Smart strategies for the transition in coal intensive regions

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TRACER website: www.tracer-h2020.eu

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Executive summary

This deliverable of the TRACER Project is the output of the Task related to the "agreeing on the regional strategies for re-skilling / re-training the workforce" for the nine target regions of TRACER (Task 6.2). This specific Task draws on the Task related to the "social challenges and re-skilling needs of the workforce" (Task 3.5) and has been integrated with Task 6.1, in which the Research & Innovation (R&I) strategies for the target regions have been developed (emphasizing on the projections made for the transition to 2030 / 2050 in the target regions).

More precisely, in moving forward energy technology innovation, the SET Plan has recognised that one of the key elements for its successful implementation at EU level is the availability and mobilisation of appropriately skilled human resources. The energy sector is an evolving field which creates new job opportunities but, at the same time, requires the development of new skills and competences (Europe 2020 Flagship Initiative '*An agenda for new skills and jobs'*). This applies more specifically, but also much more intensively, for the coal-intensive regions, which have to make the transition to a more diversified economic base and a more sustainable energy system while safeguarding the social cohesion for local communities.

One of the most keenly felt impacts of the transition of coal intensive regions to a low carbon economy are the ones on the existing labour market, and these can include the generation or destruction of employment or the re-skilling (meaning the new skills acquisition for employment in new job positions) of the local workforce, especially the one that is currently occupied in coal mining and power generation using coal activities. Any changes and upheavals that will arise as a result of the transition to a low carbon economy will be evident in the workforce as the carbon intensive industries will inevitably become less competitive and will start to decline, whereas the low carbon activities will prevail and their associated employment will need to increase. In view of these upcoming changes, the need for new skills development and the respective retraining is a high-level priority.

Therefore, in the frame of the TRACER H2020 Project, having defined in Task 6.1 the energy technologies that will be employed to help the target regions in their transition process, together with the regional priorities on Research and Innovation (R&I) in the field of energy, the efforts need further to focus on the creation of the necessary opportunities for the retaining of the existent workforce in the regions. The scope is that the current workforce will not be discarded but, on the contrary, it will be oriented towards other emerging and highly energy efficient and low carbon technologies/sectors.

This needs to be carefully planned and a "personalised", depending on each region's specific needs, resources characteristics, technological background, etc., retraining / reskilling strategy has to be drawn up. To this end, the already existent (or under construction) governance structures in the regional level have to cooperate with the local/regional training providers, trade unions, business organisations, and all other involved stakeholders to ensure that the appropriate skills will be allocated to each category of workers, depending on their background and the sector in which they are being activated.

1 Introduction

While coal remains a central fuel in the European energy mix, the transition to cleaner forms of energy and innovative technologies, such as Renewable Energy Sources (RES), “clean” hydrogen production (as a new energy carrier), but also carbon capture and storage, is imperative to meet the EU’s commitment to reduce CO_2 emissions by at least 55% by 2030 and to become the world’s first climate-neutral bloc by 2050. The decline of coal-based energy production is an ongoing reality in Europe. Since 2012, total coal power generation has dropped by almost a third in the EU. The declining use of coal has led to mines closing down and power plants being decommissioned in a number of regions across Europe, among them being the majority of the TRACER project target regions.

Furthermore, with the ambitious National Energy & Climate Plans (NECPs) towards a climate-neutral economy by 2050, the majority of the EU Member States governments are committed to withdraw all coal fired power plants by 2040, with the exception of four (4) EU Member States in which the phasing-out of coal is still under consideration. This commitment serves priorities related to the environmental protection, to the promotion of competitive electricity generation methods and to the diversification of the coal (lignite) mining areas in each country, of which some of them constitute the TRACER Project target regions.

These areas face socio-economic and environmental consequences stemming from the multi-annual and unilateral focus on coal/lignite activity - to the detriment other economic activities - but also from the lack of planning of a new, balanced and sustainable development model. It is obvious that these consequences have accumulated due to the gradual and steady reduction in coal/lignite production over the last few years. In this light, the main priority of the EU Member States and the regional governments is to ensure the economically and socially just transition of these regions, by minimising the above consequences through the diversification of their production model for the creation of new values in different sectors and branches.

In more than half of the 42 coal regions in the European Union, the switch to clean energy can create more jobs than currently exist in the coal sector, finds the latest relevant report of the European Commission (JRC)[1]. The report follows the adoption of the European Green Deal communication and the announcement of the EU’s Just Transition Mechanism, which aims to support communities most affected by the transition to climate neutrality by 2050, especially in the EU’s coal regions.

JRC estimated that there are more than 200,000 direct coal-related activity jobs in the coal regions. On the other hand, the deployment of renewable energy technologies in the coal regions facing coal phaseout can create up to 315,000 jobs by 2030, and up to 460,000 by 2050, as the “*Clean energy technologies in coal regions: Opportunities for jobs and growth*” report underlines. However, these estimates became rather conservative in the meantime, due to the latest developments in the energy sector (as expressed in the Member States' National Energy and Climate Plans, as well as in the latest EU plans - e.g. 'Fit-for-55'), but also in the decarbonization plans of the regions involved, as will be shown in what is presented for the target regions of the TRACER project in the following.

At the same time, the EU is taking decisive actions to move beyond the economic crisis by creating the conditions for a more competitive economy with higher employment. EU’s growth strategy over time aims at delivering growth that is: smart, through more effective investments in education, research and innovation; sustainable, thanks to a decisive move towards a low-carbon economy; and inclusive, with a strong emphasis on job creation and poverty reduction.

[1] “*Clean energy technologies in coal regions: Opportunities for jobs and growth: Deployment potential and impacts*”, Kapetaki Z., Ruiz P., et al., EUR 29895 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-12330-9, DOI:10.2760/063496, JRC117938

And the energy sector is one of the main areas where action is needed to meet these objectives, especially as the developments in this field are key for realising the move towards a sustainable and secure low-carbon economy - addressing the vision towards making Europe the first climate-neutral bloc in the world by 2050.

Delivering sustainable growth in a vast and developing sector such as energy creates also prospects for enhancing the competitiveness of European enterprises, creating new markets and job opportunities, and strengthening the European industrial base. Implementing the EU policy objectives in this field is largely dependent on the advancement of efficient and cost-effective low carbon energy solutions. The launched in 2007 European Strategic Energy Technology Plan (SET Plan)[2] is the technology pillar of the EU energy and climate policy in order to address the energy innovation challenge. SET Plan has established a strategic frame for the development and advancement of low carbon energy solutions, encouraging joint actions among the Commission, EU Member States and industry/research organisations with the aim to pool resources and achieve quicker and cost-efficient implementation.

In moving forward energy technology innovation, the SET Plan has recognised that one of the key elements for successful implementation at EU level is the availability and mobilisation of appropriately skilled human resources. The energy sector is an evolving field which creates new job opportunities but at the same time requires the development of new skills and competences, in line with the objectives of the Europe 2020 Flagship Initiative "An agenda for new skills and jobs". The growing education and training needs in the low carbon energy area have already been highlighted in a number of recent Commission education and employment policy frameworks, such as the Communications "Rethinking Education" and "Towards a job-rich recovery".

The challenges are significant. On the one hand, a growing low carbon energy sector requires the education, training or re-skilling of a significant number of additional workforces in the coming decades. At the same time, energy innovation creates a massive need for new talents, upgrade of existing curricula and programmes, and the incorporation of training in real environment. The challenges for the education and training institutions and their legal frameworks will be to ensure a workforce flow of researchers, engineers and technicians who are able to generate new knowledge and to meet the requirements of evolving technologies and labour markets. In parallel, training for managers and decision-makers in the field is needed to design and implement appropriate frameworks for the development and deployment of new energy solutions.

Obviously, the "problem" that the coal regions in transition have to face is twofold. On the one hand, ensuring new jobs for the local workforce that was previously employed in the coal sector and which will have to change sector now, and on the other hand, addressing the needs raised by the further spread of clean and cost-effective technologies. The structure of the report on the needs for workforce retraining follows the logic that for each target Region should first be given a picture of the current situation of the workforce there, and secondly to present the vision for the region, in the perspective of its decarbonization or “green – and just - transition”.

For the current status of each region’s workforce, there is a section which outlines an updated regional profile for each target region in terms of economic indicators, population statistics (including age and education) and data showing the region’s main areas of economic activity. A second section provides up to date data on the employment and unemployment levels in each target region. It also discusses the anticipated impact of the decarbonisation process in the region on employability, i.e. the transferable skills needed by individuals within the population to make them 'employable', related to the expected skills needs of energy transition and decarbonisation processes in the region.

[2] https://energy.ec.europa.eu/topics/research-and-technology/strategic-energy-technology-plan_en

As regards the vision for the Region part, first it is briefly described the expected development of the 'energy mix' in the region (based in part on work carried out previously for the TRACER report D6.1, and updated to reflect more recently published information), as well as what is known publicly of plans to decarbonise the energy sector in the region. The next section reviews recent assessments that have been made of the number and sector of new jobs to be created through the decarbonisation processes in the targeted region (or in the country more generally). The last section of this part of each target region's report outlines the anticipated transition-related reskilling needs of the workforce there, and describes recent developments within the region which take forward the green skills agenda.

2 Bulgaria, Yugoiztochen Region

2.1 Current status of the region's workforce

2.1.1 Regional profile and specialisation

The current analysis focuses on the Bulgarian Southeast Planning Region (SER) (NUTS2), covering four administrative regions: Burgas, Sliven, Yambol and Stara Zagora, including 33 municipalities. SER has a total area of 19,798.7 sq. km (17,8% of the territory of Bulgaria) and a favourable geographical position with wide access to the Black Sea (224 km to the east) and a long border with Turkey to the south. Its crossroad position is a prerequisite for the development of intensive economic connections with other regions in Bulgaria and abroad. By 2020 the population of SER amounted to 1,022,151 people (NSI, 2021) with an average density of 57 people per sq. km. The settlement network in the region consists of 486 settlements (26 cities and 460 villages).

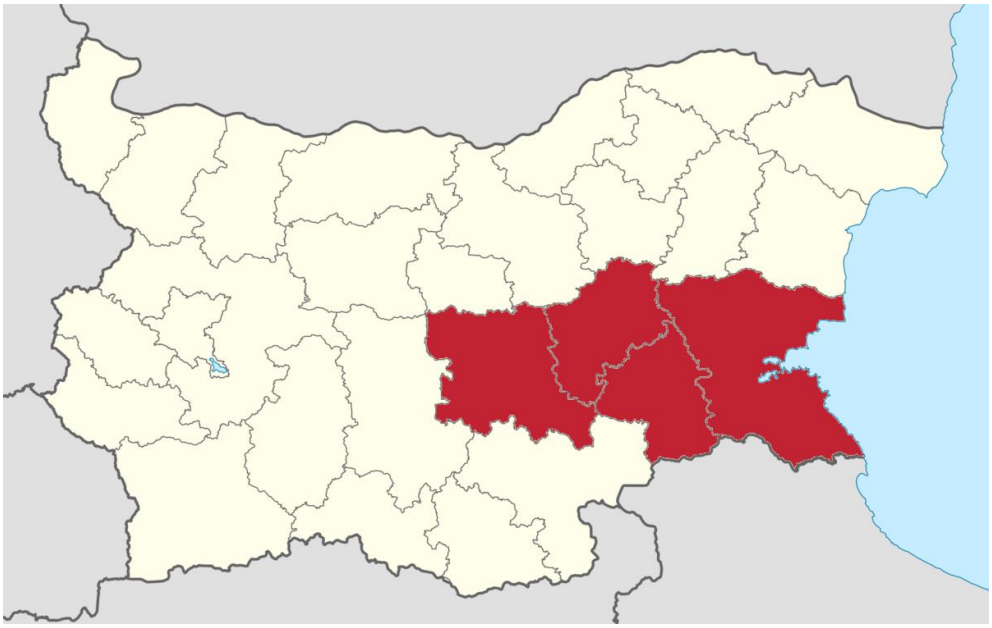

Figure 2.1: Southeast Planning Region, Bulgaria, NUTS2 [Source: Wikipedia]

The economy of the region is influenced by several factors, the most important being the strategic geographical location with access to the Black Sea. The port of Burgas with import-export cargo flow through it, defines the increased share of foreign direct investments in the SER. Another important element in the regional economy is the large lignite basin located in the region of Stara Zagora - Maritsa East energy complex.

Foreign direct investments are an important factor for the development of the region's economy. A significant part of it is directed to Maritsa East energy complex. In 2020, the region ranked third in Bulgaria in terms of GDP (EUR 6,364 million), corresponding to EUR 6,226 GDP per capita. The average annual salary in the SER was EUR 7,077 in 2020 - the third highest in the country (NSI, 2022).

In terms of demography, the population of the SER has greater reproductive and labour opportunities compared to the other regions in the country. This is evidenced by the state of its age structure: the share of people under 15 is about 16%, while the relative share of people of retirement age is below 22%. In 2020, the estimated number of people of working age was 639,193. The state of the sex and age structure of the population in the region is largely dependent on its ethnic structure, employment opportunities, birth and death rates, migration, etc. Similarly to the whole country, the natural population growth for the region is negative and in 2020 it amounted to -8,65‰ (NSI, 2021). This indicator shows worrying values for decades.

In the last 10 years, the population in the region has been characterized by relatively high migratory mobility (about 7%), mainly due to the emigration of ethnic Turks. Internal migrations are dominated by relocations between cities in the region. In the last decade, there was an increase in migration from rural to urban areas mainly because of the lack of economic resources, employment and security in rural areas. Nevertheless, the unemployment rate in the SER was only 4.5% in 2021, which is among the lowest levels in Bulgaria (NSI, 2021).

