effectiveness Patterns

Enhanced services and job search assistance consistently emerge as the most immediately effective interventions. Vooren et al. found these programs demonstrate positive effects from 6-36 months, being most effective at 12 months ($d=0.068$, $p<0.05$). Card et al. (2015), analysing 207 studies with 857 estimates spanning 1980-2014, classified these as "work first" approaches showing large short-term impacts remaining stable over time. Betcherman et al. (2004), reviewing 159 evaluations across developed, transition, and developing countries, found employment services had the most consistent positive impacts, with 16 of 21 evaluations showing positive employment effects and favourable cost-benefit ratios due to low implementation costs.

Employment and wage subsidies demonstrate the highest impact potential across multiple contexts. Levy Yeyati et al. found wage subsidies achieved the highest median earnings impact (16.7%) and strongest employment effects among all program types. The EU analysis confirmed this pattern, with employment subsidies showing 75% positive significant effects and only 10% negative outcomes. Card et al. identified subsidized private employment as having substantial medium-term (0.12 effect size) and longer-term (0.19 effect size) positive impacts, particularly effective during economic downturns.

Training programs exhibit the classic "lock-in effect" pattern across all meta-analyses. Participants initially perform worse due to reduced job search activity during program participation, but benefits emerge over time. Vooren et al. found training programs show positive but generally non-significant effects throughout 6-36 months, while Card et al. demonstrated small or negative short-term effects followed by larger positive medium and long-term impacts. Levy Yeyati et al. reported moderate effectiveness with 7.7% median earnings impact and 6.7% employment impact. Betcherman et al. found on-the-job training with employer involvement consistently outperformed classroom-only approaches across all country categories.

Public employment programs consistently underperform across all studies. Vooren et al. showed these programs have the strongest negative lock-in effects, with persistent negative impacts at 6 and 12 months, only becoming positive at 36 months but remaining statistically insignificant. The EU analysis found public employment programmes performed poorly with 62% negative significant effects and only 25% positive outcomes. Betcherman et al. concluded these programs primarily serve as effective short-term safety nets but rarely improve long-term employment prospects.

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Target Group and Contextual Variations

Gender and demographic effects show consistent patterns across studies. Women generally benefit more from ALMPs than men, particularly in training programs. Card et al. found female participants showed consistently larger program effects, while youth and older workers demonstrated smaller impacts than mixed-age groups. The EU analysis revealed no significant gender differences, suggesting equitable program impacts, but confirmed youth programs were less effective initially (42% positive significant effects, 29% negative) compared to unemployed adults (55% positive, 21% negative).

Economic context significantly influences effectiveness. Levy Yeyati et al. discovered programs perform better when GDP growth is higher and unemployment lower, challenging conventional wisdom about ALMPs serving as counter-cyclical tools. This suggests pro-cyclical rather than counter-cyclical effectiveness. Card et al. found programs show larger impacts during slow growth and higher unemployment, with human capital programs appearing more countercyclical than work-first approaches.

Development level matters substantially. Betcherman et al. found stark differences in youth training effectiveness: only 1 of 14 programs showed positive employment impacts in developed countries, while all 5 developing country programs (primarily Latin American "Jovenes" programs) demonstrated positive results.

Key Design Features and Implementation Factors

Successful programs consistently include several design elements. Individualized coaching and follow-up emerged as crucial across studies. Levy Yeyati et al. found this factor, along with monetary incentives for participants and explicit sector targeting, strongly associated with program success. Program duration shows optimal ranges, with the EU analysis revealing shorter programs (≤24 months) proving more effective than longer ones (25-48 months).

Cost considerations vary significantly by program type. Levy Yeyati et al. found employment services are least expensive (median $277 PPP 2010), while wage subsidies, vocational training, and independent worker support had comparable median costs ($1,518-$1,744 PPP 2010) with high variability.

Findings from individual studies

While meta-analyses provide valuable aggregate insights into ALMP effectiveness, individual country and regional studies offer crucial complementary evidence revealing important nuances often obscured in large-scale syntheses. These studies illuminate how institutional contexts, implementation quality, and local economic conditions fundamentally shape program outcomes, demonstrating that aggregate effectiveness measures may mask significant variation across different settings.

Multi-country studies reveal systematic differences in program performance across welfare state regimes and development levels, while single-country analyses provide detailed insights into specific program designs and implementation factors driving success or failure. Regional studies further illuminate how local labor market conditions and employer engagement influence outcomes.

Key findings emerge from this individual study evidence that complementing meta-analytic patterns. First, entrepreneurship and self-employment programs consistently demonstrate

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exceptional effectiveness across diverse contexts, often achieving employment rates of 70-98%. Second, workplace-based training substantially outperforms classroom instruction, with employment effects often exceeding 15-25%. Third, institutional quality and implementation capacity prove more critical than aggregate spending levels for achieving positive outcomes. Finally, program effectiveness varies significantly by target population, with some interventions showing strong effects for disadvantaged groups while others perform better for motivated job seekers. These contextual insights are essential for understanding not just whether ALMPs work on average, but when, how, and for whom they are most likely to succeed.

Multi-Country Studies

Training Programs

Cross-country analyses reveal divergent findings regarding training program effectiveness. eEvaluation across 31 advanced countries (Escudero, 2018) demonstrates that training measures show positive effects primarily for the overall population, with enhanced impacts when combined with proper implementation factors such as adequate resource allocation and policy continuity. The effectiveness proves particularly pronounced for low-skilled individuals when implementation variables are appropriately considered. However, contrasting evidence emerges from studies focusing specifically on youth populations. Analysis of 37 evaluation studies across eight European countries (Caliendo & Schmidl, 2016) found that labor market training produced mixed results, with 11 positive effects counterbalanced by 12 insignificant and 6 negative effects. Classroom-based training performed better than mixed practical training programs, though training often crowded out formal education participation and showed declining effectiveness under adverse economic conditions. The divergence in training effectiveness appears linked to design and targeting considerations. Evidence suggests training programs may create stigmatization effects for higher-educated participants while potentially benefiting disadvantaged groups when properly implemented with sufficient duration and quality control.

Employment Incentives and Wage Subsidies

Employment incentives demonstrate effectiveness across multiple measures, particularly benefiting low-skilled individuals. Cross-country evidence (Escudero, 2018) indicates wage subsidies increase employment prospects and show positive effects across various outcome measures, though these impacts are sensitive to economic conditions and implementation quality. Youth-focused analyses provide more nuanced findings, with wage subsidies showing promising results in favourable economic conditions (Caliendo & Schmidl, 2016). Four positive effects out of eight total effects were documented, though concerns persist regarding deadweight and substitution effects. The effectiveness appears particularly strong when subsidies are combined with additional support components rather than functioning as standalone interventions.

Start-up Incentives and Entrepreneurship Support

Entrepreneurship promotion programs emerge as among the most successful ALMP interventions across different contexts. Multi-country evidence (Escudero, 2018) demonstrates that start-up incentives show favorable results in reducing unemployment and increasing employment, with effects particularly pronounced for low-skilled individuals. These programs consistently demonstrate positive impacts across various economic conditions and

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institutional frameworks. Research examining developing countries (McKenzie, 2017) reveals that while traditional ALMPs show disappointingly modest impacts, alternative interventions addressing spatial mismatches through migration assistance and sectoral transitions show more promise, suggesting labour market mobility constraints rather than skills gaps may drive unemployment in these contexts.

Public Employment Services

Job search assistance and PES show variable effectiveness depending on implementation quality and institutional capacity. Cross-country analyses (Escudero, 2018) indicate that these services can be effective when properly resourced and integrated with other support measures. However, effectiveness varies significantly across different institutional contexts and service delivery models. Evidence from developing countries (McKenzie, 2017) suggests that search and matching assistance programs show limited success, with only 1 out of 10 interventions achieving significant employment impacts, despite much lower costs compared to training programs.

