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The Strategic Dimension of Skills in the Clean Industrial Deal

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Executive Summary

In the competitiveness and energy transition battles, the European Union (EU) must master a determinant factor: skills. After the 2022 energy crisis, the competitiveness debate in Europe has been mostly focused on energy costs and the simplification agenda, whereas several surveys and reports (European Investment Bank, Eurobarometer, Organisation for Economic Co-operation and Development) show that for a majority of EU businesses the most acute issue and the biggest obstacle to investment is the insufficient availability of skilled staff. To succeed in delivering the twin low-carbon and digital transition, the EU needs to put workers and skills at the heart of the European project.

The twin transition is nothing less than a skills revolution, with lifelong learning and cross-sectoral collaboration front and center. Up to 4.8 million additional energy transition jobs could be created in Europe in key clean technologies by 2030, but this depends on skills availability, on the thorough implementation of the Green Deal 2030 framework and on EU's ability to retain domestic clean tech manufacturing capacities. While the energy transition is expected to be a net job creator in Europe, the ongoing crisis in traditional manufacturing sectors has been translating into almost 1 million jobs losses since 2019 and, by 2040, about 8 million people in a number of fossil-fuels related industries (coal, oil refineries and petrochemical industries, internal combustion engine cars) will need to be reskilled and upskilled for new roles, with countries in Central and Eastern Europe being particularly challenged. The EU and Member States must dedicate specific funding lines for skilling and reskilling, which can be estimated to be in the order of 17-25 billion euros for skills in the realm of the energy transition and clean industrial deal, amounts comparable to the firepower of the Just Transition Fund. The most sought skills pertain to the field of Science, Technology, Engineering and Mathematics (STEM) and vocational education and training (VET), but also to transversal occupations such as project management.

Following the Draghi report, the European Commission (EC) has included skills among the pillars of the Clean Industrial Deal, recognizing their strategic value for the success of the energy transition and industrial transformation. The Union of Skills could mark the beginning of a stronger European action to address the three most important challenges for the EU: a weakened performance on basic competences (mathematics, reading and science, but also digital skills), an aging workforce (with more than a third of workers in the electricity sectors being 50-74 years old), and ensuring a just transition across European regions. The overarching

objective should be a European skills vision for a truly European social and industrial policy, financed by a strong and forward-looking European budget.

Member States should commit more resources to boosting education systems, supporting life-long learning, incentivizing companies to provide trainings, while also taking a more active and systematic role in monitoring the evolution of skills needs and their availability on the market, the gap in existing education and training offers compared to business needs, the fluctuations of the jobs market, and put a specific focus on the just transition regions with heightened challenges in terms of industry restructuring and attracting new economic opportunities.

At the European level, the Net Zero Industry Academies (NZAs), whose mandate is to boost the EU's talent pipeline for manufacturing and deploying net-zero technologies in Europe, can be a true game changer—the timely and effective delivery of the energy transition is at stake. This means that they should be reinforced to ensure:

- An impact-driven and inclusive membership to deliver on European-wide skills intelligence coordination (identification of skills needs, jobs evolution, consolidating reporting on training expenses, etc.) and address the most urgent skills gaps and just transition aspects, considering sectoral and regional fast-evolving needs.
- Boosting access to industrial training platforms by identifying "EU Skills Champions"—companies willing to make available their industrial sites to EU skilling initiatives, hence encouraging mutualization of training infrastructure, a more efficient use of EU funds and reducing the time-to-competence across the EU.
- Emphasizing skills transmission channels to create a trickle-down effect of NZAs across the European territory and beyond (for instance via the Clean Industrial and Trade Partnerships with third countries) in terms of skills acquisition, for instance through initiatives like "train the trainers" or those focusing on cross-border infrastructure/energy projects (ex. offshore wind farms). A NZA should be dedicated to electricity grids, which are the bedrock of electrification and are facing unprecedented modernization and deployment needs across Europe in a short time span, and need a collective understanding of skills needs and supply, a beefed-up training ecosystem that can rely on existing best-in-class industrial training and simulation expertise in the EU.
- Create EU-level recognized "clean industrial pathways" by identifying common sets of skills among several industries that can serve as ladders to enable mobility from one sector to another, to better manage labour market fluctuations and promote modular training.
- Raising the profile of vocational education and training around Europe, through European-wide certification schemes, European

funding for apprenticeships in critical industrial sectors and just transition regions.

- Attracting and supporting excellent foreign talents and people who have the right skills for European industries, through dedicated visas (e.g. via the EU Talent Pool), mobility schemes, and recognition of qualifications.

Résumé

Dans les batailles de la transition énergétique et de la compétitivité, l'Union européenne (UE) doit maîtriser un facteur déterminant : les compétences. Après la crise énergétique de 2022, le débat sur la compétitivité en Europe s'est focalisé sur les coûts de l'énergie et l'agenda de simplification, alors que plusieurs enquêtes et rapports (Banque européenne d'investissement, Eurobaromètre, Organisation de coopération et de développement économiques) montrent que pour la plupart des entreprises de l'UE, le problème le plus crucial et le principal obstacle à l'investissement est le manque de personnel ayant les bonnes compétences. Pour réussir la double transition bas-carbone et numérique, l'UE doit mettre les travailleurs et les compétences au cœur du projet européen.

La double transition énergétique et numérique n'est rien de moins qu'une révolution des compétences, avec au cœur l'apprentissage tout au long de la vie et la collaboration intersectorielle. D'ici 2030, jusqu'à 4,8 millions d'emplois additionnels pourraient être créés en Europe dans certaines technologies bas-carbone clés, mais cela dépend de la disponibilité des compétences, de la mise en œuvre rigoureuse du cadre 2030 du Pacte vert et de la capacité de l'UE à retenir des capacités de production de technologies propres sur son sol. Alors que la transition énergétique devrait être créatrice nette d'emplois en Europe, la crise actuelle des secteurs manufacturiers traditionnels s'est traduite par près d'un million de pertes d'emplois depuis 2019 et, d'ici 2040, environ 8 millions de personnes dans plusieurs industries liées aux combustibles fossiles (charbon, raffineries de pétrole et industries pétrochimiques, voitures à moteur à combustion interne) devront se reconvertir et monter en compétences pour occuper de nouveaux postes, les pays d'Europe centrale et orientale étant particulièrement confrontés à ces difficultés. L'UE et les États membres doivent consacrer des lignes de financement spécifiques à la formation et à la reconversion professionnelle, qui peuvent être estimées entre 17 et 25 milliards d'euros pour les formations dans le paramètre de la transition énergétique et des industries propres – des montants comparables à la puissance financière du Fonds pour une transition juste. Les compétences les plus recherchées relèvent du domaine des sciences, de la technologie, de l'ingénierie et des mathématiques (STEM), de la formation technique et professionnelle, mais aussi des métiers transversaux tels que la gestion de projet.

À la suite du rapport Draghi, la Commission européenne a inscrit les compétences parmi les piliers du Pacte pour une industrie propre et reconnu leur valeur stratégique pour la réussite de la transition énergétique

et de la transformation industrielle. L'Union des compétences pourrait marquer le début d'une action européenne plus résolue pour relever les trois défis les plus importants pour l'UE : l'affaiblissement des performances dans les compétences de base (mathématiques, lecture et sciences mais aussi compétences numériques), le vieillissement de la main-d'œuvre (plus d'un tiers des travailleurs du secteur de l'électricité ayant entre 50 et 74 ans) et la nécessité d'assurer une transition juste dans les régions européennes très touchées par les enjeux de restructuration du tissu économique. L'objectif principal devrait être une vision européenne des compétences au service d'une véritable politique sociale et industrielle européenne, financée par un budget européen fort et tourné vers l'avenir.

Les États membres devraient consacrer davantage de ressources au renforcement des systèmes éducatifs, au soutien de la formation tout au long de la vie et à inciter les entreprises à proposer des formations, tout en jouant un rôle plus actif et plus systématique dans le suivi de l'évolution des besoins en compétences et de leur disponibilité sur le marché, des écarts entre les offres d'éducation et de formation existantes et les besoins des entreprises ainsi que les fluctuations du marché de l'emploi. Une attention particulière devrait être accordée aux régions concernées par la transition juste qui font face à des défis accrus en termes de restructuration industrielle et d'attraction de nouvelles opportunités économiques.

Au niveau européen, les académies « zéro net » (NZA), dont le mandat est de dynamiser le vivier de talents de l'UE en vue de la production et du déploiement des technologies bas-carbone en Europe, peuvent changer la donne. Elles devraient être renforcées afin de garantir :

- Une participation inclusive et axée sur l'impact, avec une mission générale de coordonner un travail d'intelligence et de veille sur les compétences à l'échelle européenne (identification des besoins en compétence, des évolutions des emplois, consolidation du *reporting* sur les dépenses pour la formation, etc.), de répondre aux lacunes de compétences les plus urgentes ainsi qu'aux enjeux de transition juste, en prenant en compte les besoins sectoriels et régionaux en rapide évolution.
- L'amélioration de l'accès aux plateformes de formation industrielle en identifiant les « champions européens de la formation », c'est-à-dire des acteurs industriels prêts à mettre leurs sites industriels à la disposition des initiatives européennes de formation, encourageant ainsi la mutualisation des infrastructures de formation, une utilisation plus efficace des fonds européens et la réduction des délais d'acquisition de compétences dans l'ensemble de l'UE.
- La promotion des canaux de diffusion des compétences afin d'amplifier les retombées des académies « zéro net » sur l'ensemble du territoire européen et au-delà (par exemple dans le cadre des partenariats industriels propres avec les pays tiers) en termes d'acquisition de

compétences, par exemple par le biais d'initiatives telles que la « formation des formateurs » ou celles axées sur des projets transfrontaliers d'infrastructures/d'énergie (comme les parcs éoliens *offshore*). Une NZA devrait être dédiée aux réseaux électriques, qui constituent le fondement de l'électrification et sont confrontés à des besoins de modernisation et de déploiement sans précédent à travers l'Europe dans un court laps de temps. Il est nécessaire de développer une compréhension collective des besoins et de l'offre de compétences, ainsi qu'un écosystème de formation renforcé qui peut s'appuyer sur la meilleure expertise européenne en matière de formation industrielle et de simulation.