There are 56,455 active business entities registered in the SER or nearly 14% of all companies in the country. The main share is in the tertiary economic sector, such as trade, education, and public catering. The number of economic entities in the secondary sector is also significant - food and beverage production, construction, etc. Most of these entities are registered in the Burgas region, and in general, the orientation of production and trade is mainly concentrated in the Black Sea coast. Nevertheless, the other 3 regions (Stara Zagora, Sliven, and Yambol) also showed a positive economic development in the last 10 years, thanks to well-developed infrastructure, large industries, favourable geo-economical location, and favourable conditions for attracting local and foreign investors (NSI, 2022).

The primary economic sector in the SER is developed on the basis of favourable soil and excellent climate conditions for agriculture, the availability of various minerals, wood and opportunities for fishing. The secondary economic sector is represented in the region by many and varied light and heavy industries and activities directly connected with agriculture, mining and logging. The development of the tertiary sector in the SER is mainly based on its strategic geographical location and the concentration of economic and demographic resources in it.

The SER hosts on its territory the biggest energy complex in South-Eastern Europe - Maritsa East, located in Stara Zagora district. The complex, which includes three lignite-fired thermal power plants, a mining company, enrichment plants, a briquette plant and own railway system, is a pillar of the electricity generation in the country. The Maritsa East lignite complex is the key contributor to the economy of the region, with relatively high wages and low unemployment rates. The introduction of the EU Green Deal, however, imposes serious challenges to the complex and raises concerns about the prospects for the workers.

Regarding the educational level of the population in SER, the region nears the average rates for Bulgaria, or 17% of the population aged 25-64 have primary and lower education, 54% secondary, and 29% higher education. Statistical data show large differences between the districts within SER. The highest number of university graduates is in the district of Burgas (by more than 10 percentage points), which is accompanied there by a sharp decline in the population with primary and lower education (Slavova, Z., 2021). As it might be expected, the majority of higher educated people live in bigger cities, namely Burgas and Stara Zagora.

The education system in the SER includes 3 universities (2 state and 1 private) and specialized higher schools (in Burgas and Stara Zagora), and 68 special schools. In the academic year 2020/2021 there were 11,537 students in universities and specialized higher education institutions, which is about 6% of the total in Bulgaria.

With its almost 60 years of history, “Prof. Dr. Assen Zlatarov” University in Burgas is among the oldest universities in Bulgaria. It consists of five faculties (Faculty of Technical Sciences, Faculty of Natural Sciences, Faculty of Social Sciences, Faculty of Public Health and Health Care, and Faculty of Medicine), three colleges (Technical College, Medical College, and College of Tourism), and two departments (Department of Language Training, and Department of Qualification and Professional Development of Pedagogical Specialists). The learning process of the university is carried out in 18 professional fields, in the frame of 45 accredited bachelor's and over 30 master's programs. The university shows good potential for being a driving force of the retraining and re-skilling of the workforce that would be needed as a result of the energy transformation in the SER region.

Burgas Free University is a modern and innovative private university providing education and training in the following academic areas: Legal, Social and Economic Sciences, Humanities, Technical and Computer Sciences. It is in cooperation agreements with 36 universities and organizations in Europe, America, Asia and Africa. Within its specialties, the university is capable of developing curricula for retraining employees that require reskilling or upskilling in the energy sector.

Trakia University in Stara Zagora (founded in 1995) is in the top 5 in the ranking of universities in Bulgaria. Its structure includes 9 units: Faculty of Agriculture with training and experimental base, Faculty of Veterinary Medicine with clinics, Faculty of Medicine with University Hospital, Faculty of Education, Faculty of Economics, Faculty of Engineering and Technology (in Yambol), Medical College (in Stara Zagora), Medical College (in Stara Zagora), and Department of Information and Teacher Training. The university trains over 8,200 students in 72 bachelor's and master's programs. The university also conducts more than 70 doctoral procedures. All these achievements allow the university to be an institution of the highest importance in the process of retraining and upskilling ex-coal workers in the SER.

In February 2021, the Institute for Sustainable Transition and Development was created within the structure of Trakia University, in Stara Zagora. Its main mission is to accelerate the high-tech low-carbon energy and industrial transition in the region and the country in general by encouraging investments in new industries that will lead to significant economic transformation. It fosters applied research activities aimed at the development and commercialization of decarbonization solutions, with a view to establishing the region as a leading research center in the field of high technology. It is committed to the development of a system of a sustainable creative scientific environment aimed at building a scientific community, the discovery, promotion and validation of talents, as well as the implementation of doctoral and postdoctoral programs. As a result of the joint efforts and support of the Ministry of Education and Science, Ministry of Energy, Confederation of Independent Trade Unions in Bulgaria, Confederation of Labour "Podkrepa", Stara Zagora Municipality, Trakia University, Technical University of Sofia, University of Mining and Geology “St. Ivan Rilski”, Bulgarian Chamber of Commerce and the Association of Industrial Capital in Bulgaria, the Institute declares its initiative and responsible position in the process of transforming the business model in the regions affected by the energy transition.

2.1.2 Employment and unemployment status of the local workforce

On average in 2020, the level of registered unemployment in the Southeast region was 7.2%, compared to 7.4% for the country. In the different districts the levels were as follows: Burgas (6.6%), Stara Zagora (6.2%), Yambol (7.0%), and much higher in Sliven, i.e. 11.0% (EURES, 2021).

The SER ranked third in Bulgaria in terms of employment of people aged 15 and over in the fourth quarter of 2020. Compared to the same period of 2019, there was a decline in all four districts in terms of employment. To a certain extent, this trend can be attributed also to the recent development of the Covid-19 pandemic (NSI, 2021).

The employment rate in the fourth quarter of 2020 decreased by 1.5 percentage points compared to the same period in 2019 and reached 50.6%, in comparison with 52.9% for the country. As observed in previous periods, the employment rate was traditionally higher for men (59.0%) than for women (42.9%), but compared to the same period in 2019 there was a decrease of 0.1 and 2.8 percentage points respectively for the two categories (NSI, 2021).

The most sought-after professions by employers in the region in 2020 were those in the tourism sector (valet, waiters, bartenders, chefs, hotel administrators, sales consultants), as well as workers in various fields of industry and services, such as labourers, machinery operators, teachers, seasonal workers in agriculture and the canning industry, drivers of various vehicles, security guards, personal assistants (Employment Agency of Bulgaria, 2020). In 2020, a total of 28,176 jobs were announced in the SER in the real sector. Most of the positions announced by employers for the real sector through the labour offices in the SER were for low-skilled or unskilled workers (64.2%). 53.4% of these jobs had a secondary education requirement, and 46.6% had a primary or lower education requirement (EURES, 2021).

The employment in Bulgaria in 2020 by types of renewable energy sources is shown in the table below.

Table 2.1: Employment by types of renewable energy sources (RES) in Bulgaria

RES	**Jobs ('000)**
Biogas	1.00
Geothermal Energy	0.21
Hydropower	5.09
Liquid Biofuels	7.50
Municipal and industrial waste	0.10
Solar Heating / Cooling	1.30
Solar Photovoltaic	0.98
Solid Biomass	27.00
Wind Energy	0.54
Total	**43.72**

Source: IRENA, Annual Review 2021

According to the table, the bioenergy sector, including solid, liquid, and gaseous biomass, provides over 80% of all jobs.

The labour market in the SER continues to experience a shortage of highly qualified personnel, such as engineers in the field of information and telecommunications technology, construction and energy, technicians and electricians, language managers, personnel for the education and health care systems, as well as drivers, crane operators, excavators, welders, tailors, specialists and workers for some of the leading industries in the region, such as hotels and

restaurants and related activities. This tendency is disturbing given the fact that even more qualified employees will be needed in the context of the energy transition that will significantly affect the SER.

The relatively positive development in terms of employment in the SER will, however, face serious consequences that coal phase-out will bring. The energy transition envisaged by the EU Green Deal will significantly affect the region. According to the schedule of the National Recovery and Resilience Plan (NRRP), the indicative year for the phasing out of coal capacity is 2038 (CoM, 2021). According to the projections, the reduction of installed capacity in Maritsa East complex will begin in 2026 with 0.9 - 1.8 GW, will continue in 2030 with around 0.7 GW, and will be finalized in 2038 with 1.6 - 2.5 GW (PwC, 2021). This will accordingly result in 11,600 - 16,000 potentially affected jobs till 2026, about 6,300 jobs more till 2030, and 14,800 - 18,000 more jobs lost till 2038. The initial estimations conducted as a part of a consultancy service for the preparation of the Territorial Just Transition Plans state that 23.8% of the total employment in Stara Zagora district will be affected by the Just Transition processes, which define its effect in the region as significant (PwC, 2021).

Coal mining and electricity production have long traditions in the observed region. This implies that many employees have a set of skills related to these two sectors and will need specialized retraining to meet the requirements of a diversified economy. A significant share of the affected workforce is approaching retirement age, as about 30% of them are over 50 years old (NSI, 2021), but given the plans for phase-out the coal economy, there may be difficulties in adapting to the changing market conditions. The current market structure in SER shows potential for transfer of labour force to other economic sectors with similar skills, such as, for example, manufacturing or construction. This can be achieved, however, by targeted policies directed to retraining and upskilling in similar professional fields for the affected working population (short-term measures) and measures directly in education (VET and higher education) to minimize future skills mismatches in secondary and higher education (long-term measures).

2.2 Vision for the Region

2.2.1 The path towards decarbonization

The draft NRRP (CoM, 2021) specifies 2038 as an indicative coal phase-out year. However, there is pressure from the European Commission and national stakeholders to either completely phase out or substantially reduce coal use for electricity generation until 2030. In relation to Art.22 (4) of Regulation (EU) 2019/943 of 5 June 2019, starting from 1st July 2025 the coal TPPs could rely only on energy trade (not on capacity services) and this would almost certainly lead to their insolvency. The result of this situation is expected to be gradual, but speeds up the phase-out of the coal capacities in the region after mid-2025.

Coal briquettes are currently used in 2 district heating companies (DHC) and in a small number of households in SER. The DHC in Sliven is currently preparing its complete switch to natural gas and, in the long-term, plans to install a 10 MW biomass-fired heat boiler. The DHC in Galabovo is expected to stop operation before 2030 (Nikolaev I., 2022). The use of coal briquettes in households is expected to continue its sharp decline in the next few years (Mihaylov T., 2021).

Natural gas is not expected to play a significant role in electricity generation after coal phase-out. The draft NRRP (CoM, 2021) includes a project for the construction of gas infrastructure to supply natural gas to Maritsa East complex, so that some of the coal capacities can be replaced by combined cycle gas turbines. However, this project was cancelled in January 2022 by the new Bulgarian government (Vasilev, 2022a).

Burgas district heating company is expected to continue consuming the same amount of natural gas until 2030 (Nikolaev I., 2022). Additionally, it is likely that there is promising

potential for new gas-fired CHPs in Burgas District and Stara Zagora District (ME, 2016). Furthermore, it is expected that the trend of increased gasification in households, industry and service sectors would continue until 2030 and beyond, in line with the priorities of the draft Sustainable Energy Development Strategy of the Republic of Bulgaria (ME, 2021) and the NECP (ME, 2020). All above projections, however, are highly uncertain in light of the recent increase in gas and carbon prices, and the geopolitical risks associated with gas imports from Russia.

Due to the small untapped wind potential in Stara Zagora district, it is unlikely that wind energy projects will receive special support through their inclusion in the Territorial Just Transition Plan of Stara Zagora. It can therefore be assumed that wind energy in SER would rather develop at the average rate for the country, in proportion to the untapped technical potential in each region. This would result in an increase of the wind power capacity in SER from 121 MW in 2020 to 215 MW in 2030 and about 1,200 MW in 2050 (Nikolaev A., Kotabova A. et al, 2021).

The southern part of SER, in which Maritsa East lignite complex is located, has significant solar energy potential and many believe that large-scale solar PV plants is an excellent opportunity for the post-mining development of the Maritsa East area. The large-scale solar PV capacity in SER, amounting to 421 MW in 2020, is projected to increase to 1,262 MW in 2030 and 1,826 MW in 2050 (Nikolaev A., Kotabova A. et al, 2021). Additionally, the small-scale (domestic) solar PV and solar thermal installations are expected to substantially develop in SER, in line with the stimuli laid down in the draft NRRP (CoM, 2021).

According to the NECP, in Bulgaria, both the electricity and heat production from biomass will grow during the period 2020-2030 and most of that growth would come from the newly built biomass CHP plants. Biomass is expected to have a declining share in individual heating in SER, as users are expected to switch to cleaner and more comfortable alternatives. Although larger (community-based or industrial) biomass heating and CHP projects are expected to increase, it is not likely that they will reach a notable share in the 2030 energy balance of the region (Nikolaev I., 2022). Also, it must be mentioned that no new hydropower generation capacity is expected in SER, as almost all technical potential is utilized (Mihaylov T., 2021).

There is consensus that the intermittent renewable electricity (such as solar PV and wind) capacities in SER need to be combined with electricity storage and/or production of green hydrogen from the excess electricity. Both technologies are considered very promising for the region after 2030, when the costs are expected to go down (Nikolaev A., Dineva M., 2021). This is in line with the draft Energy Strategy, whose priorities include electricity storage systems and power-to-gas (hydrogen and methane) technologies (ME, 2021). The new Bulgarian government announced its intentions to include in NRRP battery storage projects for at least 12 GWh (Vasilev, 2022a), produced on the territory of Maritsa East complex (Vasilev, 2022b). It is likely that a large part of these batteries will be used in the complex, in relation to the expected high intermittent capacities there in the near future.