Labor Market Policy Spending

Macroeconomic analyses examining total ALMP expenditure reveal complex relationships with unemployment outcomes. Study of nine OECD countries (Irandoust, 2023) found bidirectional causality between ALMP spending and unemployment in several nations, with unidirectional positive effects observed in others. Notably, ALMPs appear more effective in reducing female than male unemployment across multiple countries. However, analysis of 26 EU member states (Juznik Rotar, 2022) found that ALMP expenditures were positively associated with increased rather than decreased youth unemployment rates, suggesting potential inefficiencies in youth-targeted programming. This finding contrasts with expectations and indicates that higher ALMP spending may not automatically translate into improved youth employment outcomes. Global evidence covering 191 countries (Ulku & Georgieva, 2022) shows while unemployment benefits generally showed no significant association with overall unemployment rates, ALMPs were consistently associated with reduced self-employment rates across all income groups, indicating a shift toward formal wage employment.

Regional Policy Clustering and Expenditure Patterns

Analysis of expenditure patterns across EU-28 countries (Rollnik-Sadowska & Dąbrowska, 2018) reveals distinct clusters of countries based on their LMP spending profiles. High-expenditure countries including Nordic and Continental European welfare states demonstrated comprehensive active measures, while low-expenditure clusters encompassed most Central and Eastern European countries. Interestingly, countries with the best labour market indicators were distributed across different expenditure clusters, suggesting that effective outcomes can be achieved through different policy approaches and spending levels.

Single-Country Studies

Training Programs

Single-country evaluations reveal substantial variation in training program effectiveness across different institutional contexts. Research in Slovenia (Burger et al., 2021) shows institutional training produced modest but persistent impacts, with employment probability effects of 2.5% after one year, growing to 4.7% after two years and maintaining 4.6% after 4.5

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years. The program also yielded modest wage premiums of 25 cents per hour, representing a 4.3% increase. Contrasting evidence emerges from other contexts. In Slovakia (Karasová et al., 2019), training programs showed limited long-term effectiveness, with some programs associated with higher failure rates than non-participation. The study revealed that external factors such as GDP growth, regional development, and job vacancy availability significantly influenced outcomes more than ALMP design features. Polish evaluations (Wiśniewski, 2022) demonstrated positive but modest effects, with training courses generating 8.7% net employment effects, though effectiveness varied considerably by course quality and labour market alignment. Research on Polish ALMPs (Szydlik-Leszczyńska & Stęplewska, 2024) found training programs exhibited the lowest effectiveness (49.61%-66.18%) with declining trends in recent years. More promising results were observed in Spain, where training and qualification programs (Arranz & García-Serrano, 2024) showed the strongest effects among all ALMP interventions, with 10-11 percentage point increases in job-finding probability persisting over time regardless of participation period.

On-the-Job Training and Workplace Programs

Workplace-based training consistently demonstrates superior outcomes compared to classroom-based alternatives. Slovenian evidence (Burger et al., 2021) shows on-the-job training producing strong effects at 25.1% after one year, declining to 18.9% after three years but remaining substantial at 15% after four years. These programs also generated significant wage premiums of €1.3, declining to €1.1 after 30 months. Research in Slovakia (Svabova & Kramarova, 2021) examining the Graduate Practice program found positive short-term effects, with fewer participants remaining completely unemployed (38.4% vs 44.7%) and better employment sustainability during the first year. However, program effects diminished in the second year, indicating primarily short-term rather than sustainable employment impacts.

Wage Subsidies and Employment Incentives

Wage subsidy programs demonstrate variable effectiveness depending on program design and economic conditions. Slovenian evidence (Burger et al., 2021) for the Employ.me program showed exceptional results, with 40.4% employment probability increases after one year, 28.8% after three years, and maintaining 25% after five years. The program also produced substantial wage premiums of €2.2 per hour after one year. However, other contexts reveal more modest or temporary effects. Polish intervention works (Wiśniewski, 2022) achieved 15.6% net employment effects, while analysis of Polish ALMPs more broadly (Szydlik-Leszczyńska & Stęplewska, 2024) showed intervention works with effectiveness rates of 89.46%-93.66% but higher costs per employment outcome. Research in Bulgaria (Atanassov & Trifonova, 2020) found a total net effect of 14.5 percentage points for ALMP participants compared to non-participants, with particularly strong effects for youth under 24 (48.3 percentage points) and individuals with primary or no education (24.6 percentage points).

Entrepreneurship and Self-Employment Support

Self-employment and entrepreneurship programs consistently emerge as the most effective ALMP interventions across single-country studies. Polish start-up incentives (Wiśniewski, 2022) demonstrated the highest impact with 62.6% net employment effects, substantially exceeding other program types. Research on Polish business start-up grants (Szydlik-Leszczyńska & Stęplewska, 2024) showed the highest effectiveness rates (94.63%-98.10%)

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across the evaluation period. German evaluations (Zoellner et al., 2018) revealed exceptional success rates, with 70-80% of participants remaining self-employed or finding regular employment after several years. These programs showed high survival rates exceeding non-subsidized businesses and created substantial job multipliers, with participants generating average 3 full-time equivalent jobs. Spanish evidence (Sánchez-Cañizares et al., 2025) for self-employment policies showed mixed results depending on specific program design. Free training programs and subsidies for hiring workers consistently demonstrated positive effects on both job creation and earnings, while some policies showed neutral or negative effects.

Public Works and Direct Job Creation

Public works programs consistently show minimal or negative effects across different country contexts. Slovenian public works (Burger et al., 2021) demonstrated minimal post-program effects on employment outcomes. Polish public works (Wiśniewski, 2022) showed statistically insignificant 4.7% effects, failing to meaningfully increase employment chances, while socially useful works produced negative effects of -8.9%, actually reducing employment prospects. German evaluations (Zoellner et al., 2018) of public job creation programs largely confirmed these patterns, with Public Job Creation showing negative impacts and eventual program termination. Research in Poland (Szydlik-Leszczyńska & Stęplewska, 2024) found public works with moderate effectiveness (83.98%-90.12%) but questioned their long-term employment impact.

Job Search Assistance and Intermediation

Job search assistance programs show moderate positive effects when properly implemented. Spanish evidence (Arranz & García-Serrano, 2024) demonstrated that intermediation services produced 8-14 percentage point positive effects, though effectiveness declined with longer time gaps between participation and measurement. Professional information and guidance services showed 6-8.7 percentage point effects for recent participants. Israeli evidence (Schlosser & Shanan, 2025) from soft skills program showed significant improvements in employment rates (8 percentage points increase), with effects persisting through both skills enhancement and threat effects motivating immediate job search activities. Twelve months post-randomization, employment rates increased by 8 percentage points, welfare dependency decreased by 11 percentage points, and monthly labour income increased by 12%. Research in Latvia (Hohlova & Rivza, 2022) revealed significant reluctance among unemployed to cooperate with PES, with only 20.3% planning active cooperation while 43% preferred independent job searching, highlighting implementation challenges in job search assistance programs.

Institutional Factors and Implementation Quality

Evidence from several studies emphasizes the importance of institutional context and implementation quality. Research in Sweden (Kantová & Arltová, 2020) during the 2007-2012 period found that greater labour market flexibility did not result in more effective matching processes, with ALMP appearing most effective for motivated job seekers but least effective for vulnerable groups including teenagers and long-term unemployed. Studies in Russia (Korzhova et al., 2020) identified significant institutional barriers to ALMP effectiveness evaluation, including lack of systematic assessment methodology and insufficient qualified personnel, highlighting the importance of evaluation capacity for policy improvement.

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Regional and Sub-National Studies

Training and Human Capital Development: Context-Dependent Outcomes

Regional-level analyses reveal how local economic conditions influence ALMP effectiveness. Research in Flanders, Belgium (Wood et al., 2025) found that human capital programs uniquely showed sustained advantages throughout observation periods without typical lock-in effects, suggesting continued benefits rather than temporary reductions in job search time. These programs demonstrated particularly high unrealized potential for non-participants. Contrasting evidence from Madrid, Spain (Arranz & García-Serrano, 2024) showed that while training programs produced positive effects, the impacts were concentrated on intermediate-quality jobs rather than high-quality positions, raising questions about the career advancement potential of training-based interventions.