- La création de « parcours de carrière bas-carbone » reconnus au niveau européen, en identifiant des socles de compétences communes à plusieurs industries/fonctions qui pourraient servir de passerelle pour passer d'un secteur à l'autre, afin de mieux gérer les fluctuations du marché du travail et promouvoir la formation modulaire.
- Revaloriser la formation technique et professionnelle en Europe grâce à des systèmes de certification européens, des financements européens pour l'apprentissage dans les secteurs industriels critiques et dans les régions concernées par la transition juste.
- Attirer et soutenir les talents d'excellence ainsi que les personnes possédant les compétences adéquates pour les industries européennes venant de l'étranger, grâce à des visas dédiés (par exemple *via* le Réservoir européen de talents), des dispositifs de mobilité et la reconnaissance des qualifications.

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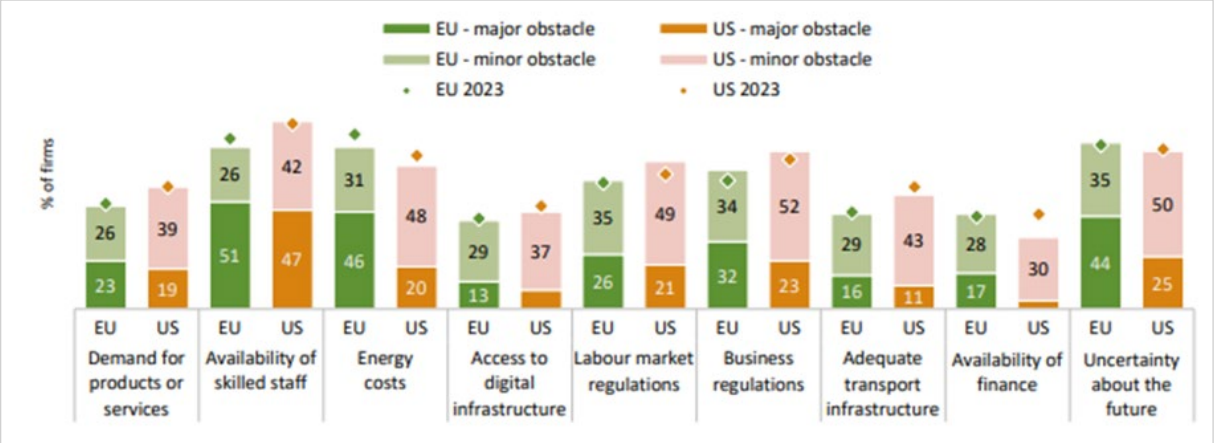
Introduction:
No skills, no Deal

The importance of skills has been largely overlooked in the European competitiveness discussion despite its urgency. According to data from the Eurobarometer[1], more than 65% of small and medium-sized enterprises (SMEs) and 72% of large companies highlight that finding employees with the right skills is their most serious problem, whereas regulatory obstacles and administrative burden (driving EU Commission's simplification agenda) come second and only far behind (only about 30% of SMEs and 26% of large companies). Based on the 2024 European Investment Bank (EIB) survey[2], skills are the most important obstacle to investment for EU firms (51% say it is a major obstacle), ahead of energy costs (46%) and uncertainty (44%). In the Organisation for Economic Co-operation and Development (OECD), skills gaps[3] (defined as mismatches between skills available and skills needed in a firm) emerge as the single most important barrier to business transformation for the next 5 years. They are especially reported by companies in the manufacturing sector, where technological change has accelerated and technical skills are key.

Figure 1. Obstacles to investment for EU and US firms



Source: EIB Investment Survey 2024, EIB.

1. "Eurobarometer - SMEs and Skills Shortage", European Commission, November 2023, available at: https://europa.eu.
2. "EIB Investment Survey 2024: European Union Overview", European Investment Bank, October 2024, available at: www.eib.org.
3. "Understanding the Skill Gaps in Firms", Organisation for Economic Co-operation and Development, December 2024, available at: www.oecd.org.

The energy and digital transitions will impact jobs through new jobs creation, jobs substitution between sectors, job destruction and changes in the tasks of existing roles, which will require updating the skills of current employees.

To deliver on the energy transition, the biggest skills challenge is to accelerate the growth of Vocational Education and Training (VET) and Science, Technology, Engineering and Mathematics (STEM) graduates to cover the overall industrial need for talent. Energy Transition Jobs (ETJs) will also require transversal skills such as soft skills (communication, negotiation, decision-making, etc.), sustainability and environmental reporting, safety and compliance knowledge or project and process management. Project management is a critical competence: as companies engage in large-scale projects, project management is essential for keeping costs in check, delivering on time, coordinating a vast array of suppliers and large teams.

The demand for digital skills in the energy sector has also been rising and, broadly, only half of companies find candidates who meet their digital skills requirements. Advances in automation, robotics, and AI-driven systems will be increasingly used to improve and innovate production processes in net-zero technologies, leading to the development of the next generation of smart low-carbon technologies. IT and cybersecurity specialists with expertise in data management, data analysis, etc., will be needed to operate smart photovoltaic (PV) systems, perform predictive maintenance on renewables installations and protect critical installations.

A global race for skills is unfolding. About 70 million people work in energy globally (around 2% of global employment) and employment in the energy sector has been outperforming employment in the broader economy, led by investments in clean energy technologies, which have reached the 2 trillion $ threshold globally. Projections of energy employment towards 2030 show a positive trend for job additions, with important job creation potential in the construction and manufacturing of clean energy technologies. For advanced countries, the issue is to boost the pool of STEM profiles and VET graduates to achieve operational excellence in clean techs and deliver at scale, while reinforcing their capacity to innovate and disrupt (especially in EU's case which is overfocused on mature technologies, as per the Draghi report).

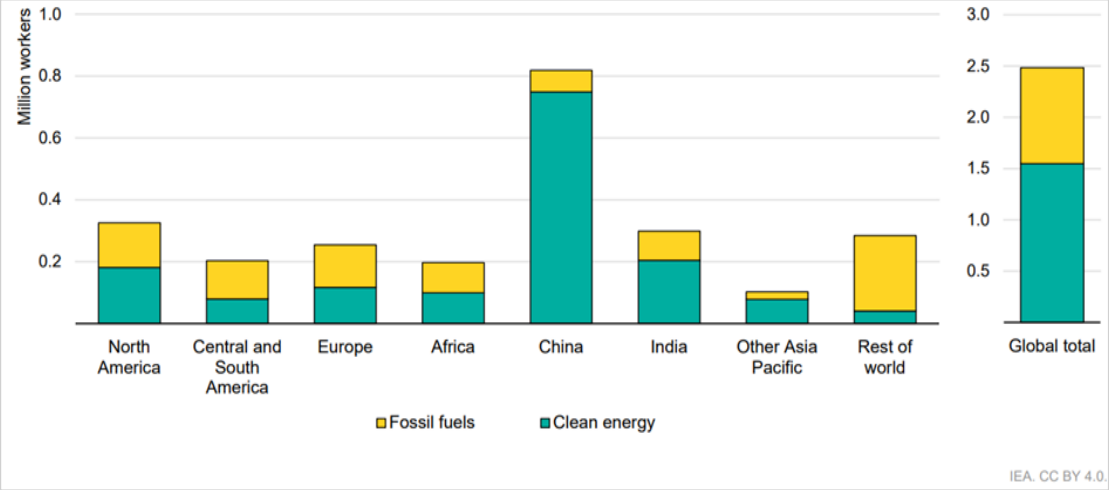
For China, whose working-age population is expected to fall from 1 billion people to 600 million people in the next 40 years[4], its challenge is to further increase the automation rate in its economy (it already went from being the 21st most automated economy in the world in 2017 to being the 5th one in 2022) and to attract more workers from abroad to be able to sustain

4. T. Slok, R. Shah and S. Galwankar, "China's Demographic Challenges", Apollo Global Management, August 2024, available at: www.apolloacademy.com.

its industrial ambitions. For fossil fuels-producing countries, the challenge will be to transition the existing workforce towards ETJs. Finally, for developing countries with increasingly important shares of working-age population, the focus is on attracting investments in order to create jobs locally and on strengthening the level of basic skills, while promoting more VET and STEM education.

Job creation in the energy sector is reflective of the political choices made by national governments, and will have deep implications in terms of the just transition and capacity to attract and build up the pipeline of future talents. According to the International Energy Agency (IEA), China represents 85% of global PV manufacturing jobs, 50% of global wind power jobs (while wind jobs growth in Europe and United-States [US] slowed down due to projects cancellations) and about 80% of global electric vehicles (EV) battery manufacturing jobs, while 90% of the jobs created in its energy sector are related to clean energy. The Middle East countries have concentrated 80% of the energy job additions in the fossil fuels sector. Emerging and developing markets are suffering from low clean energy investment but have a dominant role in the critical raw materials (CRM) supply. Indeed, Africa represents by far the largest market for CRM mining (lithium, copper, nickel, cobalt) employment, with more than 400,000 workers, followed by Central and South America with 130,000 jobs in this sector. In order to reach the energy transition targets and policies set for 2030, the total number of workers in this sector globally will have to increase from almost 800,000 currently to 1 million people.

Figure 2. Changes in energy employment by sector and region, 2022-2023



Source: World Energy Employment 2024 report, IEA.

The EC has rightly identified skills as a pillar of the Clean Industrial Deal in February 2024 and recognized its strategic value for the success of the energy transition and industrial transformation agenda. This is a good but late step forward, and it is not enough. The time is to deliver concrete results across European skills initiatives, align Member States' actions and

means, provide direction and exploit synergies. The EU is also expected to weigh in on the global talent race by attracting the brightest minds for innovation and nurturing excellent execution skills for delivering the energy transition on the ground.

The twin transition is nothing less than a skills revolution, with lifelong learning and cross-sectoral collaboration front and center. This note seeks to assess the status of play in terms of job creation opportunities and challenges linked to the energy transition and industrial low-carbon transformation, and whether the EU will have the skills it needs to operate these. And more importantly, how can the EU boost its skills ecosystem to turn the energy transition into an opportunity for workers and maintain a technological and industrial edge?

The future of energy jobs in the EU: a tale of growth tainted by uncertainties and disparities

The EU counted 7.2 million workers in the energy sector[5] (representing around 3.5% of the total EU employment), with around half of them in clean energy sectors. The number of workers in clean energy sectors have been rising fast, with employment in the battery industry doubling between 2015 and 2022,[6] and jobs in the solar sector increasing tenfold between 2016 and 2023, from 81,000 to 826,272 workers[7].