According to the NECP (ME, 2020), Bulgaria intends to enable the integration of hydrogen in its energy and mobility systems. It expects annual final hydrogen consumption of 34 GWh in 2030 and 256 GWh in 2040, all of which would be in the transport sector. The hydrogen will be produced with electrolysers using renewable electricity. On the other hand, according to EUCO3232.5, in 2030 the hydrogen consumption would be much higher - 0.8 TWh/a in the low scenario and 1.4 TWh/a in the high scenario (FCH 2 JU, 2020a). Bulgaria’s Minister of Economy launched the process to prepare a new Innovation Strategy for Smart Specialisation 2021-2027, with the aim to further explore the deployment of electrochemical sources such as hydrogen and fuel cell technologies.

Recently, the Bulgarian government announced its plans to include two more considerable energy projects in NRRP:

- waste incineration installations in the ex-coal fired TPPs in Maritsa East complex (Vasilev, 2022a), which are expected to use 55,000 t/year waste (Stara Zagora Municipality, 2022); and
- 400 MW geothermal capacities in six sites, but none of these sites is within SER (Vasilev, 2022a).

Another important direction that would remain a top priority until 2050 is energy end-use efficiency. The more and more stringent building codes and the increasing demand for passive buildings are shifting the market towards innovative building materials, automation, heating and cooling systems. Additionally, the high energy prices combined with the subsidies offered by the Bulgarian government are a strong motivation for households to undertake building renovation.

2.2.2 New jobs to be created through the decarbonization process

The energy shift in the following decades envisages that certain sectors will experience a significant decline (e.g. coal mining, TPPs maintenance, etc.), while others, such as electricity generation, will continue developing after transformation and adaptation activities. There will also be emerging sectors that are expected to grow as a result of the transition. These are, for example, the production of energy from renewable sources, production of hydrogen, production and installation of renewable energy components, materials, infrastructure and spare parts, and energy efficiency related activities.

The below sections provide projections for the employment in each energy sub-sector, based on the projected energy development described in section 2.2.1.

Jobs in the bioenergy sector

The planned 10 MW biomass heating capacity in Sliven DHC is expected to contribute to 11 full-time equivalent (FTE) jobs in SER, related mostly to the biomass fuel processing and storage (Nikolaev I., 2022).

Although there may be other new medium and large biomass heating and CHP installations in SER, as specified above, it is unlikely that the installations would be many. It cannot be expected therefore that the jobs associated with these installations would outnumber the lost jobs associated with the decline of the individual biomass heating.

Outside SER there are large Bulgarian factories for production of biomass equipment. Therefore, it is not feasible to assume construction of new such factories in SER. The installation works related to the new medium and large capacities would secure only short-term employment of a small number of installers, so the related numbers are not significant (Nikolaev I., 2022).

Jobs in the hydropower sector

Given the fact that no new hydropower capacities are envisaged in the SER due to almost full utilization of the existing potential, it is not expected that new jobs will be created.

Jobs in the PV industry

For the planning and implementation of PV plants various levels of employees are needed, i.e., from drivers and logistic experts to electrical engineers and financial experts. According to the existing estimations in the sphere, a total of 229,055 person-days are needed to develop a solar PV plant of 50 megawatts. Most of them (56%) are expected to be engaged in operation and maintenance, which represents long-term employment (IRENA, 2017).

A JRC study (Kapetaki, Z., Ruiz, P. et al., 2020) estimates that in EUCO3232.5 scenario there would be 0.12 GW solar PV in SER, corresponding to 309 full-time equivalent (FTE) jobs. This study, however, is outdated and the targets, especially for SER, are seriously underestimated in the context of the new EU, national, and regional ambitions. Most projects for decentralized PV installations currently under construction in Bulgaria are configured entirely for own consumption and are not connected to the grid (Couture, Toby D., et al, 2021). These projects, therefore, are very different from the large-scale projects and create different employment.

According to SolarPower Europe, if EU adopts 40% RES target for 2030, this would be translated in 479 GW PV capacity in 2030, including both large-scale and small-scale PV, and this would result in 741,871 solar jobs, including 131,949 for manufacturing and 609,922 for deployment, operation & maintenance, and decommissioning & recycling (SolarPower Europe, 2021). This is equivalent to 1,549 or 1,273 jobs per GW, depending on whether manufacturing is included or not. The respective results are presented below.

Table 2.2: Projected number of Solar PV jobs in SER

	2030	**2050**
Solar PV capacity, GW	1.262	1.826
Jobs total, FTE	1,955	2,828
Jobs w/o manufacturing, FTE	1,607	2,324

Jobs in the wind energy sector

The national wind energy sector provided only 0.54 thousand jobs in 2020 (see **Table 2.1**) and, due to the modest increase projected in NECP (ME, 2020), it is not expected that the number will increase significantly in the years to come. As stated in section 2.2.1, SER demonstrates only limited potential for the development of a sustainable wind energy sector, estimated according to NECP projections. On the other hand, in the context of the increased 2030 targets of “Fit for 55” Package, the NECP projections appear to be too conservative and a more ambitious wind energy pathway is likely to be required. JRC estimates that in 2030, there would be 1,409 wind jobs in SER (Kapetaki, Z., Ruiz, P. et al., 2020), but this calculation is based on very low targets, corresponding to only 0.12 GW wind capacity in the region.

The wind energy sector will inevitably lead to increased demand in the maintenance services, spare parts and operational force in SER. According to Wind Europe, NECPs in Europe altogether envisage 286 GW onshore wind in 2030. This would correspond to 250,000 jobs, including both direct and indirect jobs, of which 46.1% related to wind turbine manufacturers and components manufacturers (Pineda I., 2020). This is equivalent to 874 and 471 jobs per GW, respectively in total and excluding manufacturing. The projected number of wind energy jobs in SER are shown in the table below.

Table 2.3: Projected number of wind energy jobs in SER

	2030 NECP scenario	**2030** Accelerated decarbonisation	**2050**
Wind onshore capacity, MW	215	323	1,200
Jobs total, FTE	188	282	1,049
Jobs w/o manufacturing, FTE	101	152	565

Jobs in the hydrogen sector

There is no plan how the hydrogen jobs would be distributed in the Bulgarian regions. Considering the limited NECP's national target for 2030 for hydrogen energy consumption (34 GWh), it is reasonable to assume that all 2030 jobs will be concentrated in SER, i.e., the region with the largest allocated decarbonization funding and expected large capacities of intermittent RES. The further planned (in NECP) 222 GWh until 2040 are likely to be distributed among the 6 NUTS2 regions in the country, that is on average 37 GWh per region. The effect of the increased production on employment is unclear and would depend for example on whether the existing capacities would operate at higher load or new capacities will be installed.

The hydrogen energy development projected in EUCO3232.5 is estimated to generate employment of 1,000 – 1,700 direct jobs in production and operations & maintenance, and to contribute to a further 2,400 – 4,300 indirectly related jobs, depending on the scenario. As illustrated in the below figure, most of these jobs are expected to be created by building and operating RES and CHP technologies (FCH 2 JU, 2020a). Given that the jobs related to these technologies are considered separately in this study, they would not be attributed to the hydrogen sector.

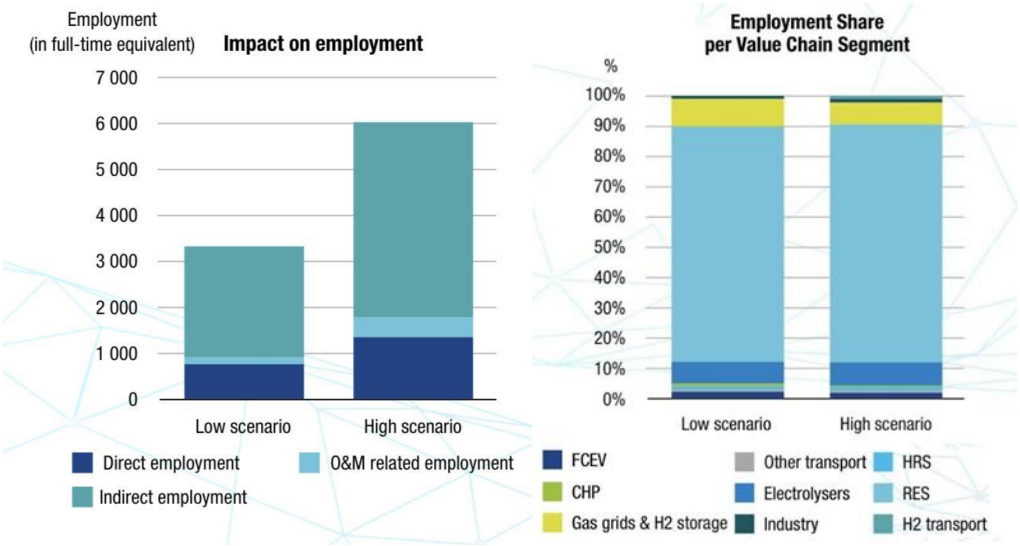

Figure 2.2: Estimated employment in 2030 Bulgarian hydrogen sector

Source: FCH 2 JU, 2020a

The EUCO3232.5 estimation of 2030 hydrogen jobs in SER, excluding the ones related to RES and CHP, is shown in the table below (FCH 2 JU, 2020a).

Table 2.4: Projected number of hydrogen energy jobs in SER

	2030 EUCO3232.5 Low scenario	**2030** EUCO3232.5 High scenario
Energy consumption, TWh	0.8	1.4
Jobs total, FTE	748	1,320

Jobs in the batteries sector

The intention of the Bulgarian government is to locate a factory for batteries production on the territory of Maritsa East basin (Vasilev, 2022b). The factory would produce 12 GWh batteries

to cover the national needs (Vasilev, 2022a). There are still no discussions about the annual factory capacity (i.e. for what period the 12 GWh capacity would be produced), the type of batteries, and which steps of the production chain will be included, so it is impossible to provide even a rough estimation of the number of related jobs.

Jobs in the waste-to-energy sector

There is no operating waste incineration plant in Bulgaria. A feasibility study for such a plant in Sofia, with a capacity of 36 kt waste incineration, estimates that it would create 44-80 new jobs (Sabev, 2019). If we assume that the same number of jobs per unit of capacity stands here, the 55 kt waste incineration plant in Maritsa East complex would create 67-122 new jobs. It is likely, however, that the numbers in Maritsa East would be lower, due to economy of scale.

Jobs in the building renovation sector

Small-scale energy projects, such as energy efficiency renovation and replacement of heating systems with RES-based ones, have many advantages over large-scale systems, some of the key ones being generation of more jobs and increased citizens' awareness about climate and sustainable energy.

According to JRC (Kapetaki, Z., Ruiz, P. et al., 2020), in 2050 in SER there will be 4,700 building renovation jobs (FTE) in BAU scenario. The study does not estimate the number of jobs in the other scenarios:

1) realization of the theoretical cost optimal renovation potential;

2) realization of the theoretical NZEB potential.

However, these can be estimated by assuming constant number of jobs created per unit of investment, as can be seen in the table below.

Table 5: Projected number of building energy renovation jobs in SER in 2050

	BAU	**Theoretical cost optimal**	**Theoretical NZEB**
Associated investment needs (MEUR)	3,666*	5,819*	10,472*
Potential Jobs (FTE/year)	4,700*	7,460**	13,426**

* *Source*: Kapetaki, Z., Ruiz, P. et al., 2020

*** Estimation, assuming constant number of jobs per unit of investment*

2.2.3 Reskilling / retraining needs of the local workforce

The decarbonization of the EU27 is expected to result in the loss of about 76,000 workers' jobs in the coal mining sector until 2025 and 154,000 until 2030 (RES-SKILL, 2020). In the SER, between 14,800-18,000 workers will be affected by the envisaged energy shift (PwC, 2021). At the same time, the intensive search for employees in the renewable energy sector is already a fact and is expected to constantly grow. In the EU, 1,317,000 direct and indirect jobs were accounted for by renewable energies in 2018/2019 (IRENA, 2020). Thus, Europe was a leading actor on the renewable energy scene and this tendency is gradually increasing. This number is expected to grow in the following decades also in the SER region, in whose economy energy will continue playing a major role.

In this context, today's coal workers will face either the fear of job loss due to the restructuring of the coal sector or the challenge of reskilling. An essential resource they possess is the fact that most of them are experienced experts, who will ideally fit for covering unfilled positions in

the RES sector due to their similar knowledge and skillset. Thus, in a period of designing future strategies and plans for development with a horizon of 10 to 30 years in the SER, it is crucial to identify, measure and assess reskilling needs that Just Transition will open and to propose adequate measures to guarantee the smooth transition towards clean energy.

The skills of coal workers (e.g., durability in hazardous environments, employment of manual & sophisticated technologies) are sought after in the solar photovoltaic and wind industries and the bioenergy branch, being particularly transferable to the occupations such as solar installers and technicians, wind turbine technicians, etc. Nevertheless, it is essential for employees in transition that they can validate their knowledge and skills, avoiding a lengthy training (which normally takes up to 2 years) and take advantage of tailor-made curricula, which facilitate their smooth transition to clean energy generation industries. In particular, the supply of new RES sector jobs in partnership countries could absorb up to 90% of current coal-related jobs (RES-SKILL, 2020). Currently, VET education and the labour market are already challenged by the spike of coal workers seeking re-employment in the near future and the surge in unfiled positions in RES. Therefore, the development of novel curricula and tailored training content to facilitating coal workers' re-orientation to the RES industry is essential for conducting a smooth transition process towards clean energy generation.