Job Search Assistance

Regional evaluations consistently demonstrate positive effects for job search assistance programs. Flemish evidence (Wood et al., 2025) showed that job search assistance achieved 60.5% versus 51.8% employment rates after 24 months compared to matched controls. Application and job interview training demonstrated the largest effect magnitudes among all program types, achieving 46.9% versus 28.9% employment rates after eight months. Research in North Macedonia (Nikoloski, 2021) examining five distinct ALMMs found that driver training showed consistently positive employment impacts and reduced unemployment, with particularly strong effects and high benefit-cost ratios. However, targeting analysis revealed systematic challenges in reaching truly disadvantaged groups across programs.

Employer Engagement and Labor Market Integration

Studies examining employer involvement in ALMPs provide insights into demand-side factors. Research in Norway (Hyggen & Vedeler, 2021) found that 53% of surveyed businesses had recent Work Training experience, with about half subsequently hiring candidates. Results indicated that both altruistic motivations and economic self-interest drive employer engagement, with structural factors like business size and sector significantly influencing participation. Analysis of mass layoffs and regional responses (Vermeulen & Braakmann, 2023) across seven European countries revealed that mass layoffs demonstrate persistent negative effects on regional employment, with more severe effects in rural areas. However, regions with lower unemployment rates tend to experience stronger negative employment effects than high-unemployment regions.

Regional Economic Resilience and Crisis Response

Studies of regional economic responses to crises provide broader context for ALMP effectiveness. Research in Sweden (Eriksson & Hane-Weijman, 2017) examining job creation and destruction patterns during 1990-2010 found that despite national employment growth, only three metropolitan regions fully recovered from the 1990s recession by 2010. The study revealed that incumbent firms, particularly SMEs, drive job creation while exits primarily cause job destruction. Analysis of plant closures in Spain (Jofre-Monseny et al., 2018) found that large plant closures have significantly smaller net employment effects than direct job losses suggest, with 30-40% of the initial employment shock offset by job creation in other local firms. These findings indicate that positive employment effects are industry-specific and geographically concentrated.

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Summary

The green transition has its sectoral (energy) and regional (coal-producing) dimensions, as well as labour market policy (active and passive) dimension. The green transition as a pattern of change is not an entirely new phenomenon (Diliuso et al., 2021). Socioeconomic changes brought about by the green transition are often all-pervasive and demand strategic, holistic and complex approaches.

Based on an extensive literature review, encompassing meta studies, comparative studies and single-case reports, this analysis addresses two related policy questions:

- What should governments and other stakeholders do to facilitate the green transition, particularly the transition away from coal?
- What are the most suitable and efficient labour market policies to prevent long-term unemployment and income losses among workers affected by the green transition and support their re-employment?

The surveyed literature was divided into 'macro' and 'micro' studies. Macro studies are methodologically and topically heterogeneous. They address the first question from various angles and use mostly qualitative and comparative methodology to describe the transition processes, to evaluate strategies and policies applied, to draw lessons learned and to suggest optimal policy choices. Micro studies are typically focused on 'scientific', or 'net impact' evaluations of active (and, very rarely, passive) labour market programmes. They are methodologically and topically more homogeneous, attempting to assess, using econometric and other statistical techniques, the 'net impact' of various programmes on labour market outcomes of beneficiaries of such programmes and to distil, in the context of the green transition, which programmes work best and for whom.

What transpires from the best experiences presented in 'macro' studies is that the green transition requires strategic cross-policy planning and extensive resources. Subnational governments and other relevant stakeholders should be actively engaged in both the design and implementation of measures (ILO, 2015). The green transition is a challenging endeavour, often causing disruptions to the economic, labour market and business and cultural identity of affected regions (Caldecott et al., 2017). To compensate for these disruptions and utilise their potential advantages by updating skills and upscaling businesses, extensive financial resources are needed to carry out investment strategies, with projects encompassing infrastructure, regeneration activities, education and R& D (Diliuso et al., 2021). Regional authorities and businesses should also be supported to pursue smart specialisation and economic diversification. Identifying skill needs at the local level and creating reskilling and upskilling programmes tailored to these needs is emphasised in many sources, including Cirillo et al. (2024). Reliance on ALMPs is important, but it is not enough (Keese & Marcolin, 2023). Effective transition strategies should prioritise early stakeholder involvement (Broughton & Wehnert, 2020; Vogl, 2019). Creating consensus, ideally through encompassing social dialogue, among regional authorities, industries, trade unions, and citizens about the sequencing and overall pace of the transition is found to be very beneficial (Galgóczi, 2019).

Compensating fully and early workers and citizens whose lives will be disrupted and who are about to suffer financial and other losses due to the green transition is crucial for the credibility, fairness and political success of the process. Authors emphasise the central role played by existing or enhanced social protection systems (Fretwell, 2017; Cunningham &

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Schmillen, 2021). Following 'the optimal speed of transition' model (Aghion & Blanchard, 1994), adequate and careful sequencing and pacing of economic and labour market restructuring is needed to navigate between the negative spiral of unemployment, demand shock and political economy risks, if the pace of transition is too fast, and status quo, leading to further lagging behind, if the pace is too slow. Finally, Nævdal and Wagner (2025) criticise politically set EU-wide milestones for emissions reductions because they are not optimally designed in individual countries.

ALMPs are interventions aimed at assisting workers in becoming employed or maintaining jobs. Using the Eurostat classification, ALMPs (LMP measures by Eurostat) include Training; Employment incentives; Sheltered and supported employment and rehabilitation; Direct job creation and Start-up incentives. These programmes are evaluated using advanced econometric techniques, attempting to isolate ex- post net effects of the intervention, comparing the actual individual labour market outcomes of the intervention with the hypothetical (counterfactual) individual outcomes without the intervention. ALMPs are widely used instruments of economic and labour market policy. Their main advantage is that, by targeting the members of the labour force at risk, rather than the entire economy, they avoid the macroeconomic disruptions that can be potentially caused by generally expansionary fiscal or monetary policy. In the context of green transition, the role of most ALMPs increases as the large number of jobs, often crucial for the well-being of a population within a region, might be under elevated risk.

The evidence from analysed studies reveals significant heterogeneity in ALMP effectiveness across intervention types, contexts, and implementation approaches. Entrepreneurship and self-employment programs consistently demonstrate the strongest positive effects across different settings, while public works programs show limited or negative impacts. Training programs exhibit mixed results, highly dependent on design quality and economic conditions, with workplace-based training generally outperforming classroom instruction. Job search assistance shows moderate positive effects when properly implemented, while wage subsidies demonstrate conditional effectiveness depending on program design and economic context. Cross-country analyses suggest that implementation quality, institutional capacity, and targeting precision matter more than aggregate spending levels. Regional studies highlight the importance of local economic conditions and employer engagement in determining program success. The evidence emphasises that effective ALMPs require careful design, appropriate targeting, and supportive institutional frameworks, rather than simply increasing program expenditure.

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6. National and Regional Policy Landscapes of ISABEL Partner Countries

The success of a just transition depends not only on international or EU-level strategies, but critically on how individual countries and regions interpret and implement these frameworks. The ISABEL project involves countries with diverse political, economic, and industrial structures, which shapes their respective policy responses to the challenges of job creation, job destruction, and skills shortages. This section offers a comparative overview of transition-related labour market and skills policies in six ISABEL partner countries: Greece, Spain, Poland, Denmark, the United Kingdom, and Serbia.

Greece

Greece is undergoing one of Europe's most rapid energy transitions, especially in the region of Western Macedonia, where lignite-based electricity generation is being phased out. The National Energy and Climate Plan (NECP) outlines the country's strategy for reducing emissions and increasing renewable energy capacity (Ministry of Environment and Energy, 2019). This has major labour market implications, particularly in coal-dependent regions.

The objectives of Greece's energy policy, which are compatible with those of the EU are contained in the updated National Energy and Climate Plan (NECP), depicting the country's energy transition to clean forms of energy. The main objective of the NECP is to design, plan and implement the most socially, environmentally and economically effective policy measures, which will contribute to the achievement of the medium and long-term national energy and climate goals, will contribute to the economic development of the country and, at the same time, they will meet the challenge of reducing energy costs and generally protecting final consumers from high prices of energy products and services.