The job creation potential of net-zero technologies in the EU is difficult to accurately predict. It was estimated at 2.5 million additional jobs in 2021 based on the European Centre for the Development of Professional Training (CEDEFOP) projections[8] but could reach around 4.8 million additional ETJs by 2030 based on up-to-date industries' projections (see table 1), yet some of which could be overly optimistic (given slow uptake rates in sectors like low-carbon hydrogen). In addition, the extent to which this job addition potential will become reality depends on steadily following through with the implementation of the 2030 Green Deal framework and ensuring an increased stream of investments and funding towards the clean tech sectors. Europe's capacity to retain clean tech manufacturing industries on its territory, in a context of extraordinary challenges (Chinese overcapacities, high energy prices, weaponization of critical raw materials supply chains and technologies, etc), will be determinant for ETJs creation. A factor of uncertainty is the evolution of productivity in ETJs, which can be impacted positively by the deployment of artificial intelligence, but negatively by climate change—extreme weather patterns like heavy rain, drought, snow, and wind could reduce workers' productivity for the construction of grids or generation plants, such as nuclear and offshore, for example.

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5. "World Energy Employment 2024", International Energy Agency, November 2024.
6. M. Bielewski, A. Pfrang, D. Quintero Pulido, S. Bobba, B. Schade, A. Georgakaki, S. Letout, A. Mountraki and E. Ince, "Clean Energy Technology Observatory: Battery Technology in the European Union - 2024 Status Report on Technology Development, Trends, Value Chains and Markets", European Commission, Joint Research Centre, 2024, available at: https://data.europa.eu.
7. Based on Solar Power Europe's Jobs reports.
8. "The Green Employment and Skills Transformation: Insights from a European Green Deal Skills Forecast Scenario", Cedefop, 2021, available at: http://data.europa.eu.

Figure 3. Current number of employees vs. estimated number of employees by 2030 in key EU clean tech sectors, based on industries' projections

	Current n° of employees (est.)	Est. n° of employees in 2028-2030
Wind	370 000	514 000
Solar	830 000	1 100 000
EVs	230 000	800 000
Heat pumps	433 000	1 000 000
Grids	835 000	2 800 000
Nuclear	900 000	1 000 000
Clean Hydrogen	N/A	1 000 000
Biogas/biomethane	210 000	420 000
Total jobs	3 808 000	8 634 000
Additional green jobs by 2030	4 826 000	

Source: Ifri, based on data from Wind Power Europe, Solar Power Europe, Joint Research Center, Euroheat & Power, Eurelectric, Hydrogen Europe, European Biogas Association and NuclearEurope.

For example, Automotive Cells Companies (ACCs) gigafactory in Douvrin (France) employs 600 people, Panasonic's heat pumps production plant in Plzeň (Czech Republic) employs 700 people (expected to double in the next years due to new investments), Vestas employs 2,000 people in wind manufacturing sites in Poland (Goleniów, Szczecin), EDF's Hinkley point C construction has been employing up to 15,000 people at the peak building phase. Germany leads in solar employment at EU level with 154,000 workers.

The energy transition is also an opportunity to bring vitality to EU's regions and countries which have been suffering from deindustrialization and emigration. With about 50% of ETJs being in medium-skilled occupations, energy transition can be a driver for inclusive employment, with VET a major lever for reducing economic and social inequalities.

While the energy transition is expected to be a net job creator in Europe, an accumulation of announcements by the private sector pointing to job losses has become a source of anxiety, fueling populism throughout European democracies. The ongoing deindustrialization in traditional manufacturing sectors has led to 853,000 job losses between 2019 and 2023 in the EU, with the biggest losses in the Central and Eastern European countries (Poland, Czechia, Romania)[9]. After the recovery from the Covid-19 crisis (2021-2022), the EU's overall industrial production fell by 6% between August 2022 and September 2024, reflecting the major energy crisis and trade disruptions that happened over this period and which will probably continue to weigh on the industry due to EU-US trade tensions and China's overcapacities.

9. "EU Loses Almost a Million Manufacturing Jobs in Just 4 years", European Trade Union Confederation, March 2024, available at:www.etuc.org.

Figure 4. Evolution of EU industrial production (index 2021 = 100), 2007-2024

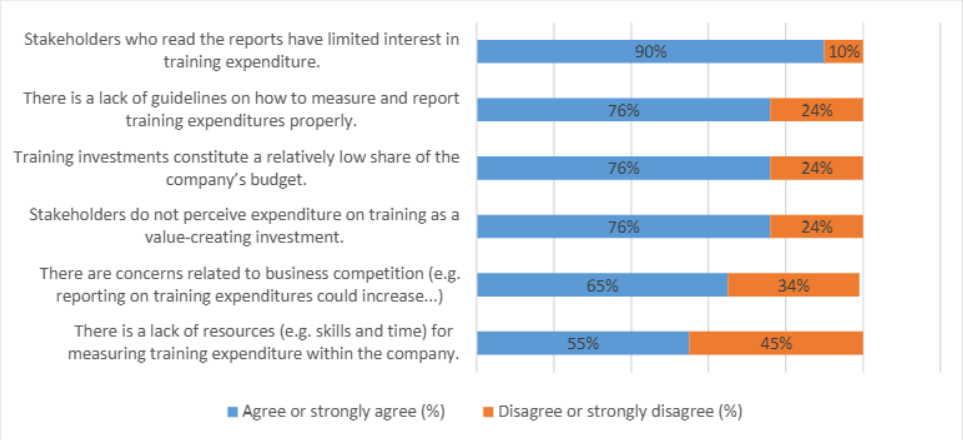
Source: Eurostat.

EU's coal workforce will decline at an accelerated pace: from about 120,000 jobs today, by 2035, at least one third of it will disappear in a conservative scenario (based on announced phase-out timelines or mines closures), but this could reach two-thirds or more, knowing that Poland holds the most important share of coal workers. Indeed, despite Poland's official 2049 coal phase-out deadline, reports show that the closure of Polish coal power plants will happen by 2035 due to the end of public support for coal power generation, to the aging and poor technical condition of the coal plants as well as falling revenues[10]. As per announcements, in 2024, about 94,000 jobs were expected to disappear in the internal combustion engine (ICE) vehicles industry[11] due to restructuring and site closures, knowing that the issue will grow in scale as an important share of the 6.7 million direct employees currently working in the ICE vehicles industry will need to be reskilled in the coming years for occupations in sectors like EVs/batteries production, EV infrastructure, defense industry, etc. The oil refineries and petrochemical industries are also expected to experience substantial layoffs, as they currently employ approximately 1.4 million people. The concentration of fossil-fuel jobs in certain regions (especially Central and Eastern European countries for coal mining, but also in the ICE vehicles industry, with Slovakia, Czechia, Romania and Hungary having 5%-6% of their total employment in the automotive sector) is a serious issue. Therefore, for skills to thrive, "stop and go" policies are not welcome and long-term investments and public funding will be key in order for the energy transition to reverse the deindustrialization trend.

10. A. Gawlikowska-Fyk, "From 2025 Coal Will Leave the Polish Energy System in Waves", Forum Energii, Eurofound, July 2021, available at: www.forum-energii.eu.
11. "Employment in the Automotive Sector", January 2025, available at :www.eurofound.europa.eu.

But how much exactly will it cost the EU, Member States and companies to train up to 4.8 million additional workers for ETJs? This is difficult to estimate, first of all because only a minority of companies report on training costs: according to the EC[12], only 15% of European companies disclose their training costs, with very limited insights into the costs associated to the development of future-oriented skills. Several reasons explain this, as seen below (Figure 5). In addition, training expenses are different depending on the type of job and sector, as well as on the initial training level of the person: for instance, the Fraunhofer Institute[13] estimates that 100,000–250,000 € of funding is needed to get a highly trained battery specialist (which will act as a job multiplier, supporting the creation of 10-25 jobs), while individual courses on battery topics available on the market can range from a few hundreds of euros to several thousands of euros.

Figure 5. Major reasons why companies do not report on training investments



(*) The question was only asked if the respondent indicated that their company does not measure training investments.

Source: based on Visionary Analytics, 2023, European Commission.

Based on the EC's Staff Working Document on "Investment needs assessment and funding availabilities to strengthen the EU's Net-Zero technology manufacturing capacity", to create 350,000 manufacturing jobs (to satisfy the NZIA manufacturing benchmarks), the EU would have to invest around 3 bn€ in skills[14] (see table below). This means that around 8,800 €/person are theoretically needed to retrain/reskill/upskill a worker

12. "Skills Pay Dividends – Accounting for Human Capital – How to Increase Employer Investment in Training and Make it More Visible in Company accounts – Final Study Report", European Commission, 2025, available at: https://data.europa.eu.
13. "Will the Development of a European Battery Ecosystem Fail Due to a Shortage of Skilled Labour?", Fraunhofer Institute for Systems and Innovation, January 2024, available at: www.isi.fraunhofer.de.
14. "Investment Needs Assessment and Funding Availabilities to Strengthen EU's Net-Zero Technology Manufacturing Capacity", European Commission, March 2023, available at: https://single-market-economy.ec.europa.eu.

in the net zero manufacturing industries. Assuming this average amount (8,800 €/person) is relevant for all clean technologies industries and assuming that at least 40%-60% of the new jobs (i.e. of the 4.8 million people based on industry estimates) will imply some type of retraining/reskilling/upskilling, the EU (and its Member States) will need to dedicate between 17 bn€-25 bn€ to this specific task, an amount close to the total firepower of the Just Transition Fund.

The fact that the EC has foreseen in the European Competitiveness Fund the inclusion of an EU skills guarantee of 11 bn€ to support workers in sectors undergoing activity closures or restructuring is a great step forward and should be maintained during the negotiations and topped by national funds and companies' investments. Under the current Multiannual Financial Framework (MFF), the Just Transition Fund should be more consistently directed towards financing reskilling and upskilling based on local needs, as well as attracting energy transition and clean tech investments.