As the renewable energy workforce continues to expand, education and training along with the reskilling and upskilling rise in importance. Thus, targeted policies and adapted programs on vocational training, curricula, teacher training, information and communications technology, and public-private partnerships are needed in order to meet the growing market demand for the RES workforce. What is more, employment in RES is not only generated in the energy-producing facilities. This is for the benefit of the SER since it shows good potential for developing several renewable sectors.

Thus, the region can be economically active in all 4 sub-sectors of the RES industry:

- Manufacture and distribution of RE equipment, including the necessary research and development (R&D). Activities that expect not only huge investments, but also the respective knowledge and experience for the proper management, therefore, experienced energy experts from the region will be appropriate candidates. Furthermore, the SER has at its disposal a relatively well-developed R&D network, which is a prerequisite for promoting new technologies and innovations.
- Project development. In the context of RES boost on the territory of SER, the project development is a cornerstone for the successful planning and implementation of the envisaged plans and programs. It offers significant potential for motivated employees to reskill or upskill.
- Construction and installation work for the development of RE projects. Ex-mine workers are experienced in construction and installation works and after tailor-made curricula, their previous expertise can easily be implemented to the new field of occupation.
- Operation and maintenance (O&M) of RE facilities (Malamatenios, C. 2016). As previously mentioned, the analysis for installation of RES capacities shows that this sub-sector has also potential for creating jobs for ex-coal workers in the SER.

Covering the skills gaps and shortages that are going to open because of the transition processes can be easily facilitated by enhancing the role of education and training. Nevertheless, different scenarios are possible when observing the development in the SER. An optimistic case would be if the worker undertakes the respective reskilling or upskilling initiative with or without the support of the new employer and, after the adapted training, he/she can start a new career in the RES sector (or also in other relevant fields). Another possible path would be to seek assistance from the local labour agency, whose personnel, however, needs also respective training for coping with the sensitive group of ex-coal workers. Institutional guidance towards the RES sector is essential for the successful transition process and the career reorientation of the target group.

Third way of development is the creation of independent economic activity by the coal workers, including the establishment of an own private company. This scenario is beneficial at multiple levels in a region such as SER, which is expected to experience increased rates of unemployment. Another possible development can be that the employee is near retirement age, so his/her career approaches a natural end. All these possible paths for development require strict supervision, planning and strategic thinking in order to be adequately prepared and adapted to the current necessities of the envisaged target group.

If the total number of the newly created jobs as a result of the boom in the RES sector is compared to the potentially lost employment due to the gradual coal phase-out process in the region, it is evident that a serious shock is not to be expected. Indeed, there are many circumstances that will also influence the employment landscape in the SER, such as for example migration tendencies and retirement of the workforce, which will ease filling the gap between newly created and lost jobs. What is more, the emerging sector of RES, if properly managed, attracts many specialists who may be ready to migrate because of a good job offer. All these side effects are important factors in the conduction of a smooth, fair and just transition in the SER.

When analysing the potential for job creation of the RES sector in the SER, it is essential to also elaborate on the different types of occupations that the RES sub-sectors can offer. Starting with wind energy, the branch can propose jobs of all possible hierarchical levels, for example, project developers, service technicians, data analysts, maintenance and repair electricians, energy electricians ITs, mechanical and construction engineers, machine operators and HVAC system installers. Solar energy can generate vacancies for PV and solar thermal system installers and maintainers, building inspectors, machinists of road construction machinery, PV electricians. Hydropower can create jobs for electrical and operations & maintenance engineers, technicians, tradespersons, sustainability specialists, etc. (RES-SKILL, 2020)

A methodology that can be applied to the process of identifying retraining needs of the population in SER engaged in the lignite sector is the creation of transition profiles that will enable coal workers to transit smoothly from the coal industry to the RES sector. To this end, occupation profiles of former coal workers need to be matched with the most relevant occupations in the RES sector based on skills.

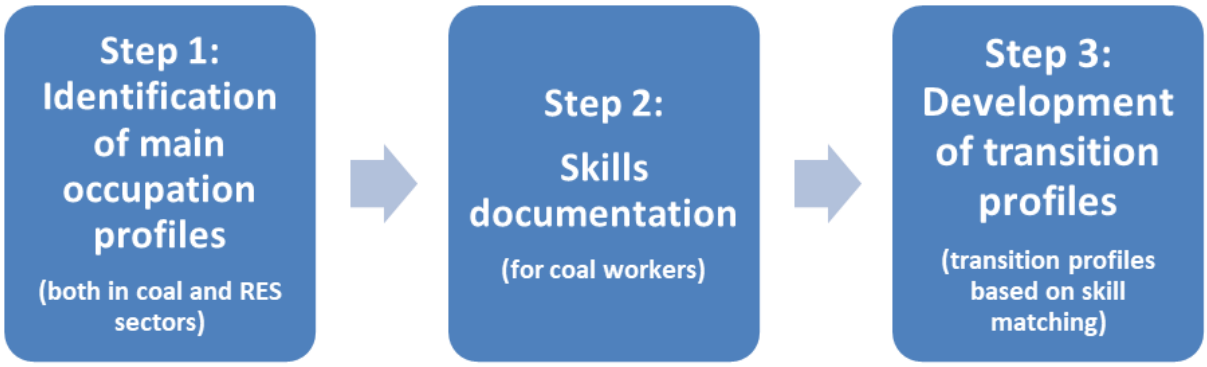

Figure 2.3: Methodology for the identification of retraining needs.

Source: RES-SKILL, 2020

The analysis, based on a match of knowledge and skills, shows that the most common occupation profiles in the coal industry have logical equivalents in the RES sector (RES-SKILL, 2020):

- Mining machine operators → machinist of road construction machinery (PV) and machine operators (wind) (approximately 6 months of retraining)
- Fitters in the coal industry → PV fitter/installers and HVAC system installers (approximately 1 month of retraining)

- Maintenance and repair workers → PV operation and maintenance technicians (approximately 1 month of retraining)
- Construction equipment operators → Machinist of road construction machinery (PV), Machine operators (wind) (approximately 1 month of retraining)
- Heavy vehicle & mobile equipment service technicians & mechanics → PV operation and maintenance technicians, Maintenance and repair electricians (approximately 1 month of retraining)
- Mining electricians → PV electricians, Electricians (wind), Maintenance and repair electricians (wind) (approximately 3 months of retraining)

When analysing the retraining needs in the SER that the coal phase-out will cause, it is important to identify the profile of the workforce that is about to be reskilled. There is, however, no reliable public information on the sequence of the personnel of the 3 TPPs and the mining company that forms the Maritsa East complex. Partial data can be found only about the workers in the Maritsa East Mines. The limited available numbers show that staff members have been gradually increasing in the last years. In 2018, production and operating activities occupied about 6,000 employees and the administrative staff was nearly 1,200 (Maritsa East Mines, 2019). Indeed, the comprehensive analysis of this data is the proper basis for the development of strategies for the management of the transition process in the SER.

The transection of the target group's educational level is also an essential element for discovering the real retraining needs of the affected workforce. According to the available data (only for the mining company in the complex), about 21% of the employees have higher education, more than 70% possess vocational-technical education, and less than 10% have secondary or lower education (Maritsa East Mines, 2019). In order to grasp the regional socio-economic characteristics in the energy complex and to design a feasible plan for the gradual transformation of the energy sector, this data needs to be the driving force for the envisaged shift. This bottom-up approach will allow the fine-tuning of the educational structure, its capacities and shortcomings, so as to be able to respond adequately when the time for active career re-orientation comes.

The new jobs creation in the framework of decarbonization naturally seeks to reskill through exploring and developing the RES potential. To achieve this several steps are shown as necessary, namely reduction of the administrative barriers and fees of small and medium-sized power plants, facilitation of their connection to the grid and the release of excess energy, as well as build comprehensive policies and regulatory environment to support investments. This can be achieved by introducing a clear legal and regulatory framework for consumers who are also producers (i.e. producer-consumer), in accordance with the European RED II Directive, and to make appropriate use of EU funds, including the European Green Deal (Couture, Toby D., et al, 2021)

The pathway towards decarbonization goes through guaranteeing long-term employment and maintaining the high quality of life in the SER. This process requires the joint effort of all engaged stakeholders, namely local and regional authorities and their organisations, national authorities, trade unions, employers' organizations, vocational training and retraining centers, vocational high schools, vocational colleges, secondary schools and high schools with classes for acquiring professional qualification, universities, NGOs.

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3 Czech Republic, Northwest Bohemia

3.1 Current status of the region's workforce

3.1.1 Regional profile and specialisation

Within the Northwest NUTS 2 region, two regions at NUTS 3 level are assessed together, namely the Ústí nad Labem Region (or Ústecký Region) and the Karlovy Vary Region. Socio-economically, this is a structurally disadvantaged region, where changes due to the decline in coal are already manifesting or expected, but in recent years the structure and employment of the local population may be affected by the COVID crisis (closure of restaurants and accommodation facilities, quarantine, disruption of production, etc.) and now by the war in Ukraine (greater pressure on jobs, negative effect of supply chain in chemistry and other industries etc.) and inflation and rising prices in general. More detailed consequences are described in Table 3.1.

Table 3.1: Salary in the two regions in consideration and in the national level

Q1/2022	Ústecký Region	Karlovarský Region	National level
Average gross salary	35 655 CZK	33 165 CZK	37 839 CZK

According to the Czech Statistical Office (ČSÚ, 2022), a total of 145,013 men and 148,298 women lived in the Karlovy Vary Region by 2020, while slightly more women than men also lived in the Ústí nad Labem Region (406,610 men and 412,843 women). In recent years, the outflow of population has become more pronounced, not only in the Karlovy Vary region but also in the Ústí region (Table 3.2).

Table 3.2: Population overview, age structure and migration

Category		Ústecký Region					Karlovarský Region				
Years		2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Resident population (no.)		821377	821080	819323	820965	817004	296749	295686	294896	294664	293311
Age distribution (no.)	< 15 years	130785	131548	127924	131591	131156	44413	44352	44461	44750	44518
	15-64 years	540254	534972	535401	527847	522895	196260	193867	191556	189736	188009
	> 65 years	150338	154560	155998	161527	162953	56076	57467	58879	60178	60784
Net migration		-678	433	948	176	-3961	-703	-410	-54	-232	-1353

Source: ČSÚ, 2021

The share of employees by age in the Ústí nad Labem Region is basically stable during the period under review. In the age groups 18-25 and 26-30, there is a similar trend of the share. In the groups 31-35 and 36-40, there is a declining trend. A certain turnaround in the share of the number of employees by age occurs in the 41-45 age group, when in the first part of the observed period this share increased and in the second part it decreased. The same is true for the age group 51-55. The opposite case then applies to the 46-50 and 56-60 age groups. The age group from 64 to 65 is characterized by a growing trend.

The trends of the development of the shares of the number of employees by age in the Karlovy Vary Region are stable, especially in the groups 18-25, 26-30 and 31-35 years, as well as in the 46-50 years group. The age group of 36-40 years is declining, and the age group of 61-63 years is growing. In summary, in the observed period the share of groups of workers according to age up to 45 years gradually decreased and, on the contrary, increased above 45, while the most significant differences between these groups arise in the last monitored year 2020. Not only in the Ústí Region, but also for all the other monitored, it can be stated that the mining workforce is aging.

3.1.2 Employment and unemployment status of the local workforce

Both studied regions are among the ones with the highest unemployment rate, together with the Moravian-Silesian region, which is also affected by the decline in mining and related industries (Figure 3.1).

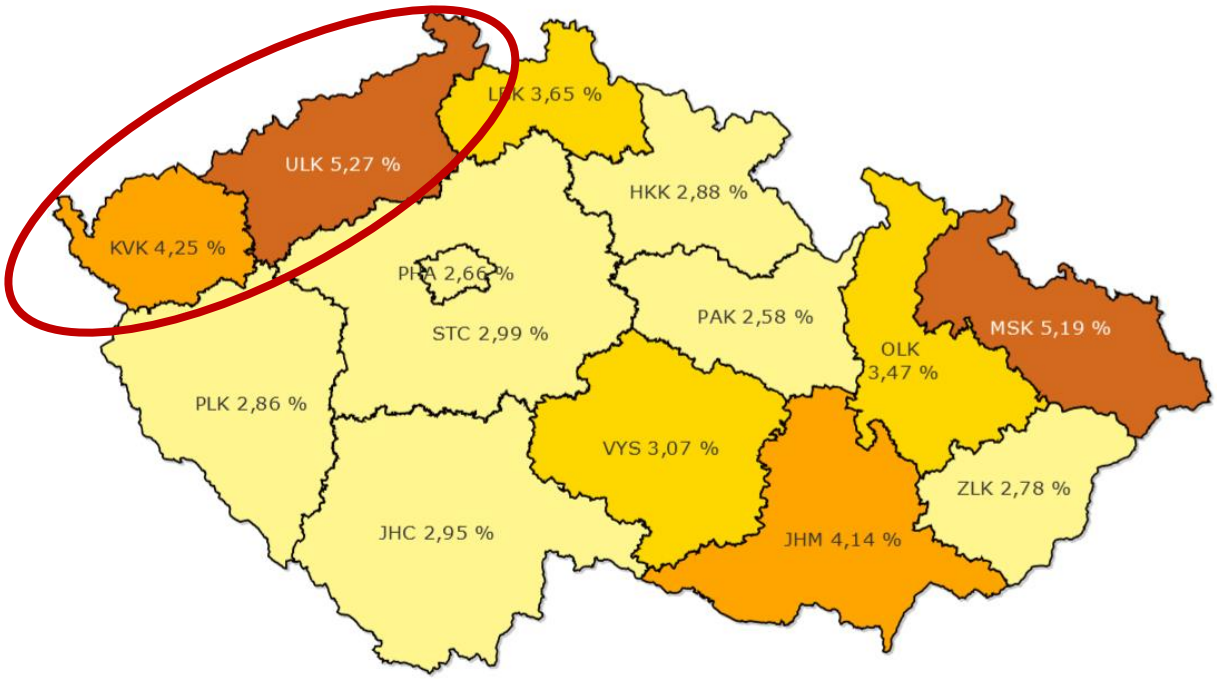

Figure 3.1: Unemployment rate as of 28.2.2022 in individual regions of the Czech Republic (Ministry of Labour and Social Affairs - MLSA)

The situation in the Ústí nad Labem Region remains stable in the labour market. As of 31 July 2021, a total of 30,573 jobseekers were registered at the Labour Office and the unemployment rate was 5.5% (6.1% for women and 4.8% for men). The highest unemployment is in the Most district, where it reaches 7.1% (8.1% for women and 6.2% for men). As in other regions, the problem is long-term unemployment, especially in excluded localities. As of July 31, 2021, employers reported a total of 15,054 vacancies. The ratio of job seekers to 1 vacancy is higher than the average for the Czech Republic. In the Ústí nad Labem region there are 2 applicants for one vacancy, while in the Czech Republic the corresponding figure is 0.76 applicants per vacancy.