Greece, in the context of its participation in the collective European goal of a successful and sustainable transition to a climate-neutral economy by 2050, prepared in 2019 and in addition to the forementioned NECP, the Long-Term Energy Strategy for 2050, which is essentially a Roadmap for Climate and Energy issues.The Greek Government prepared and voted for a series of laws for decarbonisation. Specifically:

- Law 4759/2020 (Gov. Gazette A' 245/09-12-2020): Modernization of Spatial and Urban Planning Legislation.
- Law 4872/2021 (Gov. Gazette A' 247/10-12-2021): "Just Transition Development" and provisions on delignification.
- Law 4956/2022 (Gov. Gazette A' 140/19-07-2022): Programmatic agreement between the Ministry of Development, PPC, and METAVASI S.A.
- Establishment of the "Just Development Transition 2021–2027" Monitoring Committee (Gov. Gazette B' 4757/09-09-2022).
- Law 4821/2021 (Gov. Gazette A' 134/31.07.2021) – National Recovery and Resilience Plan "Greece 2.0"
- National Just Development Transition Plan
- Just Transition Development Plans (Territorial) for Western Macedonia and Megalopolis (2021–2027)

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To support affected regions, Greece developed a Territorial Just Transition Plan (TJTP) for Western Macedonia and the Peloponnese. These plans identify strategic priorities such as economic diversification, reskilling programs, green entrepreneurship, and sustainable tourism. However, challenges remain in policy coherence and local administrative capacity.

Labour market responses are led by the Public Employment Service (DYPA), including vocational training, wage subsidies, and entrepreneurship support. However, challenges persist: participation by older and low-skilled workers is limited, and local administrative capacity remains uneven.

Spain

Spain's green transformation is backed by an ambitious legislative framework and strategic alignment with EU objectives. With strong public investment, supportive regulation, and attention to social inclusion, the country is laying the foundation for a sustainable and competitive future. Spain has positioned itself as a frontrunner in the EU's environmental transformation, with a robust legal and policy framework. The Just Transition Strategy, launched in 2020, is an ongoing effort spearheaded by the Ministry for the Ecological Transition and the Demographic Challenge (MITECO) through its Institute for Just Transition. This initiative is specifically designed to address the social and economic challenges faced by workers and regions affected by Spain's decarbonization process, particularly in areas such as Asturias and León, which have experienced significant impacts from coal plant closures.

The strategy aims to ensure that no one is left behind in the transition to greener energy. It includes comprehensive measures such as retraining programs to equip workers with new skills for emerging industries and economic diversification plans to stimulate job creation and sustainable development in affected regions. The Climate Change and Energy Transition Law, officially known as Law 7/2021, was enacted on May 20, 2021, by the Spanish Parliament (Cortes Generales).

The law sets out an ambitious framework to achieve carbon neutrality by 2050, which underscores its pivotal role in the country's green policies. Among its transformative provisions is the ban on the sale of new vehicles emitting CO_2, which is set to take effect by 2040. This measure aims to accelerate the transition to cleaner and more sustainable mobility solutions. Another critical aspect of the law is its target to ensure that 100% of Spain's electricity is generated from renewable sources by 2050. This important goal highlights the nation's dedication to reshaping its energy landscape and reducing its reliance on fossil fuels. The law's enactment has been officially recorded in the Spanish Official State Gazette (Boletin Oficial del Estado) under the reference BOE-A-2021-8447, marking it as a cornerstone in Spain's environmental transformation.

The Integrated National Energy and Climate Plan (PNIEC) for the period 2023–2030 represents another keystone of Spain's strategic approach to meeting its climate objectives and aligning with EU regulations, particularly EU Regulation (EU) 2018/1999. Updated in 2023, the plan underscores the Spanish government's commitment to addressing climate challenges through actionable and measurable goals. One of the primary objectives of the PNIEC is to reduce greenhouse gas emissions by 32% compared to 1990 levels, setting a significant benchmark for environmental protection. Additionally, the plan aims to achieve 48% renewable energy

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consumption by 2030, marking a substantial stride towards a cleaner and more sustainable energy grid. To reach these ambitious targets, the plan involves a comprehensive mobilization of public and private investment, with an estimated total of over €294 billion. This substantial financial commitment highlights the scale and urgency of Spain's efforts to combat climate change and transform its energy economy. The PNIEC not only contributes to Spain's national goals but also strengthens its alignment with broader EU objectives for a greener and more resilient future.

As a final remark, Spain's Hydrogen Roadmap, introduced in 2020, represents a significant milestone in the country's commitment to advancing renewable hydrogen technologies. Central to this initiative is the ambitious objective of achieving 4 GW of installed electrolyzer capacity by 2030. This target underscores Spain's determination to integrate green hydrogen as a cornerstone of its energy transition strategy. To support this vision, substantial financial investments have been allocated under the Recovery, Transformation, and Resilience Plan (PRTR). Between 2023 and 2025 alone, over €1.5 billion in aid programs have been directed toward hydrogen-related projects. These funds are aimed at fostering innovation, scaling up infrastructure, and ensuring the seamless integration of renewable hydrogen within Spain's broader energy framework.

Poland

Poland represents a complex case. Coal dominates the power sector in Poland, however with significant dependence on external supplies of natural gas and crude oil, the aspects of energy safety, transformation, and clean air have been usually the most important part of Polish energy policy for decades. The combined share of coal in electricity generation amounted to 57.1% in 2024, compared to approximately 83% in 2015. Moreover, Poland was importer netto of coal over last 10 years. While it remains heavily reliant on coal, it has committed to phase-outs in specific regions, notably Silesian Voivodship, which is home to over 63,000 coal-related jobs (Trembaczowski 2024) and employment in mining-related industries ranging from 93,600 to 112,000 (Frankowski, Mazurkiewicz 2020) — or from 110,000 to 130,000 (Ingram et al. 2020), depending on the methodological approach used.

The Polish Just Transition Plan, integrated into its National Recovery and Resilience Plan, channels EU Cohesion and Recovery funds to support economic diversification, worker retraining, and environmental rehabilitation (European Commission, 2021b). Yet, the pace of implementation has been criticised. Social resistance, political uncertainty, and limited regional capacity have slowed progress (Kowalski & Lewandowski, 2022). Vocational training systems remain underfunded, and few programs specifically address the long-term unemployed or older workers in transition regions (CEDEFOP, 2020). Poland has implemented several legislative initiatives in recent years aimed at promoting energy transition and increasing the use of renewable energy sources. The Act on Renewable Energy Sources (OZE), which was passed in 2015, is the most significant piece of legislation pertaining to this transformation. Tax breaks, lower grid access fees, and the ability to sell extra energy to the grid are just a few of the advantages the act offers to encourage the growth of renewable energy. Despite several amendments to the Renewable Energy Sources Act, the development of energy cooperatives in Poland continues to face numerous challenges and regulatory bottlenecks (Orłowska et al. 2024). Furthermore, Poland has agreed to the Renewable Energy Directive, which outlines the EU's objective of raising the proportion of renewable energy in its energy mix to 15% by 2020 and at least 32% by 2030. The National Energy and Climate Plan

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(NECP), which describes the nation's approach to achieving these goals and advancing energy efficiency, reflects this commitment.

The transition to a low-carbon economy in the coming years will be a major challenge both for the country and for regions with a mining tradition. In 2018, Poland adopted its Strategy for the coal sector in Poland until 2030, in 2019 Poland approved its National Energy and Climate Plan for the years 2021–2030 (NECP) which stipulated its objectives relating to increased energy efficiency and decarbonization, and in February 2021 it adopted Energy Policy 2040 in which a diminishing role of coal in energy generation and heating is foreseen, but in which also activities connected with Just Transition and a reduction in energy poverty are emphasized.

However, the NECP 2030 and EP2040 documents are not fully coherent with each other, particularly regarding the pace and structure of coal phase-out and future energy mix assumptions. In 2021, a Social Agreement on the Transformation of the Hard Coal Mining Sector was signed between representatives of the government, trade unions, and mining companies. The agreement is significant in that it marks the first formal acceptance by trade unions of the systematic phase-out of the hard coal sector in Poland. An annex to the agreement includes a detailed timetable for the closure of coal mines, extending until 2049.