Figure 6. Additional jobs in manufacturing and investment needs for retraining/reskilling/upskilling until 2030

Scenario	Status quo		NZIA Policy Proposal		NZIA+ Scenario	
Technology	Additional Jobs (in thousands)	Investments in Skills (mio EUR)	Additional Jobs (in thousands)	Investments in Skills (mio EUR)	Additional Jobs (in thousands)	Investments in Skills (mio EUR)
Wind	31	270	31	270	40	353
Solar PV	<1	3	25	223	66	578
Heat Pump	28	243	28	243	60	529
Battery cell	139	1214	261	2284	294	2578
Electrolysers	0	0	5	41	7	59
Total	198	1730	350	3062	468	4097

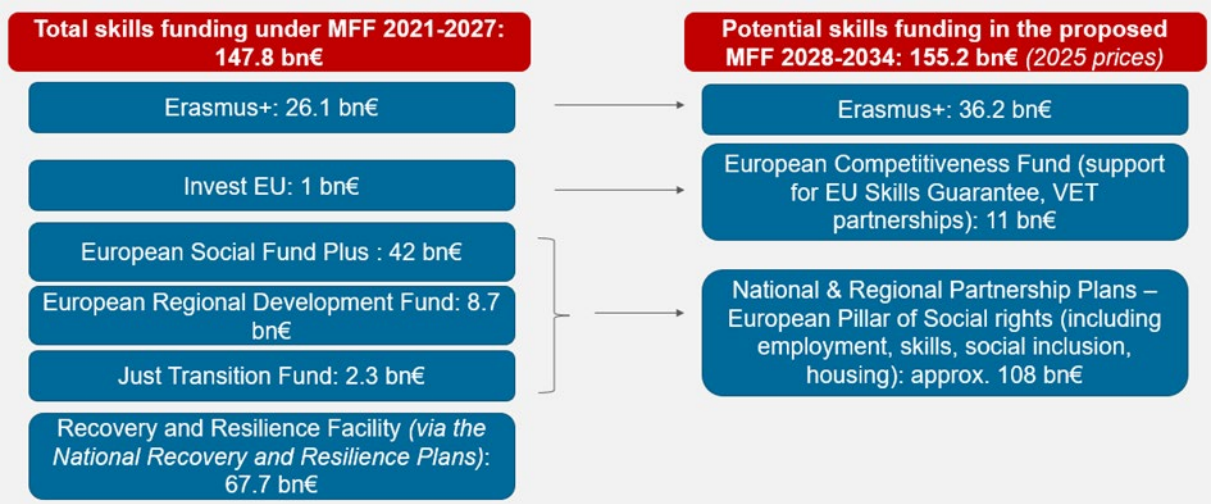
Source: JRC estimate based on manufacturing capacity expansion derived in section 5, GECO 2021 macroeconomic baseline, and training expenses from ESDE 2020 report.

Source: European Commission, 2023.

More broadly, according to the EC, as part of the current MFF, the EU has allocated almost 150 bn€ in funding to skills and education through different instruments, yet it is unclear how much of this amount has been specifically directed towards reskilling/upskilling and training activities, especially in the energy transition sectors. In the next MFF proposal, it is difficult to determine what will be the total amount of funding available for skills and education. Indeed, this pillar falls mostly under the National and Regional Partnerships, which are supposed to dedicate 14% of their budget (approx. 108 bn€ in 2025 prices) towards social spending (that includes, but is not limited to, skills), and it would depend on each Member State to determine the specific spending priorities. A clear achievement under the MFF proposal is the boost to the Erasmus+ programme (by around +40% in 2025 prices). An important step forward would be to dedicate a specific

share of the MFF to education and skills policies, in accordance with the proposal of the EU Parliament Intergroup on Education and Skills that proposes a 20% target.

Figure 7. EU funding for education and skills available under the current MFF vs. next MFF (based on the EC proposal)



Source: Ifri, based on EU Commission communications.

An EU-level approach to skills is emerging and needs to be turned into a systemic enabler of energy transition and industrial transformation

Labour market statistics in the EU show some relative improvements over the past years, with respect to unemployment rate standing at 5.9% in Q1 2025[15] and having almost halved compared to its peak in 2013 (11.7%). The NEET rate (young people aged 15-29 neither in employment nor in education and training) has been decreasing from levels above 15% in 2010-2015 to about 11% by the end of 2024, according to Eurostat, although with important differences across Member States (5.4% in Netherlands vs. 20.2% in Romania in Q1 2025). Yet, in the "Union of Skills" communication of the EC from March 2025, the state of play in the skills area is bluntly concerning:

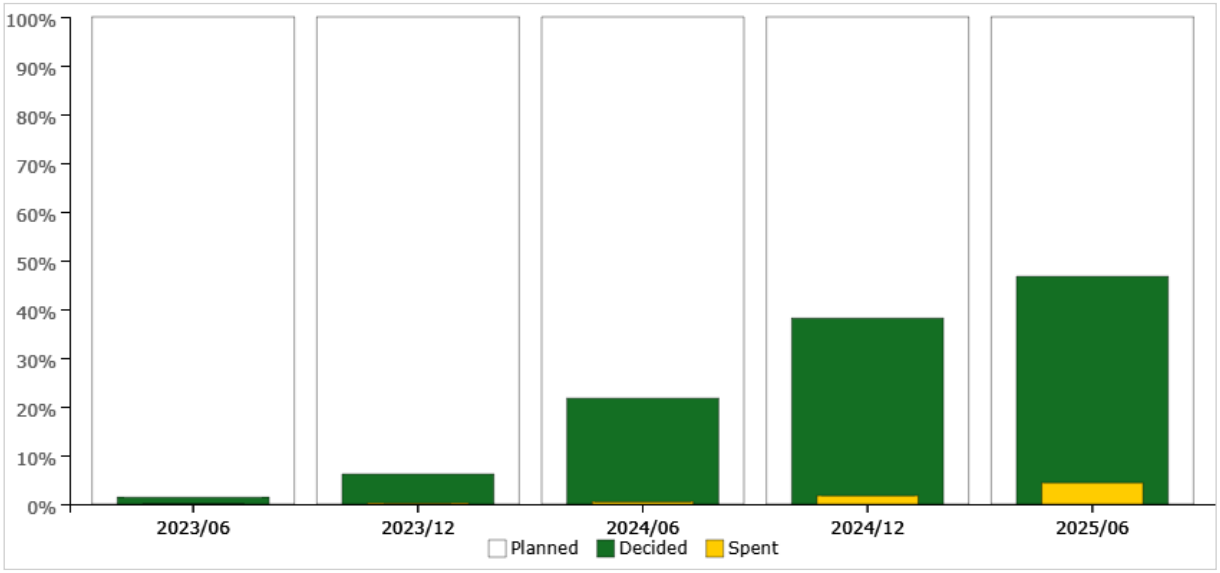
- **Weakened performance on basic and future-proof skills**: based on the OECD PISA report[16], the EU registers a drop in mathematics, reading and science performance among the 15-year-old, in addition to which, 1 in 5 adults struggle to read and write, and about 50% of young and adult population in Europe lack basic digital skills which will be required in a majority of future jobs. If the number of STEM graduates has been increasing between 2014 and 2023, it remains insufficient. In addition, the gender divide remains entrenched, with almost twice as many male graduates as female ones in STEM fields. The energy transition can be an opportunity to break barriers and attract more women into the STEM sectors by valuing the meaningful contributions they can make to the most crucial issues of our times.
- **An aging workforce** which directly affects the core of the energy transition as 36% of workers in the electricity sector were 50-74

15. "Quarterly Review of Employment and Social Developments in Europe (ESDE) Employment Exposure to Exports to the US - July 2025", European Commission, July 2025, available at: https://employment-social-affairs.ec.europa.eu.
16. "The Twin Challenge of Equity and Excellence in Basic Skills in the EU. An EU Comparative Analysis of the PISA 2022 Results", European Commission, 2024, available at: https://op.europa.eu.

years old in 2021[17], and overall companies struggle to attract enough young people (even more so when it comes to women) to work in the industrial sector. The EC estimates that around 1 million adults will be leaving the EU labour market every year until 2050. Conversely, the working-age population will expand exponentially in developing countries, with the World Bank forecasting that out of the 1.2 bn young people in emerging economies that will arrive on the labour market over the next 10 years, about 800 m will struggle to find a job in their countries. Yet, the EU struggles to attract talent and to create a progressive and forward-looking common migration policy against the backdrop of the rise of far-right movements.

- **A just transition challenge** stemming from the closure or restructuring of GHG emissions-intensive sectors, which can have powerful regional destabilizing impacts and the potential to fuel populism and anti-democratic movements. Based on EU data[18], only 4.4% of the EU Just Transition Fund (with a firepower of 20 bn€ to be spent over 2021-2027) has been effectively spent as of June 2025.

Figure 8. Progress tracking of the implementation of the Just Transition Fund (as of June 2025)



Source: EU Cohesion Open Data Platform.

17. A. Kuokkanen, "Skills for the Energy Transition in the Changing Labour Market", European Commission, 2023, available at: https://publications.jrc.ec.europa.eu.
18. Cohesion Open Data Platform, available at: https://cohesiondata.ec.europa.eu.

The Union of Skills – the opportunity for resolute EU action on skills

Whereas Member States oversee the content and structure of the education systems, the EU can support and encourage cooperation among them. The ambition of the EC to create a "Union of Skills" must hence be understood in the context of an alarming realization that the EU risks falling behind in preparing the workforce of tomorrow. The Union of Skills will be structured around four pillars with several promising initiatives that are much needed to improve the EU's competitiveness:

- Building skills (Basic Skills support scheme, STEM strategic plan, EU VET strategy)
- Upskilling and reskilling for the green and digital transition (namely via the EU Skill Guarantee, improved linkages between existing Pact for Skills initiatives, transnational university-business partnerships)
- Skills mobility (Skills Portability Initiative, joint European degrees, European Schools Alliances, etc.)
- Attracting, developing and retaining talent in Europe (EU Talent Pool to recruit talent in occupations with skills shortages, MSCA Choose Europe with the 2030 objective to have 350,000 non-EU students/year acquiring a EU tertiary degree, Visa Strategy, Talent Partnerships, etc.)

Many EU initiatives in the field of skills have already been put in place prior to the Union of Skills, some of them aiming at building bridges between skills and industrial ecosystems, as illustrated below. For instance, the Renewable Energy Large Skills Partnership brings together representatives of different renewables industries and sectors of the value chain to provide a vision of skills needs across the sector, to boost training initiatives on the ground and offer guidance to the public sector. The partnership has recently delivered a set of policy recommendations on boosting skills in the renewables sector[19], which emphasizes the need to make training an industrial priority, to act swiftly on most critical shortages, on improving the attractiveness of vocational education, and further develop skills recognition and mobility. Yet, there are no assessments on the usefulness and effectiveness of the different types of partnerships the EU has put in place, nor is there a clear vision of how these are supposed to complement and reinforce each other, which likely leads to dispersion of efforts, symbolic actions and a lack of accountability.

19. "Position Paper on Skills: Policy Recommendations and Best Practices for Addressing the Skills Challenge", Renewable Energy Skills Partnership, June 2024.