Table 3.3: Long-term development of workforce and unemployment trade

Region	Parameter	2016	2017	2018	2019	2020
Karlovarský Region	Working force (thous. persons)	154,7	154,7	156,3	156,1	149,6
	including:					
	Employed	146,4	149,6	151,8	149,6	142,6
	Unemployed	8,3	5,1	4,5	6,5	7,1
	Economically inactive (thous. persons)	98,7	97,5	95	94,3	100,1
	General unemployment rate (%)	5,4	3,3	2,9	4,2	4,7
Ústecký Region	Working force (thous. persons)	403,4	399,1	399,7	395	399,3
	including:					
	Employed	382,6	385,2	385,2	385	384,6
	Unemployed	20,7	13,9	14,5	9,9	14,7
	Economically inactive (thous. persons)	289,2	291,4	290	294,6	290,2
	General unemployment rate (%)	5,1	3,5	3,6	2,5	3,7

Source: ČSÚ, 2021

The situation in the Karlovy Vary region remains stable as regards the labour market. In 31 July 2021, a total of 9,955 jobseekers were registered at the Labour Office and the unemployment rate was 5.0% (5.4% for women, 4.6% for men). The highest unemployment is in the Sokolov district, where it reaches 5.8% (6.2% for women and 5.5% for men). As in other regions, the problem is long-term unemployment, especially in excluded localities. As of July 31, 2021, employers reported a total of 5,733 job vacancies. The ratio of job seekers in the Karlovy Vary Region is 1.74 job seekers per vacancy (Table 3.3 and Figures 3.2, 3.3).

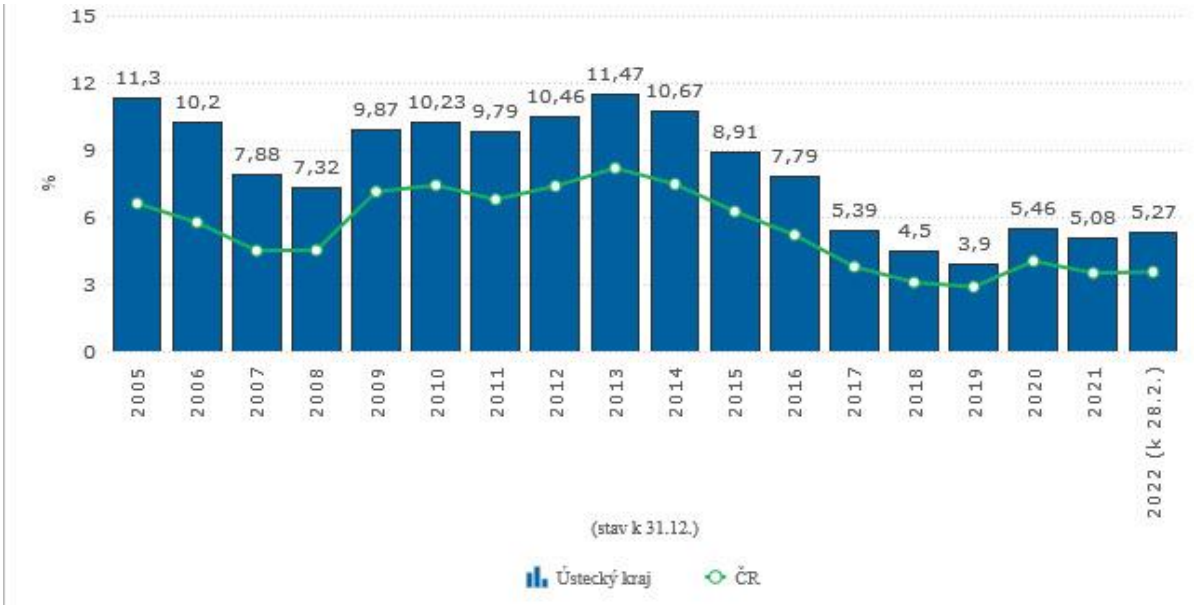

Figure 5.2: Comparison of the unemployment rate in Ústecký Region and the national unemployment rate (ČSÚ)

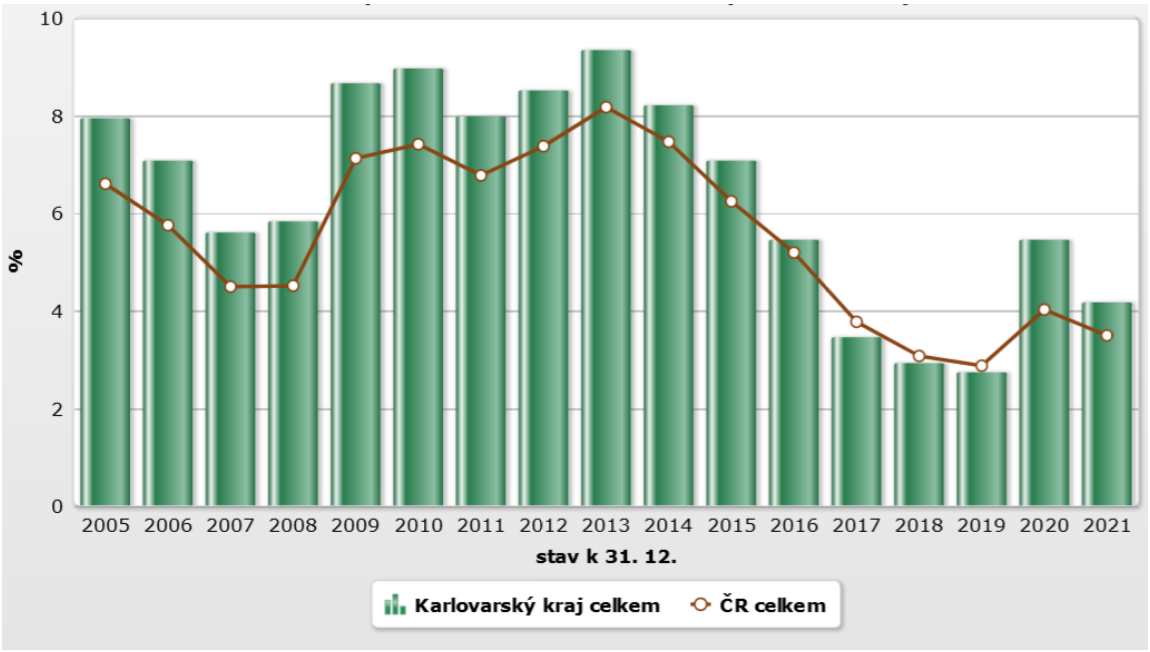

Figure 5.3: Comparison of the unemployment rate in Karlovarský Region and the national unemployment rate (ČSÚ)

Unemployment has risen slightly in recent times. However, no vulnerable group of candidates is significantly affected compared to others. The current unemployment rate in coal regions is not significantly above the national average. There are differences in the level of unemployment within the regions affected by the decline in coal mining within individual districts (else, micro-regions). While in the Karlovy Vary region these differences are

insignificant, in the Ústí nad Labem region the unemployment is higher than the average one, especially in the Most district.

Unemployment is higher in these regions for women than for men. According to the employment statistics in individual coal regions, in the sectors affected by the coal decline employment is significantly higher for men than for women This is contradictory to the other regions in the country. Generally unemployed men are more successful in looking for job in the labour market (ČSÚ, 2021).

3.2 Vision for the Region

3.2.1 The path towards decarbonization

Post coal era is expected to bring significant changes in the economy of both regions which will require specialization and new development in several other areas, that will eventually replace coal mining in future. Major regional domains of specialization in Karlovarský region are: 1) Mechanical engineering, electrical engineering and mechatronics; 2) Automotive industry and autonomous transport; 3) Traditional industries - ceramics, porcelain and glass; 4) Energy transformation and new challenges; 5) Spa, balneology and tourism. Major regional domains of specialization in Ústecký region are: 1) Energy - resources, supply and related fields; 2) Organic and inorganic chemistry; 3) Glass and ceramics; 3) New opportunities, namely machinery industry, automotive, mobility.

To wrap this up both regions relay on new developments in automotive industry. Important example may be the building of BMW testing facility in Podkrušnohorská Heap (i-dnes, 2021). Also, traditional industries, such as chemistry of ceramics, are expected to grow together with services in tourism and spa. However, in both regions energy production is expected to remain an important part of their portfolio.

In terms of new energy sources, new ways of energy utilization (smart technologies of energy transmission, storage and consumption, geothermal energy and other renewable sources, battery storage, utilization of waste heat) are mentioned in particular. In addition to classic renewables, such as wind, solar or biomass, Sokolov district has strategic advantage of Lake Medard and of the planned in the future lake in the locality of the current Jiří quarry in the form of a strategic water reservoir.

Like an example of the transformation of the area affected by mining activities can be mentioned in the project large greenhouses. This project could be implemented on a brownfield after termination of mining activities using the potential of Lake Medard, both for the supply of heat through heat pumps and for irrigation, as well as for use of other renewable energy sources.

3.2.2 New jobs to be created through the decarbonization process

In the Karlovy Vary region, where the largest employer in the region is Sokolovská uhelné a.s., up to 10,000 jobs would be jeopardized if mining will be ended in 2025. The company itself has therefore decided to face the challenge and is transforming into a modern, not only energy group, the SU a.s Group. By its nature, it is one of the largest projects in the region. The energy field will remain the basis of the group, but at the same time it will focus on the circular economy, real estate, construction and development activities. Simultaneously with the transformation of SU a.s, the economic, social and climate transformation of the region is also planned, which should be supported, for example, by funds from the Operational Program for Fair Transition.

In the Ústí nad Labem Region, various projects are already being worked on to replace the carbon and oil related parts of the economy. There are several strategic projects of the Ústí

Region also directly deals with the labour market. One such project is a joint project of the region, the City of Ústí nad Labem and Spolchemie a.s., which will use the hydrogen produced in Spolchemie for public transport in the city. Other possibilities for the use of hydrogen are also being traded commercially on open market.

Further production of green hydrogen is planned in the ČSA quarry, where surface mining is now ceasing and a complete revitalization of the area will take place. The aim is to create new settlements, a research center, greenhouses, use of aquaponics, floating photovoltaics, etc., which are all activities that provide new jobs for laid off miners and other related specialties. It will be similar for other strategic projects in the region, where, for example, it is planned to build a new battery plant, obtain geothermal energy, etc.

3.2.3 Reskilling / retraining needs of the local workforce

The Czech Coal Commission called on the developers of the “Compass - Labour Market Prediction” project to interpret the data obtained in connection with the termination of coal mining and utilization. The study simulates various future labour market scenarios, in particular focusing on employment developments in the mining and energy-producing sectors (MLSA, 2021). The results of the prediction model indicate trends in the development of the labour market, but logically cannot fully take into account exogenous influences, which at the time of compiling the model were not easy predictable. Such unpredictable effects are, for example, the widespread effects of the COVID pandemic or the war in Ukraine.

Assuming that the development of the economy and labour market will be stable, predictions can be considered very likely. The outputs of employment predictions already take into account the ongoing remediation and reclamation works in the area of closed quarries and their impact on employment in the region. The study does not include the positive effects on employment based on the investments that can be made to replace electricity produced from coal by other cleaner generation methods.