Modeled after the German approach, the agreement guarantees that miners will not lose their jobs but will remain employed until they reach retirement age. The provisions of the agreement, however, require notification and approval by the European Commission, which has not yet been granted. Nonetheless, based on its framework, the Polish government allocated PLN 7 billion in subsidies to the hard coal sector in 2024 alone, with a projected increase to PLN 9 billion in 2025. This creates a significant risk of uncontrolled sectoral collapse if EU notification is ultimately denied, potentially requiring mining companies to repay the public funds received.

Moreover, the timeline and structure set out in the Social Agreement are inconsistent with the NECP 2030 and EP2040 strategies, both of which foresee a substantially faster reduction in coal demand than the schedule of mine closures suggests. As a result, the entire process of transition remains marked by uncertainty and a lack of coordination. In addition to defining the long-term restructuring of the coal industry, the Social Agreement on the Transformation of the Hard Coal Mining Sector, signed in 2021, explicitly references broader regional development frameworks, most notably the Programme for Silesia (Program dla Śląska). This government initiative serves as a strategic backdrop for managing the structural transformation of the region. While the Social Agreement outlines the timeline for mine closures and job protection schemes for miners, the Programme for Silesia aims to shift the economic profile of the region toward innovation-driven, high-tech industries. Its objectives include enhancing industrial competitiveness, raising workforce qualifications, and leveraging Silesia's energy and infrastructural potential to support national energy security. As such, the Social Agreement and the Programme for Silesia should be seen as complementary instruments — one focused on safeguarding social stability, and the other on laying the groundwork for sustainable economic reinvention.

Since the era of centrally planned economy through the economic transition of the 1990s, regional development in Silesia has largely been approached through a sectoral lens, focusing predominantly on mining and heavy industry. However, in a region so deeply interwoven with

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coal and industrial heritage, a broader territorial approach is essential for guiding its long-term transformation. The significance of the green transition is increasingly reflected in the region's key strategic documents, most notably in the Development Strategy of the Silesian Voivodeship – Śląskie 2030: Green Silesia (Urząd Marszałkowski Województwa Śląskiego, 2020).

The vision of development presented in the document is a continuation and elaboration of the strategic thought implemented since 2000 in successive editions of the Strategy. However, the issues of the region's transformation taking into account respect for the natural environment – Green Silesia – are more and more consciously addressed in this document. The vision of voivodeship development until 2030 is defined as follows: The Silesian Voivodeship will be a modern European region with a competitive economy as a result of responsible transformation, providing development opportunities for its inhabitants and offering a high quality of life in a clean environment.

Achieving this vision requires actions focused around four strategic objectives:

- Strategic Objective A – the Silesian Voivodeship as a region of responsible economic transformation,
- Strategic Objective B – a resident-friendly region,
- Strategic Objective C – a region of high-quality environment and space,Strategic Objective D – an efficiently managed region.

The Territorial Just Transition Plan for the Silesian Voivodeship (Urząd Marszałkowski Województwa Śląskiego 2022) outlines a diverse range of planned operations aimed at supporting the region's shift from a coal-based economy to a more sustainable, climate-neutral model. According to the document, these operations focus on five main areas: (1) economic diversification and investment in SMEs to foster innovation and entrepreneurship; (2) revitalization and redevelopment of post-industrial areas, including brownfield investments and conversion of mining lands; (3) development of renewable energy sources and improvement of energy efficiency; (4) labour market interventions, including retraining, job placement services, and the creation of new jobs; and (5) social inclusion and quality of life improvements, such as education, healthcare, and combating energy poverty. These interventions are coordinated with the Smart Specialization Strategy of the region and aim to create new jobs while supporting both decarbonization goals and local community resilience.

Labour market interventions form a central pillar of the Silesian TJTP, aiming to soften the employment shock caused by the gradual closure of coal mines and restructuring of the energy sector.

These interventions are multifaceted and include the retraining and upskilling of workers, particularly those exiting the mining sector, through certified vocational programs and cooperation with regional education institutions. Additionally, targeted job placement services and career counseling will be offered to assist workers in transitioning into emerging sectors such as renewable energy, environmental services, and IT. The plan also supports wage subsidies and incentives for employers to hire workers affected by the transition, especially in high-unemployment zones. There is a strong emphasis on inclusive employment, ensuring participation by women, youth, and older workers who may be at risk of long-term exclusion from the labor market. Furthermore, the plan includes funding for entrepreneurship support, including start-up grants, incubation services, and mentoring for former mining

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employees seeking self-employment opportunities. According to estimates based on the effects of earlier regional programs, the TPST foresees the potential creation of approximately 31,200 new jobs by 2030, assuming full implementation of planned support measures for businesses and labor market interventions. Territorial Just Transition Plan (TJTP) for the Silesian Voivodeship allocates a comparatively smaller share of funding to education and skills development than other mining regions in Poland. According to WiseEuropa's 2021 analytical review, Silesia's plan lacks a coherent strategy for linking educational investments with long-term labor market transformation.

Denmark

National Level

Denmark's labour market remains resilient with high employment (80.2%) and low unemployment (6.2% in 2024). However, workforce growth is expected to slow due to demographic decline, high youth inactivity (43,000 NEETs), and lower employment rates among non-Western migrants. Key challenges include shortages in healthcare, social work, and education, alongside risks from AI-driven job displacement in administrative roles (Danish Government, 2023).

To address these issues, the Danish government aims to expand the labour force by 45,000 workers by 2030, focusing on the following. Vocational training with tripartite agreements to boost apprenticeships and establish climate vocational schools for green skills (e.g., solar panels, energy audits). Inclusion, integrating migrants, reducing youth NEETs, encouraging elderly employment, and shifting part-time workers to full-time roles. Upskilling, to align education with labour market needs, particularly in green and digital sectors (e.g., wind energy, digital infrastructure). Policy reforms, with tax incentives for single parents' entering the labour market, faster university completion, raising the retirement age to 70 by 2040, and attracting skilled non-EU workers via a 415,000 DKK salary threshold. It is worth highlighting Denmark's "flexicurity" model that supports transitions through flexible contracts, income support, and lifelong learning, mitigating automation risks while maintaining low average working hours, potentially implying insecurity and precarity (Kapitsinis and Gialis, 2023).

Regional Level (Sjælland)

Shifting to the regional level, it had to be noticed that in Denmark the regions' role in implementing policies that affect the labour market is limited compared to other EU Member States and the Danish municipalities or the central government. The regions can achieve strategic coordination between the two aforementioned administrative levels rather than direct intervention, although they can indirectly affect the regional labour market by the Regional Growth and Development Plans, which include measures that could strengthen the labour market by supporting business growth and innovation as well as promoting skills development in alignment with regional needs. Regions in Denmark coordinate rather than directly intervene in labour markets. Sjælland's 2019–2022 Growth and Development Strategy (Region Sjælland, 2018) addresses:

- Skills gaps: 39% of workers lack vocational training; high demand for green/digital jobs.
- Youth NEETs (12%) and aging workforce: Partnerships with universities/vocational schools for high-demand fields (e.g., wind turbine maintenance, healthcare tech).

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- Programs:
    - KompetenceLøft: SME grants for digital/green training.
    - Senior til Nyt: Reskilling elderly for tech roles.
    - Green Jobs Hub: Wind energy and circular economy training.
    - Employer-led initiatives like Erhvervsklasser (firm-shaped vocational courses).

The 2020–2024 update (Region Sjælland, 2020) prioritizes retaining youth talent via local education (e.g., Roskilde University) and a Sjælland Skills Database to address labour shortages.

Local Level (Kalundborg Kommune)

Shifting to Kalundborg Municipality, which as a geographical level of administration has a decisive role in directly intervening to the local labour market, several strategies have been recently adopted. The main challenges that Kalundborg labour market is currently facing in the context of the twin transition include the following. There is a skill shortage, since the demand for high skilled jobs, mainly driven by the Symbiosis project and the biopharma industry in the area, cannot be satisfied by the local workforce. That is, the local workforce supply has not kept pace and many jobs are filled by commuters or outsiders, leaving critical gaps in skilled and technical roles. To address these gaps, the municipality is actively promoting the local labour market in other Danish regions and internationally, which then creates issues around language and cultural integration. Moreover, the growth of the local labour market has forced the housing market to its limits, while concerns are raised about how to manage the accommodation of workers with short-term contracts, such as in construction. The housing market barriers may influence, among other factors, the fact that newly employed do not move permanently to Kalundborg.