Figure 9. EU Skills Partnerships linked to selected EU industrial systems relevant for the energy transition

Skills partnerships – under each of the 14 EU industrial ecosystems (aerospace & defense, agrifood, construction, creative & cultural industries, digital, energy intensive industries, health & care, electronics, mobility & transport & automotive, proximity & social economy, renewable energy, retail, textiles, tourism)				
	Renewable energy	**Mobility, transport, automotive**	**Energy intensive industries**	**Construction**
Large Skills Partnerships	- Renewable Energy Skills Partnership - Onshore Renewable Energy Ecosyst. LSP - Digitalization of the Energy System LSP *Labour market: 7.7 m in energy sector, 1.5m in the renewable energy*	- Automotive Skills Alliance *Labour market: 14.6 m* *KPI: re/upskill 5% of workforce/y* - Skills partnership for Shipbuilding & Maritime Technology *Labour market: 1.07 m* *KPI: re/upskill 7% of workforce/y*	- Skills Partnership for energy intensive industries *Labour market: 7m people (20% of EU manufacturing labour)* *KPI: re/upskill 50% of workforce / y*	- Skills Partnership for Construction *Labour market: 12.7m (24.9 m for the whole ecosystem)* *KPI: re/upskill 30% of workforce / y*
Regional Skills Partnerships	B-MORE	B-MORE	European Chemical Regions Network	
Blueprint alliances	RESKILL4NETZERO, EDDIE, MATES	DRIVES, SkillSea, ALBATTS, STAFFER, LeaderSHIP, TRIREME	ESSA, SPIRE-SAIS, ChemSkills	2018 Construction Blueprint
Centers of Vocational Excellence	T-SHORE, SECOVE, VOLTAGE, SEED, H2Excellence, P4ELECS	EE4M, AUTOCOVE 2.0		ALLVIEW, EPLUG, BuildSkills Academy, HABITABLE, SEBCoVE, TEACH4SD, INSIDE-CoVE, EXCEL4HOUSING 4.0
Forward looking partnerships	FLORES	FLAMENCO, CHAlleNGE4S		Pact4Youth

Source: Ifri, based European Commission communications.

Net Zero Industry Academies – a much-needed bridge between industrial ambition and skills

Net Zero Industry Academies are one of the latest EU flagship initiatives aimed at building the skilled workforce needed for each of the clean tech sectors under the Net Zero Industry Act and delivering on the ambitions of the Clean Industrial Deal and the Green Deal. The prototype that inspired Net Zero Industry Academies is the European Battery Academy, launched in 2022, which reports having trained 100,000 workers in the battery sector. InnoEnergy Skills Institute was a key force behind the batteries academy and is continuously reinforcing its position in the European skills sector, as it also ensures the management of the European Solar Academy. The European Net Zero Academies are shaped along the following lines:

- After a competitive bid among EIT Knowledge and Innovation Communities (KICs), the EC selects a KIC as a provider (ex. EIT Raw Materials, Innoenergy Skills Institute, etc.) to implement a specific Academy. The EU provides financing for a fixed period (ex., 9 m€ for the European Solar Academy, 9.8 m€ for the European Raw Materials Academy). The implementing party must develop the Academy in such a way that it can become financially viable after the funding period.
- The daily functioning of the Academy is based on a network of industrial players, academic and training institutions, under the coordination of the implementing partners.

- The general objectives are to develop lifelong learning content for education and training providers, facilitate the recognition of qualifications at the EU level and the mobility of learners. In the long term, it is expected that the NZA will lead to the standardization of the process of upskilling and reskilling workers, thereby simplifying the development of talent pipelines. Hence, NZAs are expected to become the reference scheme at the EU level for upskilling and reskilling.

The Net Zero Solar Academy is managed by InnoEnergy Skills Institute, with the support of Solar Power Europe. The Solar Academy is focusing on two key initiatives:

- Developing training for local permitting authorities to tackle the issue of excessive delays in renewables permitting procedures by making existing human resources more performant and effective (given that, due to constrained budgets, governments experience difficulties in increasing the number of civil servants). The first course of the training will be provided for free, to assess the interest in such an initiative and its financial viability. A business model needs to be found to be able to extend it beyond the 2-year EU funding period for more such courses to be developed.
- Creating a European solar skills credentials harmonization scheme across the EU countries to tackle the issue of the inflation of credentials in the solar industry, which makes it difficult to ensure a homogeneous quality standard of solar training. This is expected to facilitate skills circulation across EU countries, as well as facilitate hiring, ensuring that each person possessing the qualification has acquired a pre-determined set of skills. Once the solar skills benchmark is set, training providers around Europe will be able to ask for audits of their programs to obtain the Net Zero Solar Academy quality seal.

The European Raw Materials Academy, led by EIT Raw Materials, will also have as an objective to train 100,000 professionals in the raw materials sector in Europe. The academy is structured around two key deliverables. First, a pan-European learning platform with courses covering the entire value chain (exploration, extraction, processing, recycling, and waste management), train-the-trainer programs and microcredentials. Certifications will be provided and recognized around Europe. Access to training can be free (ex., in case of specific grants or scholarships) or fee-based (either financed by a company or by the individual worker). A skills-intelligence tool is also offered, allowing a better understanding of skills gaps and needs.

Member States bear great responsibility for strengthening education systems, tackling regional disparities and attracting talents from abroad

Investment in education is one of the first indicators for success in building the skills base, as according to the World Bank, for every dollar spent by governments on education, the gross domestic product (GDP) increases on average by 20 $[20]. If competitiveness truly matters for EU Member States, then they need to strengthen its foundation—a performant education system delivering a well-educated workforce. In the EU, 4.7% of national GDP was, on average, spent on education in 2023, with slight variations over the period 1995-2023 (between 4.6% and 5.1% of GDP). There are marked differences among Member States, from best-in-class players like Sweden reaching 7.7% of GDP, whereas Ireland and Romania lag behind at 2.8% and 3.3% of their GDP, respectively. Only 0.1% of GDP is spent on adult learning at the EU level, a poor performance that will become more debilitating in a world of rapid technological change, digitalization and automation. Closely linked to this, Member States need to have much more accurate and systematic monitoring and intelligence gathering on the skills needs, gaps and key trends in the jobs market, in order to be effective in their plans to boost lifelong learning and keep up to date their educational offer, as today these efforts are insufficient or even missing.

Based on a benchmarking exercise done by the Flanders region, with funding from the EU Technical Support Instrument[21], an array of skills initiatives dedicated to the energy transition at national, regional or local level were identified: ex. Spain's Green Jobs Programme (to promote the greening of skills and employability of workers), Ireland's Green Schools Programme (for fostering environmental awareness and action in schools

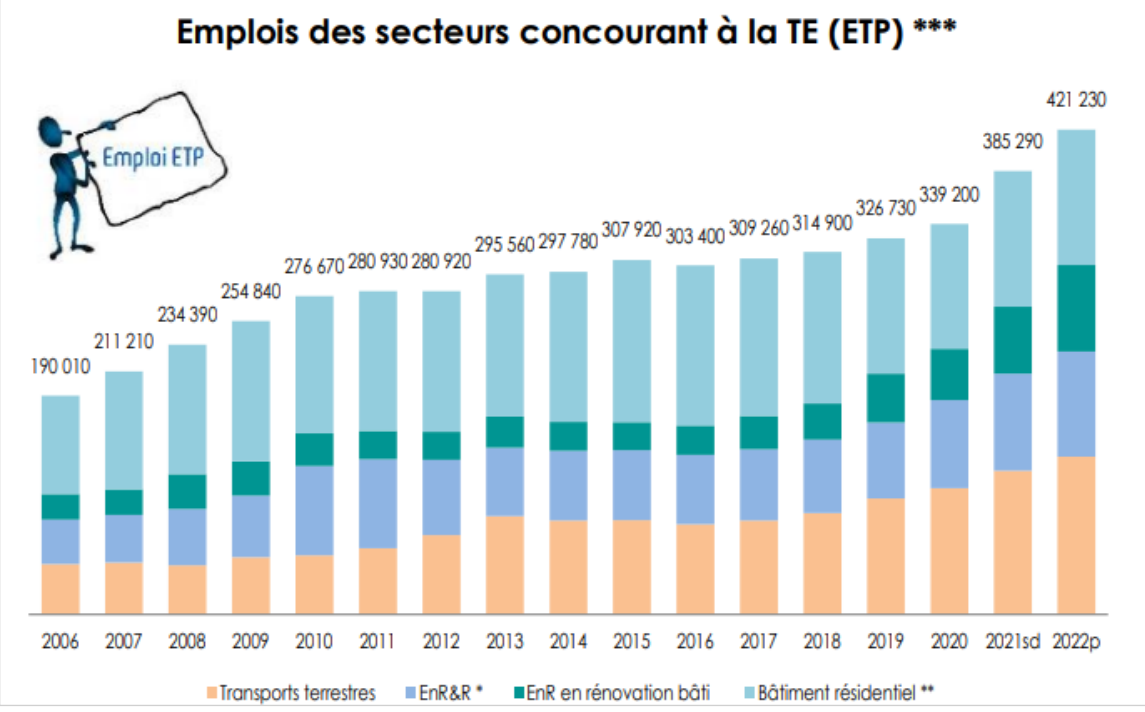
20. "The Future at Risk. Why Investing in Education is Critical", United Nations Educational, Scientific and Cultural Organization, 2024.

21."Green Skills Roadmap Flanders. Best Practices Report", Trinomics, March 2023, available at: https://www.vlaanderen.be; R. Berger, "Skills Roadmap Voor de Vlaamse klimaattransitie – Focus op de Energie-Intensieve Sectoren [2020-2035]", Vlaanderen, 2021, available at: www.vlaanderen.be.

and communities) and Centers of Excellence for Green Building Skills, or Finland and Denmark adapting their VET training systems to be more reflective of energy transition skills demand. Highlighted as a successful model is Germany's dual VET system, combining theoretical studies in vocational schools with hands-on practice in small and medium enterprises across the territory, which has been promoted outside its borders by German companies and the German Office for International Cooperation in VET, as a strand of win-win cooperation with third countries.

France is among the most proactive countries in the EU in terms of future-proofing its skills base. Policy initiatives include the Skills Investment Plan 2018-2022 (despite a good strategic vision of rewiring the French workforce for a more competitive economy, the plan suffered from poor implementation and management), the 2018 reform of the apprenticeships system (*alternance)* which led to a tripling of apprentices in the French economy, the reform of the public employment service (France Travail) towards more proactive actions in favour of reskilling and upskilling unemployed people. In addition, the French agency for ecological transition (ADEME) has also taken up a role of clarifying clean jobs creation trajectories and preventing skills shortages, including by providing data on jobs created by the green transition and their acceleration after 2019, and highlighting the potential for 300,000-500,000 new jobs based on the national low-carbon strategy by 2030.