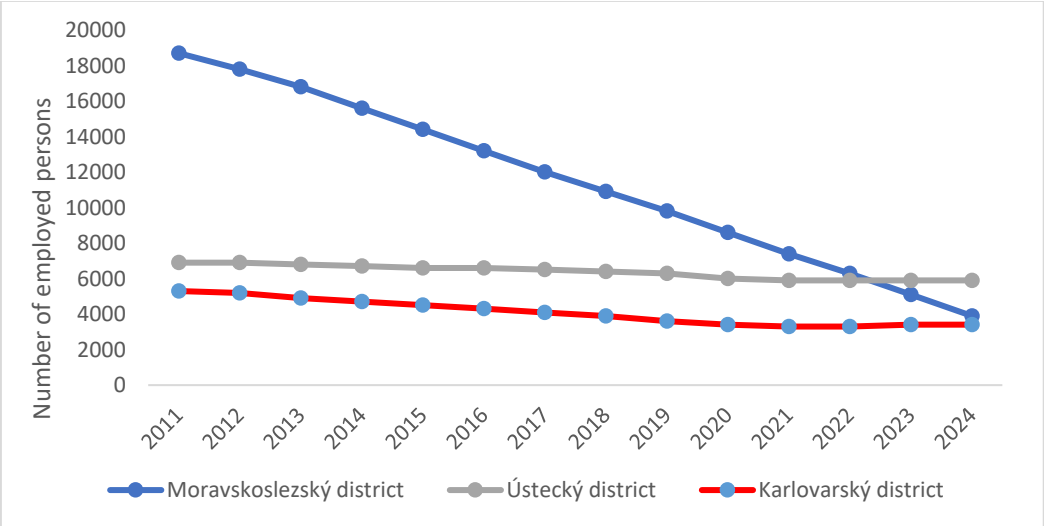

Figure 3.4: Number of employees in the mining industry in years 2011-2024 in Czech regions

The modelling tool predicts future employment demand only in a five-year horizon for occupational groups, industry groups and educational groups. In the case of professions and industries, these estimates can be interpreted as the expected future number of people employed (for education clusters, this is the expected change in demand for people with a given education and cannot be confused with the expected number of people with a given education). Within the model, the supply and demand for labour among the employees and educational groups in individual sectors are predicted, the balance on the labour market is estimated, while macroeconomic indicators, immigration from abroad and the inflow of new

labour in the form graduates are taken into account. The most important outputs of the study are presented in Figure 3.4 (MLSA, 2021).

The trend of the total number of employees in the group of mining and quarrying is different in all displayed regions. While in the Moravian-Silesian region it is relatively markedly declining over the entire period under review, in the Ústí nad Labem region the trend is relatively stable to slightly increasing and, in the Karlovy Vary region the trend remains constant. It is therefore clear that while in the area of hard coal mining the process of declining mining activity is already relatively rapid (even with its impact on employment), in the area of lignite mining this process is however only in its initial stages (Figure 3.4).

The group "Operation of mining and processing equipment" has the largest share, which nevertheless shows similar values of the development trend in the share of employment. It is also worth mentioning the groups "Installers, mechanics and repairers of electrical equipment" and "Operation of mobile equipment", which have a completely opposite trend (Figures 3.5 & 3.6). The largest shares are the groups "Operation of mining and processing equipment", with an increasing trend, and the "Blacksmiths, toolmakers and related workers" one with a declining trend.

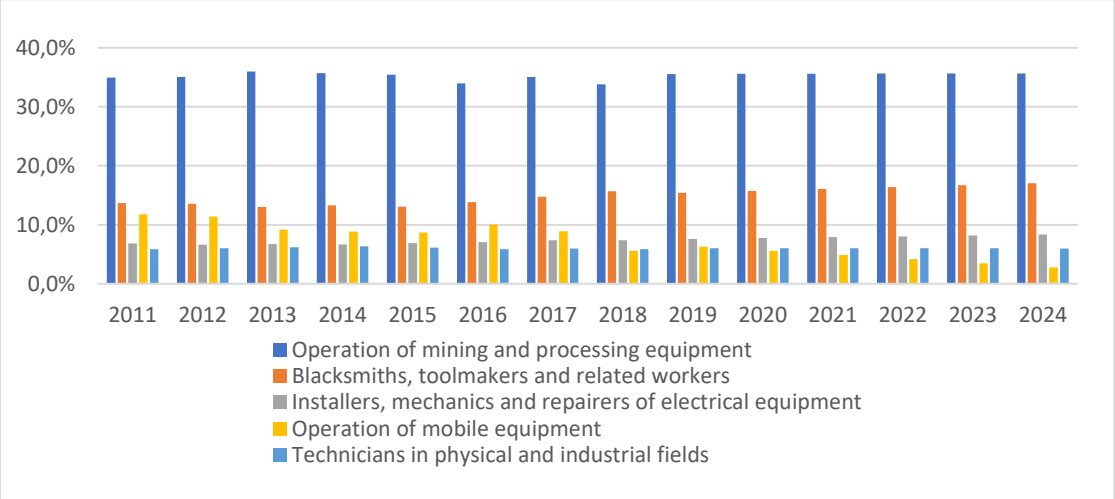

Figure 3.5: Percentage share of employment in the mining industry in Ústecký region (according to selected CZ-ISCED)

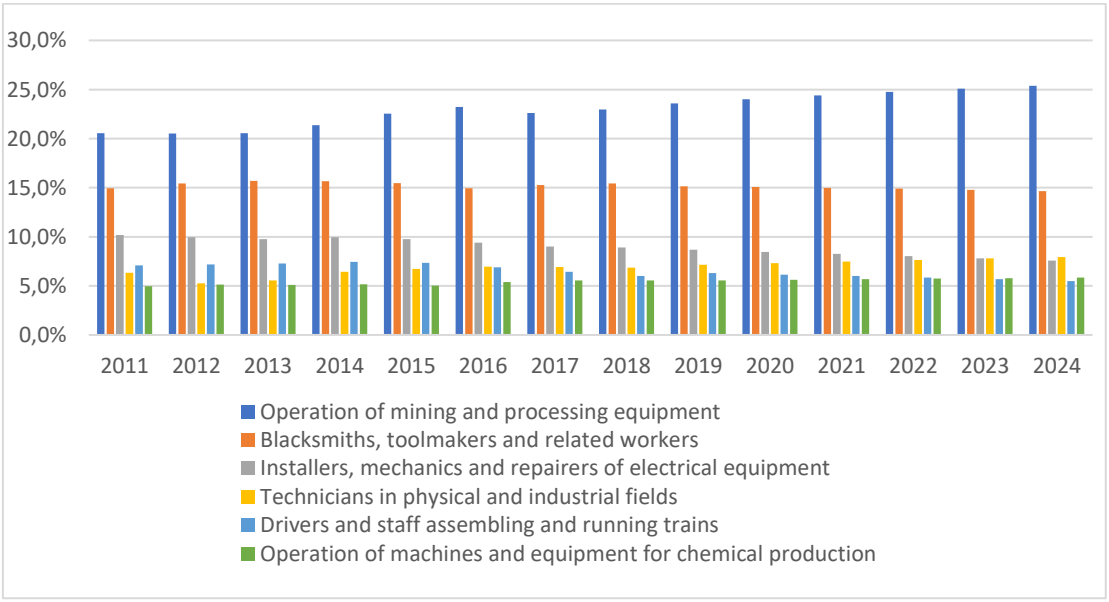

Figure 3.6: Percentage share of employment in the mining industry in the Karlovy Vary Region (according to selected CZ-ISCED)

Changes in the composition of major profession are reflected also in changes in major groups of society according to their education (Figures 3.7 & 3.8 and Tables 3.4 & 3.5). A similar, steady trend in the development of the share of employment is observed in all monitored groups of education in the Ústí nad Labem Region. With the exception of the group "High school without diploma, metallurgy, foundry, engineering, mechanics", the demand for workers should be higher than the supply for the other specified groups according to the IFLM index. Within groups with a higher demand for labour, the highest demand is expected for the group of secondary education, without a high school diploma, in the fields of education, motor vehicles and means of transport.

For all monitored groups of education in the Karlovy Vary Region, with the exception of the group "Basic and without education", which shows a growing trend in the last monitored year, a similar, steady trend in the development of the share of employment is observed. With the exception of the groups "Basic and no education" and "High school without diploma, motor vehicles, manufacture of transport equipment", the other specified groups according to the IFLM index should have a higher demand for workers compared to the supply.

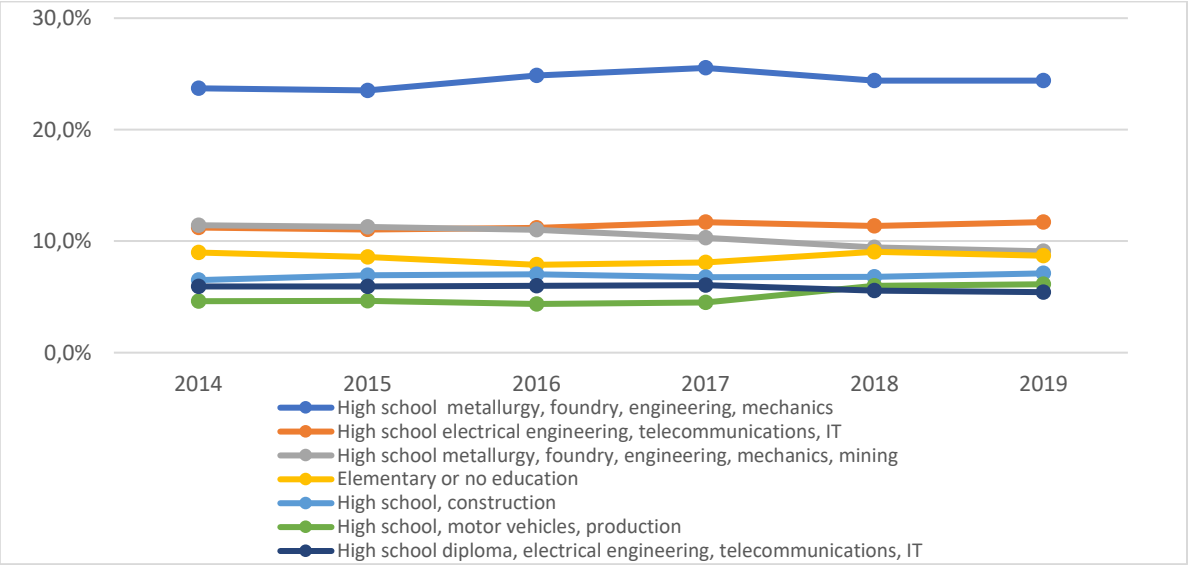

Figure 3.7: Percentage share of occupation in employment in mining industry in Ústecký Region (according to selected CZ-ISCED)

Table 3.4: Changes in percentage share of occupation in employment in mining industry in Ústecký Region (according to selected CZ-ISCED)

	Difference 2019-2014
High school metallurgy, foundry, engineering, mechanics	0.68 %
High school electrical engineering, telecommunications, IT	0.49 %
High school metallurgy, foundry, engineering, mechanics, mining	-2.34 %
Elementary or no education	-0.27 %
High school, construction	0.61 %
High school, motor vehicles, production	1.52 %
High school diploma, electrical engineering, telecommunications, IT	-0.51 %

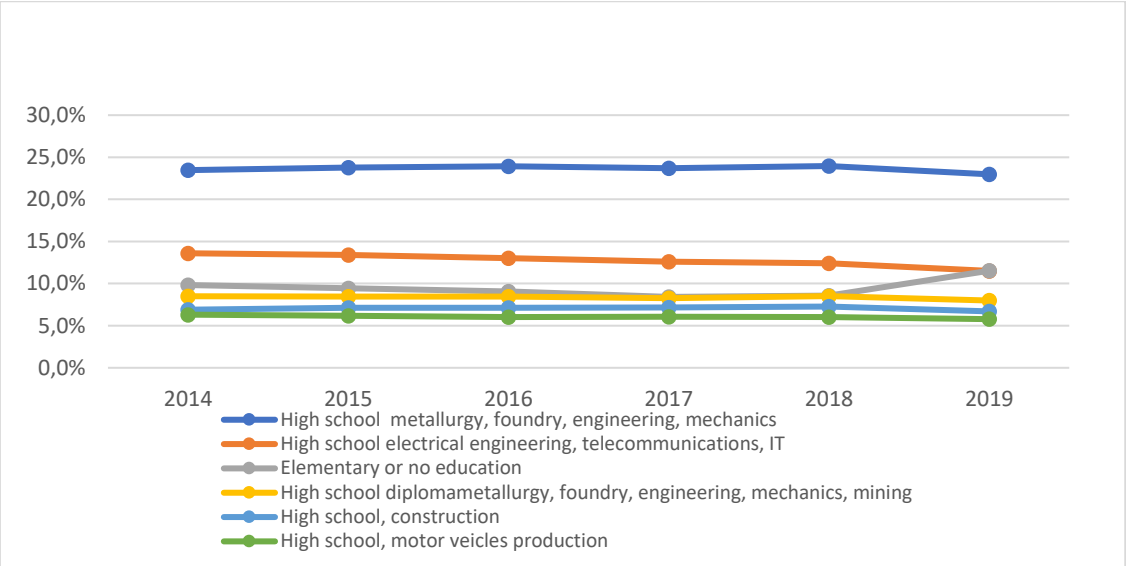

Figure 3.8: Percentage share of occupation in employment in mining industry in Karlovy Vary Region according to selected Czech categories of education (CZ-ISCED)

Table 3.5: Changes in percentage share of occupation in employment in mining industry in Karlovy Vary Region (according to selected CZ-ISCED)

	Difference 2019-2014
High school metallurgy, foundry, engineering, mechanics	-0.515 %
High school electrical engineering, telecommunications, IT	-2.091 %
Elementary or no education	1.679 %
High school diploma, metallurgy, foundry, engineering, mechanics	-0.517 %
High school, construction	-0.192 %
High school, motor vehicles, production	-0.530 %

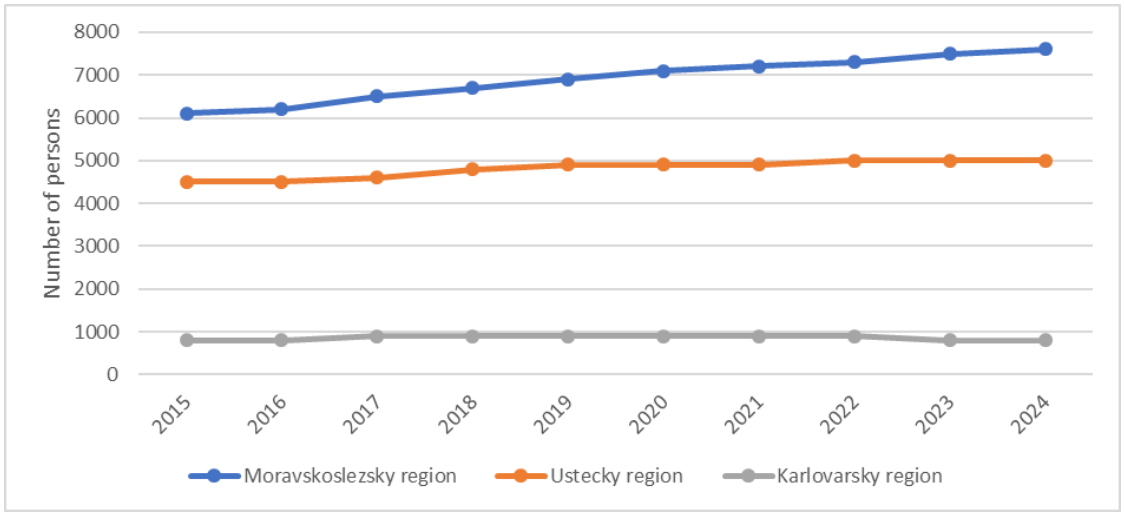

Figure 3.9: Number of employees in the electricity, gas, steam and air conditioning supply sector in 2011-2024 in Czech regions

In industries that are related to coal industry in terms of energy production, namely in electricity, gas, steam and air conditioning supply sectors, there is an apparent overall stagnation in Karlovy Vary and Ústí nad Labem Regions or even steady increase in Moravskoslezký Region (Figure 3.9), suggesting that these industries can compensate decrease of coal mining by other opportunities.