In particular for the twin transition, while several firms in Kalundborg have the potential to "green" their production, the lack of adults with green skills is a barrier. In terms of digital transition, there is a noticeable lack of digital and AI skills, particularly in the municipality workforce. Thus, the local production structure needs adults with green and digital skills, which could be satisfied either by training the local workforce or continuing with the re(al)location of workers from other areas, within and outside of Denmark, although posing new challenges in the municipality (housing, infrastructure, welfare). Overall, it is argued that local labour supply has not matched the strong job creation, driven by the Symbiosis project, the robust growth of manufacturing, and the presence of large corporations in the area. The main issues related to this skills mismatch are housing shortages, insufficient local talent, integration of international workers.

Among the policies, the Kalundborg Municipality's Development Strategy Towards 2035 (Kalundborg Kommune, 2023) sets out that the municipality seeks to strengthen partnerships between businesses, schools, and universities to align education with labor market needs and attract skilled workers, including international talent, in terms of labour market. Kalundborg Municipality is in a period of significant growth, with business development in high gear, particularly in biotech and energy. The strategy toward 2035 focuses on maintaining and expanding this development through strong partnerships between businesses, educational institutions, and the municipality. Efforts are made to attract and retain skilled labor—both nationally and internationally—and ensure access to education for all citizens.

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In particular, the municipality aims to expand Kalundborg campus, hosting universities (e.g., Absalon Professionshøjskole) and research institutions to retain talent. To address labour shortage and skills mismatch, it aims to attract international talent, for example via Alliance Biotekbyen for biosolutions (an ecosystem partnership for biosolutions created in 2020 by the Danish Chamber of Commerce, companies and research institutions), support lifelong learning and upskilling programs and promote apprenticeships, internships, and student jobs in local industries. The municipality seeks to implement a digitalisation strategy, with focus on staff upskilling. In terms of project-based initiatives, the municipality participates in the EU project "Talent to a Green Denmark", seeking to help SMEs attract foreign workers with green skills.

Considering that Kalundborg faces skill shortages in biotech and energy (driven by the Symbiosis project and PtX Cluster), with housing shortages complicating international recruitment, the key initiatives include the following. In terms of education, to expand Kalundborg Campus (STEM, biotech) and EU projects like Talent to a Green Denmark for SME upskilling.

Regarding digitalization, efforts for automation in public services (e.g., chatbots) and VR training for remote workers. In terms of specific initiatives, the following are illustrative of the efforts of the municipality. First, Kalundborg campus, that is a unified education hub with universities, vocational schools, and corporate R&D, focusing on STEM, biotech, and energy sectors to align with industry needs. Second, several biosolutions and energy clusters have been established in the area. On the one hand, Kalundborg Symbiosis, which is a world-leading industrial symbiosis, with activities such as waste heat reused for district heating, established in 1972. Since then, it has created and will create more green jobs, raising the concern about whether these jobs can be absorbed by the local labour market. On the other hand, the PtX Cluster Zealand, which is a green hydrogen production from renewable energy. In terms of supporting digital and green skills, the municipality has initiated training programs in sustainability, digitalization, and advanced manufacturing, while also deploying partnerships with Knowledge Hub Zealand for innovation in life sciences.

An illustrative case study of the synergies between the Sjælland Region and Kalundborg Municipality is the efforts of the wider region to satisfy the emerging labour market demands in the occasion of the construction of Femern Tunnel which is currently built to connect Germany and Denmark. Specifically, the region and the municipality established new courses of tunnel engineering at Kalundborg Tech College in order to provide the regional labour market with 5,000 skilled workers needed for construction between 2024 and 2029, under the project Connection Workforce Pipeline (Region Sjælland, 2020). Important here is the international collaboration established, as the project offered joint certifications with VET schools from Schleswig-Holstein in Germany.

United Kingdom

North-East Scotland remains Europe's most concentrated hub for offshore oil and gas. The region's labour market is therefore balanced between the employment the sector provides and the strategic commitment—at both UK and Scottish levels—to reach net-zero greenhouse-gas emissions by 2045.

North-East Scotland is actively pursuing a just energy transition, with policies focused on managing the shift to a low-carbon economy while ensuring fairness for affected

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communities, workers, and businesses. A key component is the £500 million Just Transition Fund for the North East and Moray, supporting projects that contribute to the region's net-zero goals and creating new opportunities in green energy, skills, and infrastructure.

Key Policies and Initiatives:

- Just Transition Fund: A £500 million, ten-year commitment to support projects in the North East and Moray that aid the transition to a net-zero economy.
- Scottish Government's Just Transition Planning Framework: This framework guides the development and implementation of policies and projects to ensure a fair and inclusive transition.
- Energy Transition Fund: Supports key projects in the region and is working with the UK Government on a new Regional Skills Pilot scheme.
- Offshore Wind Investment: Up to £500 million is being invested to support the expansion of offshore wind, creating high-quality jobs and supporting the development of a competitive offshore wind economy.
- Skills Development: The region is prioritizing skills investments through initiatives like the industry-led Offshore Energy Skills Passport and the Energy Transition Skills Hub.
- Hydrogen Economy: The Hydrogen Action Plan supports the development of both renewable and low-carbon hydrogen, with a target of 5 GW of production by 2030.
- Grangemouth Just Transition Plan: A draft plan was published for public consultation in November 2024, with a £25 million Grangemouth Just Transition Fund announced in February 2025.
- Just Transition Commission: The Commission's advice continues to guide the Scottish Government's work on just transition planning.
- Climate Change Act 2024: Maintains a commitment to just transition principles, ensuring that the costs and benefits of climate action are shared fairly.

Serbia

Serbia, as an EU candidate country, is in the early stages of aligning its energy and labour market policies with EU standards. The Serbian National Energy and Climate Plan (NECP) is under development, with support from EU instruments such as the Instrument for Pre-Accession Assistance (IPA) (Energy Community, 2022). Coal mining regions such as Kolubara face long-term transition challenges, including limited economic diversification and weak institutional capacity. Current labour market policies remain largely reactive, with insufficient coordination between education providers, labour offices, and regional authorities (Stanojević & Stojanović, 2022). Nevertheless, donor-funded pilot projects and the involvement of international organisations (e.g., UNDP, ILO) offer potential avenues for developing more integrated and inclusive strategies.

Serbia, like many other countries, is facing the challenges and opportunities of the twin transition - the simultaneous shift towards a green economy and digital transformation. These structural changes are reshaping the demand for skills, the nature of jobs, and the functioning of the labour market. In general, labour market policies in Serbia are implemented by the Public Employment Service (National Employment Service - NES) and consist of two components: active labour market policies and passive labour market policies. Active labour market policies encompass a set of state interventions designed to help specific groups find

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suitable employment or directly create jobs for them. On the other hand, passive labour market policies tend to ensure the preservation of consumption during periods of unemployment.

Measures and services within the active labour market policies in Serbia are divided into seven programme groups:

- Mediation in employment and provision of support for employment
- Professional orientation and counselling on career planning
- Measures of active job search
- Additional education and training
- Subsidized employment and self-employment
- Public works
- Active employment policy measures for persons with disabilities who are employed under special conditions

The first three programme groups are classified as labour market services. Services, while useful, have a limited potential to help the unemployed in declining sectors for two reasons. First, compared to the financial measures, services have much lower costs per person and consequently have little effect on employability of their users. Second, services are aimed at all unemployed people rather than those losing their jobs due to the green transition. Some examples of services are Job fairs, Job clubs, Active job search training, Self-efficacy training, etc. The last two programme groups also have a limited impact due to their focus. The Public Works programme is predominantly directed to the unskilled and low-skilled unemployed often with multiple vulnerabilities, while the ultimate programme group is specifically designed for persons with disabilities. Therefore, the most effective measures in the context of the twin transitions come from the two programme groups: Additional education and training and Subsidized employment and self-employment.