Figure 10. Jobs in sectors participating to the energy transition – France, 2006-2022

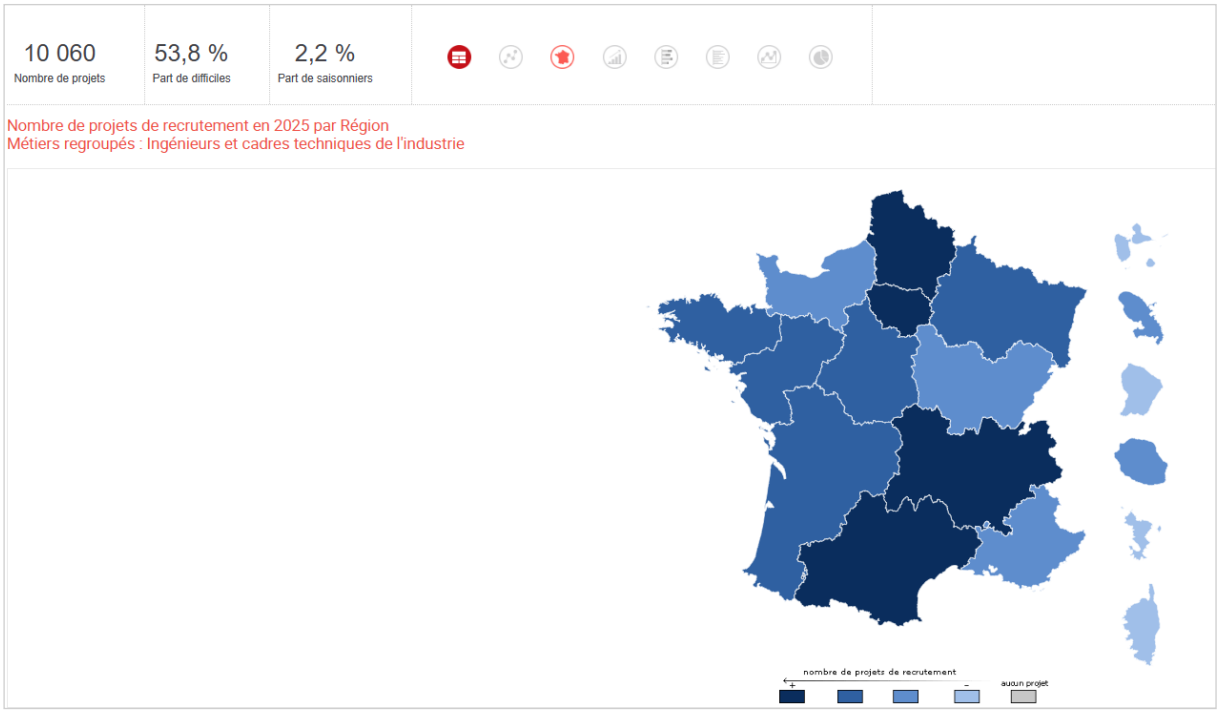


Source: "Marchés et emplois concourant à la transition énergétique", ADEME, 2024.

French regions have also gotten involved in improving their competitiveness by increasing the quality and availability of their skilled workforce. For instance, the region of Hauts-de-France has used funding from the Just Transition Fund to develop a forecast of skills and jobs evolution in the area of Dunkerque until 2030, in order to better support the deployment of an impressive number of clean industrial projects located in this region, which already suffer from difficulties in recruiting the right people even though the hiring peak is yet to come.

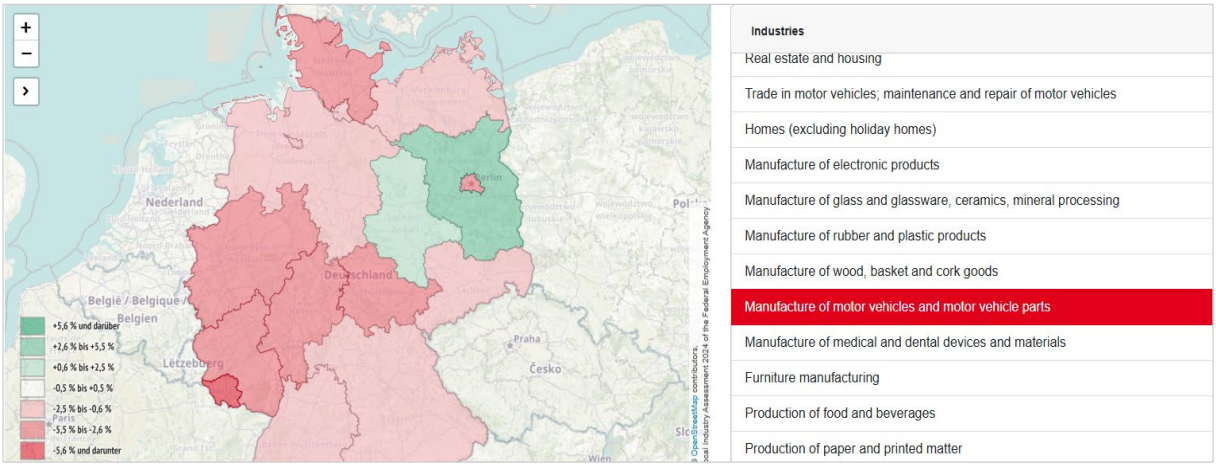
Regions' involvement in skills and job forecasts and development should not be an exception but a natural consequence of the territorial challenges they face. Data mapping from national observatories of skills and jobs in Germany, France or Netherlands illustrate such regional differences both in terms of job creation (see the maps on France) and in terms of job losses (see the maps on Germany related to the ICE vehicles industry), which implies that regions need to develop proactive employment and skills strategies to ensure that they maximize the benefits of the energy transition on their territories, reduce social disruption, and strengthen their competitive positioning and industrial vision.

Figure 11. Number of recruitments foreseen for engineers and technical roles in industries, in France, by region, 2025



Source: "Enquête besoins en main-d'œuvre", France Travail, 2025, available at: https://statistiques.francetravail.org.

Figure 12. Industry employment development in 2025 by German region in the sector of motor vehicles and motor vehicle parts manufacturing



Source: Arbeitsmarkt Monitor, Arbeitsagentur, available at: https://arbeitsmarktmonitor.arbeitsagentur.de.

At the national level, the issue of labour and skills shortages is also linked to a more politically controversial aspect: migration. A case in point is Hungary, where, despite its entrenched anti-immigrant stance since 2016, the country has been steadily increasing the number of "guest workers" in its economy, mostly to sustain its ambitions as an assembly hub in the automotive, electronics, and EV battery sectors. So far, existing reports show this has not been a success story, as it has resulted in a general degradation of the working environment in the Hungarian manufacturing sector, due to foreign employees experiencing a precarious status (temporary positions, lack of information about labour rights and local institutions, financial distress, fear of sanctions, etc.)[22]. With an aging population, declining birth rates and faced with debilitating labour shortages (in agriculture, tourism, construction, ITC services etc.), Italy has for its part adopted an anti-illegal migration policy but has encouraged and developed pathways for legal migration: over 450,000 permits were issued to migrants between 2023 and 2025 and 500,000 more will be distributed until 2028, while until 2050 up to 10 million migrant workers could be further integrated in the Italian economy[23].

Based on Draghi's report, the working age population in the EU between 2023 and 2070 will shrink by about 2 million people per year without migration, while keeping current migration trends would halve this number. Hence, if migration policy has so far mostly been discussed from a reactive standpoint, mainly in terms of reducing illegal migrant flows, time is ripe for the EU and its Member States to look at migration flows through

22. K. Bodor, "Foreign Workers in Hungary. Key Facts and Labour Market Challenges", Friderich Ebert Stiftung, December 2024.
23."Italy to Issue Half Million Non-EU Work Visas over Next Three Years", Reuters, June 2025, available at: www.reuters.com.

strategic lenses, to strengthen the collective capacity of creating safe and legal migration pathways and supporting illegal migrants towards clarifying their administrative situation and putting their skills at work in the European economies. The EU should further address issues of qualifications recognition and transferability of skills with third countries, promote private sector investment in skills mobility and consider "energy transition skills visas" linked to relevant shortage occupations.

Key private sector involvement for building the talent pipeline and innovating

The implementation of the Green and Clean Industrial Deals has created new recruitment needs for companies, which have stepped up their efforts not only to reskill and upskill workers, but also to enlarge their recruitment pools by boosting their attractiveness and reputation in the public space, tapping into the female workforce and underrepresented population segments, building career pathways and enticing benefits packages. Companies need not only the brightest minds, but also people with excellent execution skills to deliver the energy transition at scale and within ever-more accelerated timelines.

Yet, if public education systems represent the cornerstone of a well-educated and competitive European workforce and need to be supported and strengthened, schools and universities are confronted with a rapidly changing world, where skills and knowledge need to be continuously updated. As a consequence, curricula are being revised and some efforts are ongoing to rethink the educational offer, although the breadth of this move is difficult to measure at the European level. What is clear, however, is that the academic sector and the industrial one are increasingly cooperating, capitalizing on the private sector's ability to provide real-world industrial training platforms, operational knowledge and a detailed understanding of the skills needed at each step of the value chain. While companies need to strengthen their investment in training and skills and boost disclosure and reporting on this item, as a key contribution to the European skills intelligence and monitoring, an increasing number of actors in the European energy and industry sectors are deploying efforts to fill existing skills gaps and avoid future ones, with different strategies at play that can be mutually-reinforcing. This paper attempts to classify the private sector's approaches to skilling in three categories

In-house training

This consists of companies developing their own training facilities for skilling newly recruited workforce or up-skilling/re-skilling existing employees on an ongoing basis. Established large industrial players (ex. RTE, Renault) usually have the internal resources and the industrial platforms to deploy such a training program. On one hand, in-house training is an opportunity for trainees to get access to excellent industrial

know-how, to enhance their operational capabilities and to secure a job or even a career pathway through lifelong training and mobility opportunities within the company. On the other hand, from a company perspective, this is a safe route for building a steady influx of talent, boosting employees' loyalty, guaranteeing quality performance, preventing skills mismatches and supporting innovation.