According to Figure 3.10 and Table 3.6, there is a clear increase in the share of employed persons with a high school diploma in electrical engineering, telecommunications, electricity, gas, steam and air conditioning supply in the Ústecký Region between 2014 and 2020. The share of other levels of education and fields practically stagnated. With the exception of the education group "high school, metallurgy, foundry, engineering, mechanics", the demand for workers should be higher than the supply for other specified groups in the Ústí nad Labem Region according to the IFLM index.

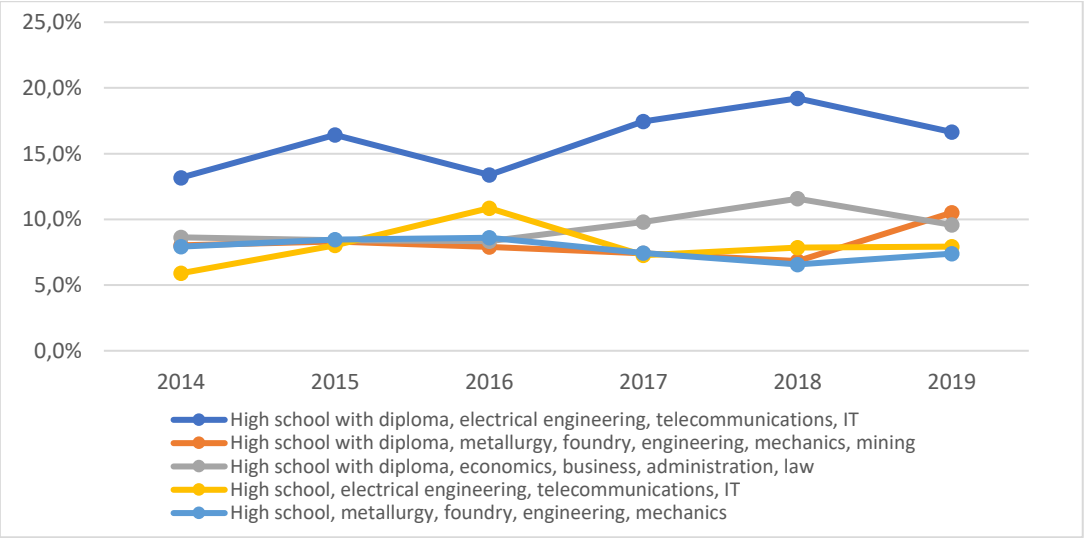

Figure 3.10: Percentage share of occupation in employment in energy industry in Ústecký Region (according to selected CZ-ISCED)

Table 3.6: Changes in Percentage share of occupation in employment in energy industry in Ústecký Region (according to selected CZ-ISCED)

	Difference 2019-2014
High school with diploma, electrical engineering, telecommunications, IT	3.5 %
High school with diploma, metallurgy, foundry engineering, mechanics, mining	2.5 %
High school with diploma, economics, businnes, administration, law	0.9 %
High school, electrical engineering, telecommunications, IT	2.0 %
High school, metallurgy, foundry, engineering, mechanics	-0.5 %

According to Figure 3.11 and Table 3.7, there is a clear increase in the share of employed persons having a secondary education without a high school diploma in electrical engineering, telecommunications, electricity, gas, steam and air conditioning supply in the Karlovy Vary region between 2014 and 2019. For all monitored groups according to education, the outputs of the prediction system result in higher or the same demand, compared to the supply of labour in the labour market.

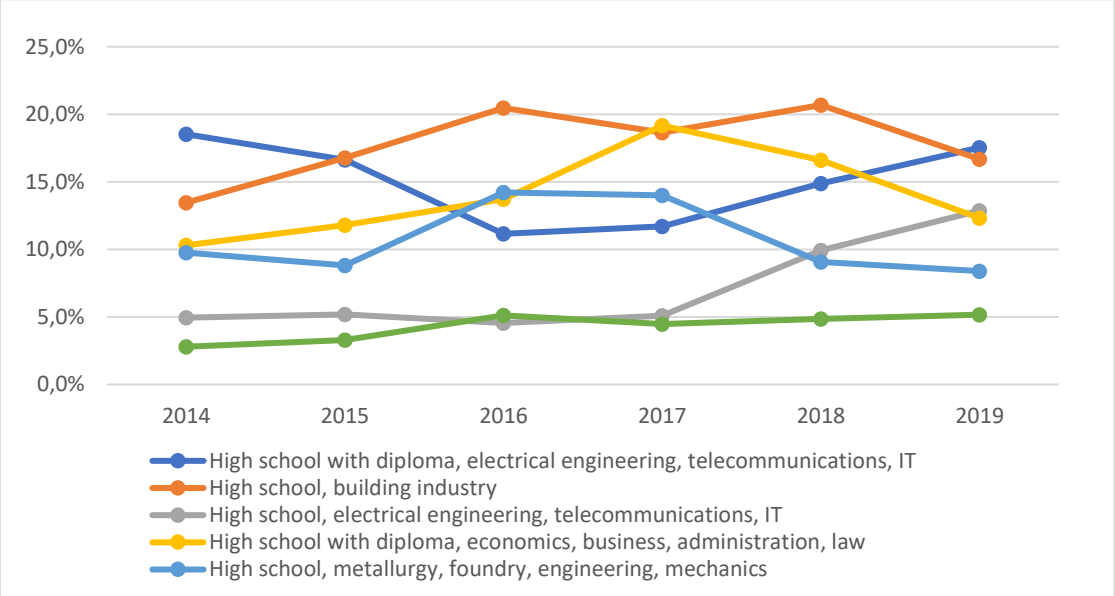

Figure 3.11: Percentage share of occupation in employment in energy industry in Karlovy Vary region (according to selected CZ-ISCED)

Table 3.7: Changes in Percentage share of occupation in employment in energy industry in Karlovy Vary region (according to selected CZ-ISCED)

	Difference 2019-2014
High school with diploma, electrical engineering, telecommunications, IT	-1.0 %
High school, building industry	3.2 %
High school, electrical engineering, telecommunications, IT	7.9 %
High school with diploma, economics, business, administration, law	2.0 %
High school, metallurgy, foundry, engineering, mechanics	-1.4 %
High school with diploma, metallurgy, foundry, engineering, mechanics, mining	2.4 %

Currently, there is a significant decline in mining in the Karlovy Vary region, which is not so much caused by a lack of mineral reserves or a decline in demand, but it is due to political decisions and a sharp rise in the prices of emission allowances. It is a centrally established trend that leads to a shortening of the mining horizon in the Sokolov district, originally planned for 2040. The decline in mining will result in the dismissal of employees in this field, it can also affect the price of energy and have a number of other negative consequences. Another major threat is the region's strong focus on the automotive industry. In this sector, too, employment is expected to fall due to the pressure to switch to electromobility, which is less demanding to the workforce like a classic automotive.

However, all this should be mitigated by the planned significant transformation of the region. As regards the number of employees in the mining industry in the area in the years 2021-2024, there will be no significant turbulence on the labour market in the Ústí nad Labem Region. Prediction of the development of employment in the group of mining and quarrying industry in the Ústí nad Labem Region until 2024 does not signal a significant decrease or increase in the number of employees in the mining industry. Even in the group "Production and distribution of electricity, gas, heat and air conditioning", the employment forecast until 2024 does not show any significant change and indicates a more or less unchanged trend. Region records the

largest decrease in employment "Other stationary machinery and equipment operators", whose share from 2011 (25.5%) dropped to the predicted 12.6% in 2024. Within the prediction in the CZ-ISCED area according to the classification of education, the IFLM index indicates only one educational area with possible labour market tension, i.e., IFLM greater than 1, namely the education group "high school, metallurgy, foundry, engineering, mechanics".

In terms of employment in the coal regions, labour market experts do not expect the redundant workers to go to work on a larger scale in neighbouring countries, as e.g. Germany, which could absorb part of the Karlovy Vary or Ústí nad Labem regions' workforce. Partially, a number of citizens from the Karlovy Vary or Ústí nad Labem regions can be expected to work in Germany, but in sectors other than the mining industry, especially for professions that are scarce in Germany. These assumptions are also based on discussions with EURES ČR employees at the Labour Office of the Czech Republic and with labour market experts in coal regions (MLSA).

During April to August 2021, the Economic and Social Council of the Ústí nad Labem Region conducted a questionnaire survey of the opinions of employees in lignite mining and energy for the cessation of coal mining and decarbonization of coal energy sources, as this need arose from the discussions at the 1st meeting of the Working Group "Coal Platform of the Ústí nad Labem Region", held in March 2021. The aim of the survey was to supplement the analytical data on the socio-economic impacts affecting the labour market, social structure, stability and quality of life, including the identification of supporting and development measures to eliminate the negative effects of energy decarbonisation. The target group was employees of mining companies and coal-fired power plants operating in the Ústí nad Labem Region and belonging to the Sev.en Energy Group (Vršany SE quarry, ČSA quarry, Počerady power plant, service activities) and CEZ Group (Severočeské doly a.s. Chomutov (SD), power plants Tušimice, Prunéřov, Ledvice).

The result of the anonymous questionnaires is presented by the Economic and Social Council of the Ústí nad Labem Region (HSR, 2021) as follows: A total of 1649 respondents participated of which 300 were women from mining and 13 from energy, as well as 1180 men from mining and 156 from energy. The 38.5% of respondents belonged to the age category over 55 years. A larger proportion of older people came from the mining group than the energy sector. Over half of the respondents had a vocational education or training without a high school diploma, 32.9% had a secondary vocational education with a high school diploma, and only 7% had a university degree.

Within the energy group, the proportion of more educated respondents was higher than in the mining group. The 78% of the respondents are operational staff. Moreover, the 63% of the respondents feel that a change in the energy concept will affect their jobs and 71% of them think that the situation needs to be addressed, as it will also have an impact on their employment. The 83% of the respondents intend to stay in their current job for as long as possible, while around 10% looks for alternatives. The overwhelming majority is convinced that there are not enough job opportunities in the Ústí nad Labem Region (65% fear future unemployment). The vast majority of respondents consider it necessary for the state to help in this situation, whether through retraining, job creation or contributions to equalize living standards. The results of the survey are graphically presented in the following Figures 3.12-3.14.

15% of respondents are convinced that they will find a new job, the same proportion of workers say that their profession will disappear and the 15% of them would stop working, 4% would like to start a business and the rest would look for a new job. Over a quarter of respondents would not like to change their field of occupation. Half of the people would be willing to commute up to 25 km for work, while 5.3% do not intend to commute at all. 62% would take the opportunity to retire early, if they were not disadvantaged in any way.