Measures under the Additional education and training are invaluable for workers in declining sectors as they can offer various upskilling and reskilling opportunities. This programme group includes different types of training, although some are less relevant to the green transition. Measures such as Professional practice and Internship are dedicated to youth and persons without working experience; Functional elementary education for adults targets unskilled labour; while Training tailored to the employer's workforce needs is aimed at those who already have a job. In context of the green transition following measures are important: Programme for acquiring practical knowledge, Training for the labour market, and Training at the employer's request for unemployed individuals.

The aim of the Programme for acquiring practical knowledge is to ensure that participants acquire practical knowledge by performing specific tasks at the employer's workplace. It is designed to enhance the employability of the unemployed within or, particularly important in this context, outside their occupations. One of the specific target groups is unemployed with secondary education who lack adequate and applicable knowledge, skills and competencies to perform specific tasks, i.e. who need new knowledge and skills. The measure lasts from three to six months, during which the employer is reimbursed for participants' salary costs. In the recent period, the annual number of participants in the measure was approximately 500.

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Training for the labour market also aims to raise the level of employability of the unemployed, but with specific attention to the needs of local labour markets. Hard-to-employ unemployed individuals who want to enhance their existing skills or acquire new ones are among the target groups. The measure is implemented in accordance with the annual Training catalogue, under which each local NES branch offers, on average, from 1 to 15 different training courses. Training for the labour market is fully funded by the NES, which reimburses training providers and pays participants a monthly allowance as well as transportation costs. The annual number of participants in recent times was around 1,000.

Similar to the Training for the labour market, the Training at the employer's request for unemployed individuals also aims to enable the unemployed to perform specific tasks and jobs. However, the Training at the employer's request is implemented only if there is no person on the NES records with the knowledge and skills needed by the employer who contacted the NES. In such cases, the NES organises training at the employer's place and participates in financing the training costs. It also pays a monthly allowance and travel expenses to the unemployed who participate in the training. In order to avoid malpractices, the employer is obliged to employ at least half of the unemployed who have successfully completed the training. Since it depends on the employers' demand, the number of participants varies significantly by year, but it hovers around 500.

Measures within the Subsidised employment programme group belong to the direct job creation measures that can play a crucial role in mitigating the adverse effects of the twin transition. In Serbia, subsidies are classified into two categories: (1) to employers for hiring unemployed individuals and (2) for self-employment. Both types of subsidies could be utilised to create more green jobs and support local economic diversification, which is especially vital in mono-industrial regions such as Lazarevac or Kolubara. Subsidies for the employment of unemployed persons from the hard-to-employ category is the full title of the first measure within this programme group. It aims to provide support for the employment of hard-to-employ unemployed persons to business entities that belong exclusively to the private sector. Hard-to-employ persons are defined by the National action plan for employment, which means that it can be extended to those who have lost their jobs in the declining sectors. The subsidy per employed person depends on the level of development of the region and ranges from 230,000 RSD to 280,000 RSD (approximately 2,000 EUR to 2,400 EUR). Unfortunately, as one of the municipalities of the Belgrade region, Lazarevac is classified among the most developed areas, meaning it qualifies for the lowest level of subsidy. The annual number of participants ranges between 3,000 and 3,500.

Self-employment subsidies goal is to provide support for the employment of unemployed persons registered with the NES through the allocation of subsidies for self-employment and encouraging the development of entrepreneurship. This measure could be especially beneficial for those who lose jobs in declining sectors in the vicinity of Lazarevac. It will open the possibility for the development of small local entrepreneurs, especially in agricultural occupations and craftsmanship. The envisaged one-off financial assistance of 380,000 RSD (around 3,300 euros) is relatively generous. The measure is popular on the national level, with approximately 4,000 individuals benefiting annually. Active labour market policies in Serbia have two important weaknesses. First, the overall stagnation in expenditure on ALMPs, which amounts to 0.1% of GDP, remains well below the EU average (0.4%). Second, the institutional capacity of the NES is constrained by limited resources and staff. The ratio of employment

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counsellors to unemployed persons in Serbia is 1:538, which is far above the threshold considered to be the ideal ratio of 1:100. The impact of passive labour market policies is also modest, as they provide only limited financial assistance to those who have lost their jobs. Unlike many other European countries, where unemployment benefits have two complementary components: insurance-based and unemployment assistance, Serbia's system relies solely on the former. Furthermore, recent methodological changes have reduced benefit amounts and curtailed future growth. All things considered, significant efforts are required to ensure that labour market policies in Serbia can effectively address the challenges of the twin transition.

7. Summary and conclusions

The objective of this document is to present a review of the state of the art regarding policies and strategies to address Job Creation and Destruction (JCD) associated with the energy transition and the full development of the digital economy and artificial intelligence technologies in Europe.

The document is structured in three parts. The first part involves an in-depth review of the academic literature using an artificial intelligence support system to select the most relevant works. The second part of the document then completes the academic overview with a more detailed analysis of active labor market policies (ALMP) related to the twin transitions. Finally, the document is completed with a specific review of the actions carried out by the countries that are part of the ISABEL Project Consortium.

The most important conclusions that can be drawn from this overview can be summarized in the following main ideas:

- Education and lifelong learning are central pillars, as highlighted across numerous studies. It is critical to develop a highly skilled workforce capable of leveraging emerging technologies in clean energy, AI, and digital systems. This entails integrating digital and green competencies not only into higher education curricula, particularly in STEM disciplines, but also across vocational training and basic education levels. Moreover, continuous professional development is essential for the current workforce, emphasizing skills mapping and tailored upskilling programs to ensure adaptability and resilience in the face of rapid technological and environmental change.
- The transformation of work, driven by digitalization, has led to widespread adoption of remote and flexible work models. While such models provide opportunities for healthier and more flexible working conditions, they also introduce regulatory, social, and spatial challenges. Remote work influences organizational structures, working relations, urban mobility, and urban form. Policymakers must ensure that remote work is not precarious and that the environmental benefits of reduced commuting are not offset by increased urban sprawl, which could generate negative environmental externalities.
- Migration policies also play a strategic role. The EU must align immigration and social integration policies to facilitate the inclusion of migrants into sectors pivotal for the green and digital transitions. This requires targeted training programs, language support, and flexible integration pathways tailored to labour market needs.
- A significant concern is the emergence of territorial disparities and "green discontent," wherein regions bearing disproportionate costs of decarbonization perceive limited benefits

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from EU policies, fuelling political disaffection and populism. Digitalization similarly risks exacerbating regional inequalities despite infrastructure convergence, as gaps persist in digital skills and usage. This underscores the importance of developing policies that minimize the social and territorial impact of the green agenda. While progress is being made toward the environmental sustainability of the European economy, policies must be developed that minimize its impact and avoid sparking discontent that could hinder the objectives and backfire on the European Union itself.

- Europe's territorial heterogeneity underscores the necessity of smart specialization strategies. Policies must be localized, leveraging regional strengths and sectoral interdependencies, to ensure an inclusive and balanced transition across diverse European territories.

Active labour market policies are interventions aimed at assisting workers in becoming employed or maintaining jobs. Using the Eurostat classification, ALMPs (named LMP measures by Eurostat) include Training; Employment incentives; Sheltered and supported employment and rehabilitation; Direct job creation and Start-up incentives. Typically, these programmes are evaluated using advanced econometric techniques, attempting to isolate ex-post net effects of the intervention, comparing the actual individual labour market outcomes of the intervention with the hypothetical (counterfactual) individual outcomes without the intervention.

ALMPs are widely used instruments of economic and labour market policy. Their main advantage is that, by targeting the members of the labour force at risk, rather than the entire economy, they avoid the macroeconomic disruptions that can be potentially caused by generally expansionary fiscal or monetary policy. In the context of green transition, the role of most ALMPs increases as the large number of jobs, often crucial for the well-being of a population within a region, might be under elevated risk.