Case study N°1: RTE Academy and its skills and expertise hub – the epitome of a "learning company"

The French national transmission system operator (TSO), Réseau de transport d'électricité (RTE), defines itself as a "learning company" which, far from being a buzzword, reflects a reality: since no school prepares students for operating and maintaining (O&M) high-voltage networks, the company was bound from the start to put in place the necessary training for its almost 10,000 workers, of which about 40% are dedicated to the O&M field. But the term also reflects a mindset and a culture of constant skills improvement and excellence, whereby the TSO is seeking to anticipate and integrate technological evolutions (such as digitalization), to address strategic challenges (like industrial resilience and data sovereignty) and to respond to environmental and societal issues (like electrification and climate change adaptation).

Despite its historical involvement in building its talent pipeline, the issue of skills for RTE has only continued to grow and become more pressing in the past few years for two key reasons:

- The acceleration of the energy transition, bringing along the need to modernize and expand electricity grids: the electrification of end uses, the deployment of massive power generation units, the aging of existing networks, the need to digitalize the power system to enable smarter consumption, the necessary boost in interconnections for greater resilience and energy security, all require building more power networks and modernizing existing ones. RTE plans to invest 100 bn€ over the next 15 years and will need to recruit about 2,500 people by 2030 (about 25% of its current workforce).
- The need to innovate in technical expertise in order to stay on top of new issues such as digitalization, climate change impacts and adaptation, the transition from a highly centralized and predictable energy system to a more decentralized system with unpredictable events, or the evolution from a national grid towards a European grid due to the increasing number of interconnections.

The RTE Academy has thus been designed as a holistic answer to these challenges. In 2024, it has deployed more than 420,000h of training (of which 94% in-person training) to 87% of RTE's employees (45h of training on average per employee), mobilizing an impressive amount of financial

resources to this end (the equivalent of 6% of the overall expenditure on salaries vs. an obligation of 1% imposed by the French law). Instrumental to the success of RTE Academy is its extensive training facility, Campus Transfo, based next to Lyon—a key industrial and technological ecosystem in France—, which serves both as a skills and expertise hub, combining technical training, international expertise and innovation capacity. RTE relies on internal training as well as partnerships with academia and external providers, not only to develop in-house skills but also to strengthen the entire value chain, including contractors and partners. Around 100 million € have been invested in creating Campus Transfo, which is the largest and most advanced training campus for grids in Europe. Among the 450 people based there, about 120 are experts dedicated to training, skills development, and supporting the energy transition, while more than 300 experts focus on preparing for the future. This training facility consists of a real-dimension industrial platform replicating the entire high-voltage transmission network (electrical post, direct current stations, dispatching room, circuit breakers, etc.), which serves not only as a training platform for the newly-recruited staff, but also as a simulation platform, where employees can constantly enhance their understanding of the system's functioning by "replaying" incidents and hence contributing to the constant improvement of the grids, to their predictive maintenance and innovation.

Indeed, Campus Transfo is actually at the core of RTE's innovation agenda: for instance, it is currently working on developing the third generation of substation control and monitoring systems (after the analogue and electrical ones) called R#space, which will allow RTE to go towards a virtual control and monitoring system, while ensuring full interoperability among suppliers of hardware and keeping the control over the software functioning and data collected. The FabLab located on the campus also allows employees and students to develop their ideas, projects and take part in innovation challenges.

The RTE Academy and Campus Transfo are also oriented towards attracting the future workforce to the grid sector, acting as a training provider for universities and the French employment service, France Travail. For instance, RTE provides 1-year or 2-year long apprenticeships to students in specific bachelor's and master's degrees (focused on electricity, energy management, electrical and industrial and networks engineering) at University Lyon 1 and INSA Lyon, with the opportunity for students to be hired upon graduation. For people looking for a professional reconversion or who are unemployed, RTE proposes a 7-week internship called "operational preparation to work", in partnership with France Travail, allowing trainees to test their interest in jobs in the network maintenance area and, accordingly, be offered the opportunity to work at RTE. In today's recruitment context, Campus Transfo also serves as a place of inspiration and outreach. Each year, it welcomes around 6,000 participants from RTE and external organizations, providing opportunities for knowledge-sharing

and raising awareness of the central role of power grids in the energy transition.

In addition to its in-house training, RTE is involved in "in-network" training, as part of the French Networks School (*Écoles des Réseaux*), which gathers actors across the grids sector in France. RTE International, a subsidiary of RTE, created in 2006, is also involved in providing training to actors in third countries, proof of its internationally recognized expertise and excellent industrial know-how.

"In-network" training and sector-level mobilization on a well-identified common issue

In-network training is based on the shared acknowledgment by actors across a specific value chain that they are confronted with a systemic skills issue that cannot be tackled efficiently by any of them on their own, resulting in a shared commitment to work as a network to address it. The merit of such initiatives is first and foremost that of breaking silos and providing a comprehensive cartography of jobs and skills needs across the value chain (as done for instance by the grids sector in France, which assessed that the sector needs to recruit 43,000 people by 2030, offering a detailed account of the existing skills issues and the possible solutions[24]).

For new clean tech sectors (like the batteries sector, ex., École de la Batterie, Electro'Mob, etc.), in-network training supports building a dedicated value chain expertise, creating scale in order to represent a sufficient incentive for the academic system to adapt its educational offer, and the mutualization of training facilities for cost-optimization and synergies. For more established sectors like the grids (ex. École des Réseaux—French Networks' School), it allows to raise the visibility of players in the mid- and up-stream sectors in order to make sure that the whole value chain manages to find the right skills at an optimal pace and bottlenecks are avoided.

Case study n°2: Verkor's École de la Batterie (The Battery School)

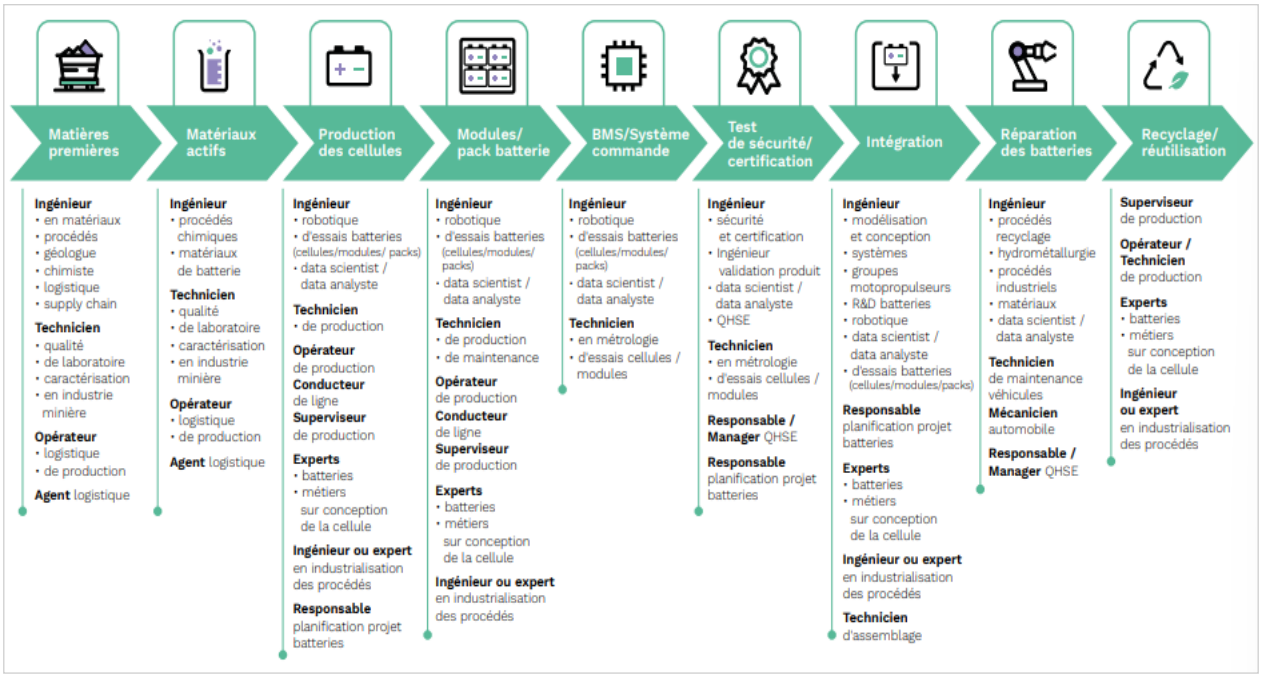
Verkor is one of the most promising European companies in the space of battery manufacturing, working steadily towards building and operating a 16GWh gigafactory in the North of France at Dunkerque to equip 300,000 electric vehicles per year with low-carbon batteries, the equivalent of 15% of France's target of producing 2 million electric vehicles domestically by

24. "Les besoins en emplois et compétences de la filière des réseaux électriques", Écoles des réseaux pour la transition énergétique, November 2024, available at: www.info.gouv.fr.

2030. More than 40,000 workers will need to be trained by 2030 in France to deliver on the 2 million EV production ambition, and Verkor's École de la Batterie (EdlB) aims to be one of the driving forces by training 1,600 people every year as of 2026. Initiated by Verkor in 2022 to provide for its own staff needs and now extended beyond its own hiring purposes, EdlB is designed as network-based learning ecosystem, bringing together a large array of academic (ex. CEA/INSTN, CESI, Grenoble INP-UGA, ENSAM, IUT Lyon1) and training providers (ex. AFPA, Pole Formation Isère etc.), including lifelong education providers (ex. CNAM, Innoenergy Skills Institute) as well as competitivity hubs (ex. Tenerrdis) and Corys—a leading company providing training simulators for the energy, transport and industrial processes sectors. The EdlB is among the skilling initiatives that receive a direct support from the French government through France 2030 program (financed by the Recovery and Resilience Facility), amounting to 13.58 m€ (out of a total budget of 19.85 m€).

This learning ecosystem presents several advantages, namely the industrial training platform and operational expertise offered by Verkor, the accessibility of training across different sites in France, a rich network of actors offering training opportunities across the value chain, across academic levels (from VET to doctoral degrees) and ages or professional status (open to students, job seekers, employees in reconversion of all ages).

Figure 13. the battery value chain and the roles specific to each stage



Source: Rapport d'étape Novembre 2022 – Décembre 2024, École de la Batterie (EdlB).

In two years of existence, EdlB has made steady progress on its four objectives:

- Consolidating the understanding of industrial needs and the existing training offer: a first sector diagnosis led to identifying urgent skills gaps, particularly engineers (R&D, electrochemical, design etc.) and technicians (production, maintenance), and to acknowledging a general lack of attractiveness of the industrial sector as an employer and an education ecosystem that is insufficiently prepared to provide the skills needed for the battery sector. Training in the chemistry and metallurgy fields will be the most impacted in terms of needing to adapt to the requirements of the battery industry. Transversal skills (digital knowledge, value chain view, etc.) will be key.
- Training the trainers and putting in place the technological infrastructure for trainings: EdlB has trained more than 100 trainers through its "train the trainer" initiatives, a key enabler of skills transfers. Verkor has also reached out to foreign experts from abroad to build state-of-the-art trainings and educational content.
- Developing training pathways for both initial and lifelong education linked to the battery sector: ex. the initiative helped building or adapting 80 trainings for the battery industry.
- Boosting the attractiveness and visibility of the battery sector as an employer: EdlB deployed 60 awareness-raising and promotion activities, reaching out to more than 5,000 people, and identified the importance of nourishing a proximity with trainees and teaching personnel in order to meaningfully boost interest in the battery sector.

The success of EdlB hasn't gone unnoticed: local authorities from the Quebec region in Canada reached out to Verkor in order to develop a similar battery school for the Canadian ecosystem, to provide the right skills for the local battery ecosystem and to encourage mobility of skills between Canada and France. On the longer term, EdlB aims to provide trainings and open its learning ecosystem to interested countries around Europe to encourage European skills mobility, knowledge transfer and innovation.

Case study n°3: Solar Power Europe – focus on certification and skills circulation

The solar power industry is already employing about 830,000 people (44% of direct jobs, 56% of indirect jobs across the full value chain), with an overwhelming majority focused on the deployment of solar panels (87%) and only a mere 5% in the manufacturing segment (dominated by invertors production–66% of jobs, a rather low-intensity labour segment overall in the PV manufacturing). After the 2022 energy crisis and the resulting solar installations boom in Europe, the workforce in the EU solar sector has

increased by almost 30%, especially in the deployment segment. Nevertheless, the solar PV sector is now at a crossroads in terms of job creation. The solar PV market growth shows signs of slowing down in 2024-2025 (due to policy changes, reduced incentives, declining energy prices) and a switch from residential installations to much less labour-intensive utility-scale solar PV installations is taking place, which means that, in a moderate scenario, no drastic increase in the solar workforce should be expected. More alarmingly, in a scenario of weakened economics (manufacturing not taking off, much slower deployment rate due to flexibility issues, etc.), EU's solar workforce could even decrease by 19% by 2028 (compared to 2023)[25]. Whereas deployment jobs will remain dominant by the end of the decade, the share of people working in operations and maintenance is growing rapidly and is expected to grow further. Depending on the implementation of EU's industrial ambitions (ex. 30GW of PV manufacturing capacity benchmark), the share of manufacturing jobs could increase to 9% by 2028.

To support and anticipate these evolutions, the solar sector is particularly mobilized on boosting credentials recognition across Europe through common certification schemes, via the European Installer Training and Credential Initiative (Innoenergy Skills Institute and Solar Power Europe), on training provision and creating pathways for skills transfers between renewables industries via the RESKILL4NETZERO project (with participation from other industries: Wind Europe, EuropeON, European Biogas Association, RenewAcad etc.), in order to facilitate workers circulation from one clean industry to another.

Third-party training

Delegating the training to a third party is another way through which companies, but also local public authorities, can proactively tackle skills and labour shortages. This offers a series of advantages especially for medium and small companies that lack the scale for deploying their in-house training platform, among which: access to flexible training (based on specific needs/timelines, going from general to tailor-made), access to industrial/online training environments (which would be too costly to develop internally) and to a diverse range of expert trainers. InnoEnergy Skills Institute is the most prominent actor at the European level specializing in the skills provision for companies or other actors, with a capacity to address upskilling across solar, battery and hydrogen value chains and a value proposition centered around reduced time-to-competence and streamlined skilling processes (through the "talent as a pipeline" offer).

25. "EU Solar Jobs Report 2024 - A Solar Workforce Ready for Stronger Growth", Solar Power Europe, September 2024.

Case study n°4: Terra Academia

Founded by Veolia (a global leader in the water, waste and energy management sector) in 2023, Terra Academia is a non-profit association and certified provider of training in the field of the ecological transition in France. The specificity of Terra Academia is its focus on the local level, whereby the first step is forging a good understanding of the impacts of the ecological transformation on a specific territory and deducing the consequences in terms of jobs and skills needs. This territorial diagnosis can be performed at the demand of a public authority or of the private sector and usually results in a Skills Action Plan (based on Terra Academia's skills' repository of 101 skills), followed by the creation of dedicated training or the evolution of the existing learning offer through cooperation with academic partners. Individuals can also independently enroll in training. Beyond training, Terra Academia also has a mission of improving the knowledge of the wider public on topics related to sustainability and energy transition through organizing public events, workshops and dedicated coworking spaces, while also aiming to boost the image of industries and the attractiveness of industrial jobs as an essential component of the clean reindustrialization and climate change agenda. Its revenues are derived from training/other associated activities it deploys on demand to public authorities, companies or individuals. Over the period 2023-2024, the association opened three campuses, put in place 27 partnerships with public, private, academic and civil society organizations, reached out to more than 2,000 people and trained about 120 people.

By 2030, Terra Academia aims to train 60,000 people, to raise the awareness of 100,000 young people with respect to the jobs and training opportunities related to the ecological transition, and to be present across all regions in France, while also working on expanding its international presence.

Perspectives: boosting the Union of Skills through the Net Zero industry Academies

Skills are not just one among many enablers of competitiveness, but truly a crucial one, as SMEs and large companies alike witness it. To succeed in delivering the twin low-carbon and digital transition, the EU needs to put workers and skills at the heart of the European project.

EU's clean industrial transformation and energy transition cannot happen without a skilled workforce well available across European Member States and regions. Jobs cannot be created without the stability and predictability of European energy and industrial policies, consistent funding enabling the uptake of industrial ecosystems and training facilities and maintaining a European foothold into the manufacturing of current and next generation of clean technologies.

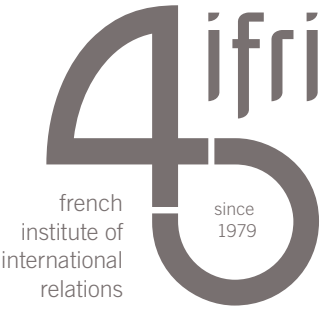
First, the EU needs to reconsolidate the performance of European students and adults on basic skills, from math and literacy to digital skills, which means that Member States have an absolute duty to strengthen public education systems through more public funding for universities and schools, better staffed schools especially in least developed and remote areas, state of the art infrastructure and revised skills-oriented curricula. The EU Skills Guarantee in the next MFF is a much-needed initiative and should be preserved and complemented by funding from Member States and companies, while the Just Transition Fund must be more systematically directed towards reskilling/upskilling initiatives.

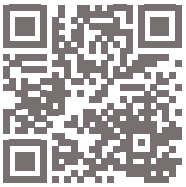
Second, the EU and its Member States need to fix the issue of insufficient data collection around skills and workforce trends in the clean technologies and related to the just transition regions. Member States should do a more accurate and systematic job in gathering skills intelligence, monitoring the gaps and evolution of needs on the job market and anticipating fluctuations across sectors in terms of job creation/destruction. Net Zero Academies (NZAs) should serve as a body to centralize skills intelligence coming from national and regional authorities, agencies and industrial associations to assess and forecast trends in energy workforce demand and supply across Europe and better inform EU and Member States skills policies and programs. They could also serve as a monitoring board for the implementation of EU funds (under the new MFF budget structure) in the field of skills and examine their efficiency.

Third, NZAs should focus the EU's efforts on areas where a European-wide coordinated approach would bring the most benefits in terms of a timely and cost-effective delivery of the Clean Industrial Deal, such as:

1. **Design NZAs to be operational and results-driven by involving the private sector and social partners.** The private sector and social partners should be actively involved in measuring skills and labour gaps, forecasting labour market trends, designing training programs and curricula and harmonizing certification skills. NZAs should be grounded in clean and realistic KPIs and avoid broad targets with weak definitions. They should target the most urgent skills gaps and tackle the just transition dimension.
2. **Boosting access to real-dimension industrial training platforms:** NZAs should label as EU Skills Champions those companies that provide real-dimension industrial training platforms for clean technologies (ex. the sites made available by companies like Verkor, Renault, RTE, etc.) and facilitate access to EU funds for them, linked to KPIs on the number of people trained (with requirements on reaching out to workers across EU countries and targets on retraining workers in fossil-fuels sectors). This would allow a more hands-on and cost-effective approach to skilling, encouraging synergies and mutualization of industrial training infrastructures, reducing time-to-competence, while having an equalizing effect in terms of training opportunities for citizens from different Member States.
3. **Emphasizing skills diffusion channels.** The EU's energy transition timeline is very ambitious from an industrial point of view, hence NZAs should focus on enhancing the channels for skills dissemination across the Member States and regions (but also beyond Europe, through the Clean Investment and Trade Partnerships with third countries), to boost investment equally across the European territory. Training the trainers could be particularly effective in some sectors (ex., batteries, grids), while training permitting authorities could be beneficial for reducing project timelines. Another way of looking at this is by focusing on cross-border projects, such as power interconnections and CO_2 pipelines. As a matter of fact, a NZA should be dedicated to electricity grids, which are the bedrock of electrification and are facing unprecedented modernization and deployment needs across Europe in a short time span, and need a collective understanding of skills needs and supply, a beefed-up training ecosystem that can rely on existing best-in-class industrial training and simulation expertise in the EU.

4. **Create clean industrial career pathways based on common skill sets.** NZAs should actively work on anticipating and managing the labour market fluctuations across technologies, by developing "clean industrial career pathways" (recognized at the EU level) based on identifying sets of skills that are transferable from one sector to another. This can give a clear view over career options available for workers and promote modular and lifelong training.
5. **Raising the profile of vocational and technical training** by creating European-wide certification schemes (ex., like the Solar Installers Credentials Initiative), awareness-raising campaigns and outreach strategies, managed by each NZA for its respective value chain, as well as European funding for apprenticeships in clean tech sectors with most urgent skill gaps and in just transition areas.
6. **Attracting and supporting excellent foreign talents** and people who have the right skills for European industries, through dedicated visas (e.g., via the EU Talent Pool), mobility schemes, and recognition of qualifications.





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