Regarding policy evaluation, the evidence from analysed studies reveals significant heterogeneity in ALMP effectiveness across intervention types, contexts, and implementation approaches. Entrepreneurship and self-employment programs consistently demonstrate the strongest positive effects across different settings, while public works programs show limited or negative impacts. Training programs exhibit mixed results, highly dependent on design quality and economic conditions, with workplace-based training generally outperforming classroom instruction. Job search assistance shows moderate positive effects when properly implemented, while wage subsidies demonstrate conditional effectiveness depending on program design and economic context. Cross-country analyses suggest that implementation quality, institutional capacity, and targeting precision matter more than aggregate spending levels. Regional studies highlight the importance of local economic conditions and employer engagement in determining program success. The evidence emphasises that effective ALMPs require careful design, appropriate targeting, and supportive institutional frameworks, rather than simply increasing program expenditure. However, without adequate funding for the challenge at hand, the impact of ALMP is likely to remain limited.

Finally, across the ISABEL partner countries, significant policy reforms are underway to manage the social and economic impacts of the twin transition. Greece and Spain have developed robust national frameworks, with Greece focusing on phasing out lignite through its National Energy and Climate Plan (NECP) and territorial plans targeting economic

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diversification and reskilling in affected regions. Spain, meanwhile, has enacted the Just Transition Strategy and pioneering legislation like the Climate Change and Energy Transition Law, aiming for carbon neutrality and massive investments in renewables and green hydrogen, while ensuring social inclusion through retraining and regional development initiatives.

Poland's path remains complex, as coal still plays a dominant role despite commitments to phase-out, particularly in regions like Silesia. Policies such as the Social Agreement on Hard Coal Mining, the Programme for Silesia, and the Territorial Just Transition Plan reflect attempts to balance economic restructuring with social stability. However, inconsistencies between national energy strategies, political uncertainty, and limited vocational training funding hamper cohesive action. Denmark, by contrast, leverages its flexicurity model and strong social dialogue to manage labour market transitions, focusing on green and digital skills development, though spatial disparities like those in Kalundborg reveal local mismatches between booming green industries and workforce availability, compounded by housing constraints.

The United Kingdom and Serbia also exemplify divergent experiences. The UK's transition policies are marked by industrial strategy shifts, skills initiatives, and region-specific interventions, though political shifts have introduced some uncertainty. Serbia, still aligning its frameworks with EU standards, faces early-stage challenges in coal-dependent areas, with limited institutional capacity and fragmented labour market interventions.

Across all countries, common threads include efforts to promote economic diversification, green and digital skills training, and social inclusion, yet practical implementation varies widely depending on governance capacity, regional contexts, and socio-economic legacies.

The outputs of this deliverable will be disseminated to the scientific community through various publications and events. They are already submitted to be presented with dedicated publications to the AECR's Annual Congress, at Pamplona, Spain and to the 2025 RSA Regional Futures Conference at London, GB.

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Annex: summary of the discussion in the co-creation workshop (July 2025)

To enrich the research process and insights of D2.3, we organized a co-creation workshop on the 10th of July 2025. The exact and detailed procedure, participants and feedback of this first co-creation workshop of ISABEL are described in D2.4. The feedback received and how we addressed can be found in this annex.

In the discussion of the co-creation workshop were remarked that the literature review faced challenges due to the vast number of papers available. Using AI techniques, around 140 highly relevant papers were selected based on specific research questions. The number of studies on this topic has grown rapidly in recent years. Key policy recommendations from the literature include:

- Education and Continuous Training: Emphasis on lifelong learning for current workers, not just future generations, to prepare for ongoing transitions.
- Immigration: Immigrants can either support or hinder transformation depending on their skills and adaptability; selective immigration policies are important.
- Workplace Transformation: Digitalization will change company structures and urban mobility, which can synergize with green city initiatives.
- Green Discontent and Geography: Regional disparities and "left behind" areas must be considered in policy, linking green transition challenges with spatial inequalities.
- Heterogeneity in Regions: Smart specialization policies should be tailored to diverse regional contexts within the EU.
- Need for More Research: Current recommendations are general; more precise, territory-specific studies are needed to design effective policies.

Most reviewed papers are recent (last three years), indicating rapid evolution in the field. This academic insight will be complemented by analysis of actual policy measures currently underway.

A brief overview of social and economic impacts from the ongoing digital and green transitions across several countries, highlighting key policies and challenges:

- Greece: Focuses on economic diversification and reskilling affected labor forces through just transition plans and vocational training programs. Challenges include limited participation of older, low-skilled workers and uneven local administrative capacity.
- Spain: Implements a just transition strategy with pioneering legislation (climate change and transition law), large investments in renewables (e.g., green hydrogen), and social inclusion through retraining and regional development initiatives.
- Poland: Faces complex political context with coal still central, especially in Silesia. Policies include social agreements and just transition plans balancing economic restructuring with social stability. Challenges include inconsistent national strategies and limited vocational training funding.
- Denmark: Utilizes the "flex security" model with strong social dialogue, focusing on green and digital skills development and addressing regional mismatches between industry growth and workforce availability.

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- Serbia: Undergoes structural changes due to twin transitions, reshaping skill demands. Public employment services implement active and passive labor market policies, supporting marginalized groups through vocational training, employment mediation, and subsidized work.
- United Kingdom: Policies emphasize industrial strategy shifts, region-specific skill initiatives, but face uncertainties due to political changes.

The discussion highlighted the lack of policy evaluation. Repeatedly, a clear gap emerges in research: there is a strong need for evaluative frameworks and quantitative methods to measure the actual impact of policies at regional or national levels. So far, there have been very few attempts to assess or quantify the effects of these policies on the issues at hand. This represents a significant scientific gap currently. Internally, from an academic perspective, the literature review shows that this research space is rapidly expanding—good news because it means growing interest and opportunities for contributions in this field. However, the number of research groups working on these topics is also increasing fast, so it's crucial to leverage our current results and contributions quickly. If not, other groups might fill the gap first or produce better insights. In short, the literature review has identified a clear opportunity for impactful research, but this window may close in two to three years as more teams enter the space.

ISABEL will focus on evaluating and assessing strategies based on basic guiding principles rather than detailed outcomes. The evaluation will follow a co-creation approach through living labs, involving local stakeholders—such as regional authorities, companies, and education providers—in shaping and co-evaluating these strategies across the six regions. Additionally, the strategies may be reviewed at a higher level by EU Commission representatives. However, due to time constraints, the project does not expect to measure concrete results like actual skill gains or training outcomes within the project timeframe.

The issue of spatial inequalities versus individual inequalities is intricate and intertwined—both are connected and influence each other. One key difference between green and digital transformations is that green transformation's impacts are localized and visible within specific places and communities, making the resulting inequalities more tangible and thus more likely to produce discontent. In contrast, digital transformation spreads its impacts across many sectors and locations—such as jobs being outsourced from one city to another—making spatial effects harder to pinpoint and less likely to generate visible discontent. This explains why spatial inequalities often provoke stronger discontent than more diffuse inequalities. While this topic is philosophically interesting, it may not be the most practical focus for now.

Exploring the correlation between place-based and individual-based perspectives opens new research avenues. Individuals are deeply influenced by the specific places they live—local culture, habits, and identities—yet globalization, digital transformation, and AI promote more individualized and dispersed experiences. Balancing these territorial and individual factors is crucial to reliably understand the impacts on skills, job destruction, and creation.

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While the individual perspective on transitions is interesting, policy-making is inherently tied to geographical contexts due to practical constraints like funding. Therefore, policy focus should remain on place-based units rather than individuals. An important aspect for the ISABEL project is to explore how different regions' skill demands vary—whether regions need distinct or similar skills during the green and digital transitions. If skill needs differ, migration could serve as an adjustment mechanism, benefiting both sending and receiving areas. However, if regions compete for the same skills, this poses challenges for policy and regional development. Understanding these spatial skill dynamics and migration flows is crucial for effective policy design in Europe.

These and other ideas discussed in the co-creation workshop were taken into account in the final versions of the document. They will also be taken into account in the development of subsequent phases of the ISABEL Project. Some of the discussions are especially valuable for the future development of research projects derived from the Project, as well as for the final implementation of the living labs.

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