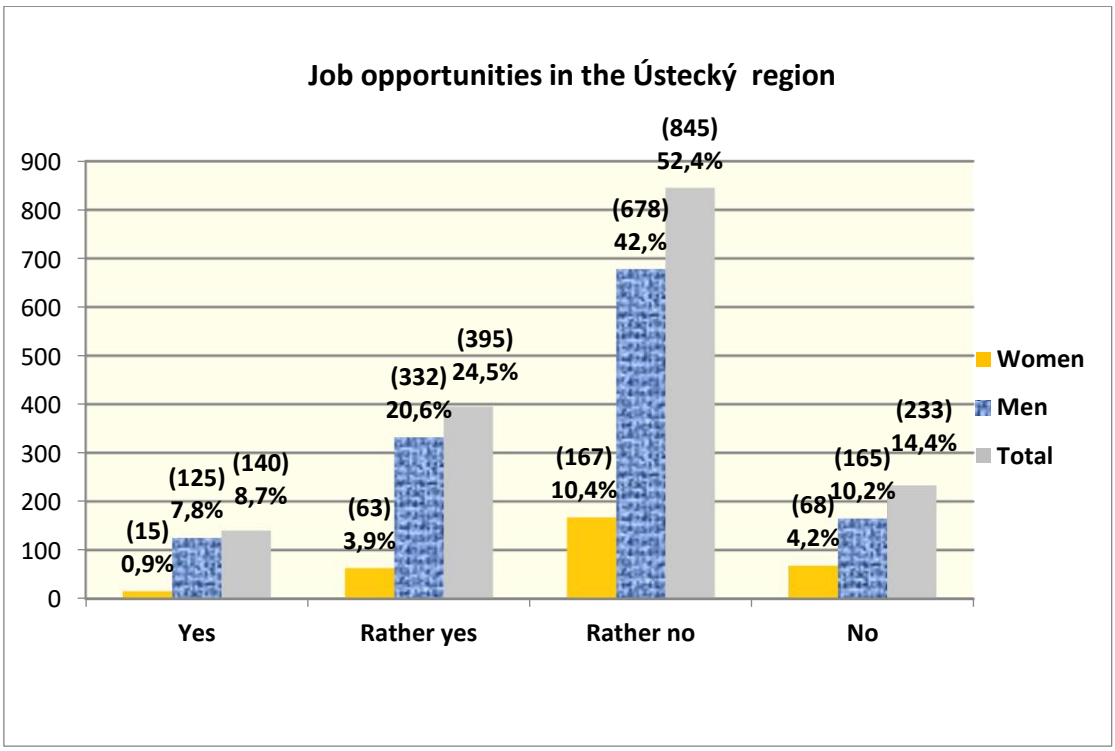

Figure 3.12: Job opportunities in Ústecký region according to anonymous questionnaires survey organized by Ústecký region in 2021

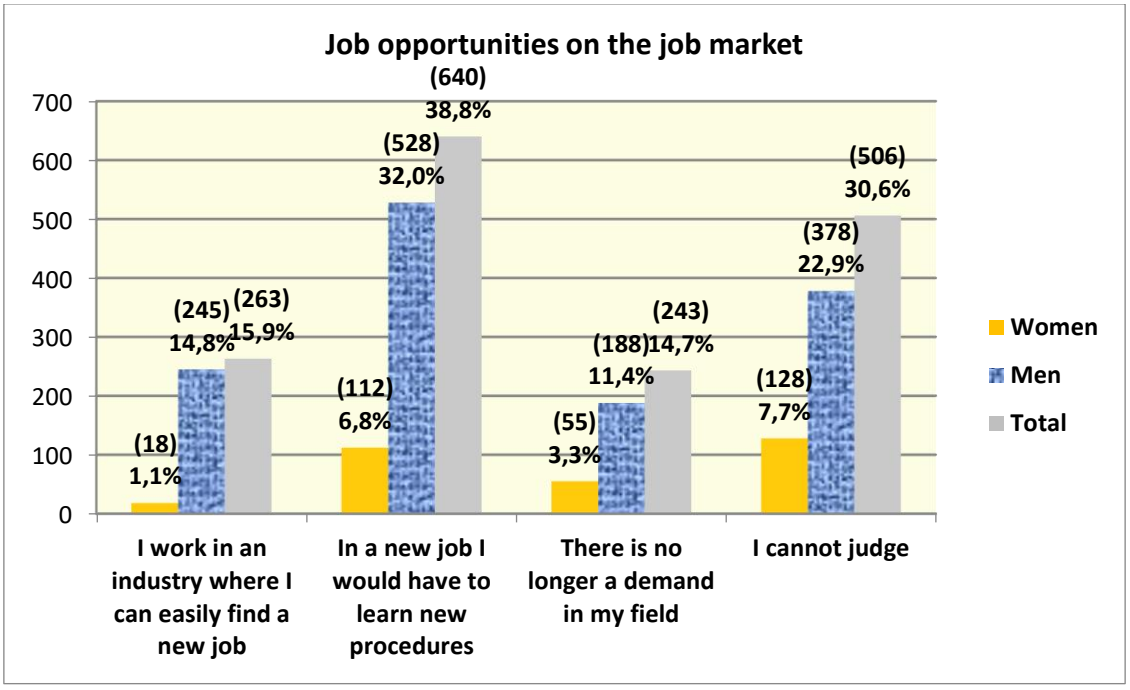

Figure 3.13: Job opportunities in job market according to anonymous questionnaires survey organized by Ústecký region in 2021

Based on the questionnaire survey (HSR ÚK), it can be stated that, according to the answers provided by the respondents, it is necessary to speed up the elaboration of the new State Energy Concept (assumed until 31 December 2023), which will guarantee reliable and secure energy supplies at competitive prices. As in Germany, the Coal Commission in the Czech Republic should define the necessary economic and social compensation to mitigate the impact on employees, companies and regions affected by energy decarbonization. The government should confirm them by law.

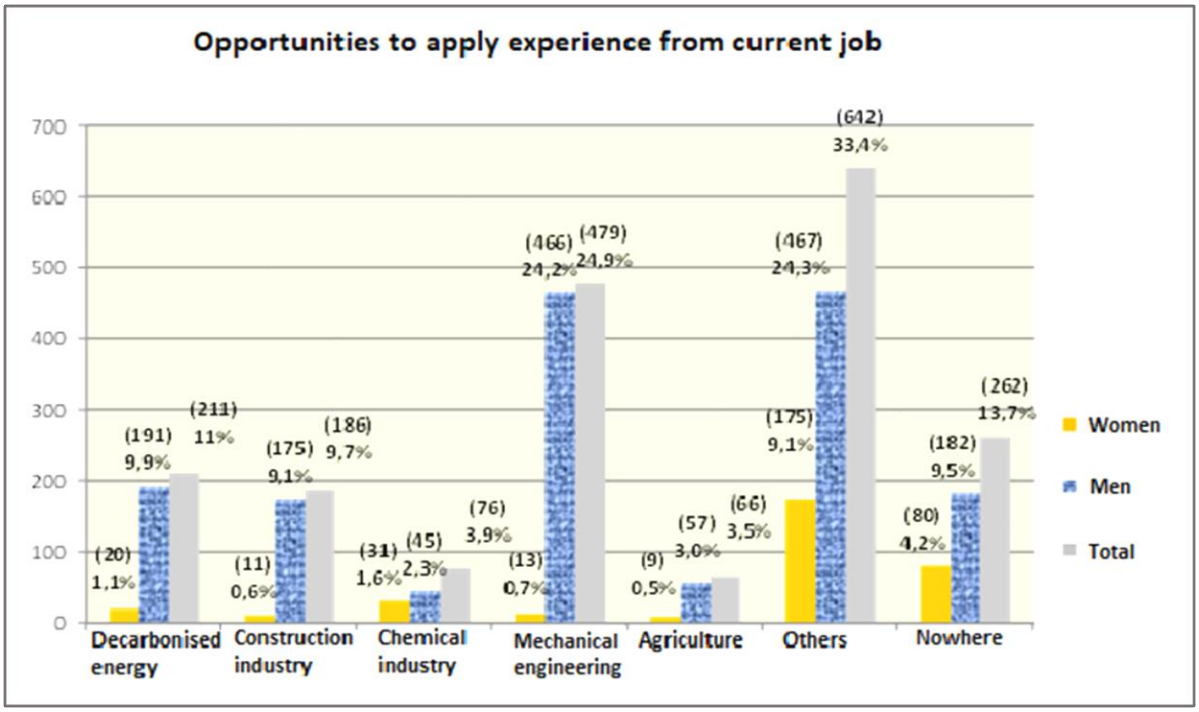

Figure 3.14: Opportunities to apply experience from current job according to anonymous questionnaires survey organized by Ústecký region in 2021

In connection with the available financial resources from the EU (including the Operational Program for Fair Transition) and national resources, and in accordance with the Plan of Fair Transition, ensure the preparation of people for the changing labour market, with maximum support of science, research and innovation, changes in economic structure, i.e., urgently modernize industry and infrastructure, prepare the necessary education system for the new economy. There is also a need to continue post-mining revitalization and re-socialization programs, especially in relation to already revitalized areas, to allow workers released from mining and coal fuelled energy production to retire early for up to 5 years without affecting pensions and to prepare social programs for mitigation negative effects on employees affected by job losses due to the ordered diversion from coal.

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4 Germany, Lusatian Lignite District/Economic Region Lusatia

4.1 Current status of the region's workforce

4.1.1 Regional profile and specialisation

Lusatia is not an administrative unit, but a historical region within several districts, cross-border the Federal states of Brandenburg (Dahme-Spreewald, Elbe-Elster, Oberspreewald-Lausitz, Spree-Neiße, City of Cottbus) and Saxony (Bautzen, Görlitz). Therefore, statistical data on the labour market situation always refer to the district level, primarily based on federal statistical data: On 1 January 2020 (deadline), there are living 1,147,870 people in the region (Table 4.1). On average, this is 1.3 percent less than five years earlier. With the exception of Dahme-Spreewald, all districts have lost between 2.2 and 3.7% of their inhabitants since 2015 (cf. also D6.2).

The average age of people in Lusatia varies between 46.9 years (Dahme-Spreewald, Cottbus) and 49.9 years (Spree-Neiße). It is thus above the Germany-wide average of 44.5 years.

Table 4.1: Population statistics and basic economic indicators

District and NUTS-3 Code	Inhabitants (2015)	Inhabitants (2020)	Average age (2020)	GDP per capita (2019)
Elbe-Elster (DE407)	104,997	101,827	49.7	25,538
Dahme-Spreewald (DE406)	161,952	170,791	46.9	33,576
Oberspreewald-Lausitz (DE40B)	112,896	109,371	49.7	28,325
Spree-Neiße (DE40G)	118,030	113,720	49.9	34,325
City Cottbus (DE402)	99,491	99,678	46.9	35,833
Görlitz (DED2D)	260,188	252,725	49.5	27,321
Bautzen (DED2C)	306,570	299,758	48.4	28,073

Sources: Eurostat, 2021b; Amt für Statistik Berlin-Brandenburg, 2021a; Bundesagentur für Arbeit, 2021

The gross domestic product (GDP) per capita ranges between EUR 25,538 (Elbe-Elster) and EUR 35,833 (City of Cottbus) in 2019. For comparison, it is mentioned that Germany-wide, the GDP per capita in the same year was EUR 41,871 (Statistisches Bundesamt, 2021).

Schmidt et al. (2018) state that lignite accounts for 4.3% of the region's gross value added in 2016. In their report, both the direct contribution in lignite extraction, refinement and electricity generation in power plants is taken into account, as well as the contribution from indirect and induced effects. Thus the total gross value added from lignite in Lusatia amounts to EUR 1,221 billion in that year. The Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie, 2019) therefore points out that in Lusatia it is possible to speak of a historically grown, special economic significance of lignite. This distinguishes Lusatia from the two other lignite mining regions in Germany (Rhineland, Central Germany), where the share of lignite to the economic value added is significantly lower.

4.1.2 Employment and unemployment status of the local workforce

According to Table 4.2, there are approx. 540,500 people employed at beginning of 2019, most of them in the Saxon district of Bautzen, which corresponds to the number of inhabitants. The current unemployment rate as of October 2021 ranges from 3.6 (Dahme-Spreewald) to 7.1 (Görlitz). For comparison, it is mentioned that the Germany-wide unemployment rate for that month was 5.2% (Bundesagentur für Arbeit, 2021), making clear that Lusatia as a whole is not a European crisis region when looking at the employment relationship. In contrast there is growing evidence for the shortage of skilled workers and need of workforce retraining in context of the approaching coal phase-out (Wirtschaftsregion Lausitz GmbH, 2020).

Table 4.2: Data on labour market

District and NUTS-3 Code	Unemployment rate (October 2021)	Number of employees in 2019
Elbe-Elster (DE407)	5.8	44,600
Dahme-Spreewald (DE406)	3.6	78,500
Oberspreewald-Lausitz (DE40B)	6.3	49,600
Spree-Neiße (DE40G)	5.6	45,400
City Cottbus (DE402)	6.9	61,900
Görlitz (DED2D)	7.1	115,400
Bautzen (DED2C)	5.1	145,100

Sources: Amt für Statistik Berlin-Brandenburg, 2021b; Bundesagentur für Arbeit, 2021; Statistisches Landesamt des Freistaates Sachsen, 2021

At the end of 2020, 7,822 people were directly employed in the lignite industry (Statistik der Kohlenwirtschaft e.V., 2021). This includes employees in the opencast mines, the power plants and other areas of activity in the lignite company LEAG, the only coal company of “active” lignite mining in Lusatia.

The German phase-out of coal by 2038 at the latest has been decided and confirmed by the Coal Phase-out Act of 8 August 2020. In order to create a concrete perspective for new, future-proof jobs in the affected coal regions in cooperation between the Federal Government, the Federal States, local authorities and economic actors, the so-called “Commission on Growth, Structural Change and Employment” was set up by the federal government in June 2018 (Bundesministerium für Wirtschaft und Energie, 2019). The public expert committee assumes that for every direct job in the lignite industry, there is another indirect - or thus induced - job directly in the mining area and another outside the narrower geographical boundary.

Schmidt et al. (2018), however, indicate a total of 13,245 employees within and attached to the lignite industry (reference year 2016). Indirect employees work in supplying intermediate and capital goods industries. Induced employment effects arise from the fact that the direct and indirect employees of the lignite sector use at least part of the income generated for consumption expenditure in the region. Satisfying this demand for consumer goods leads to additional employment in other enterprises. The share of direct employees in the lignite sector in the total number of employees subject to social insurance contributions in the Lusatian mining area is about 2.0%. The share is 3.3% if total indirect and induced employment is taken into account.

Figure 4.1 shows the age distribution of LEAG employees in 2017 (Schmidt et al. 2018). According to this, 49% of all workers are 50 years and older. When looking to the development of insurable employment in the region as a whole, the rate for the age group ≥55 years is only 27%, also growing since 2010 by 77% (Handwerkskammer Cottbus, 2022).

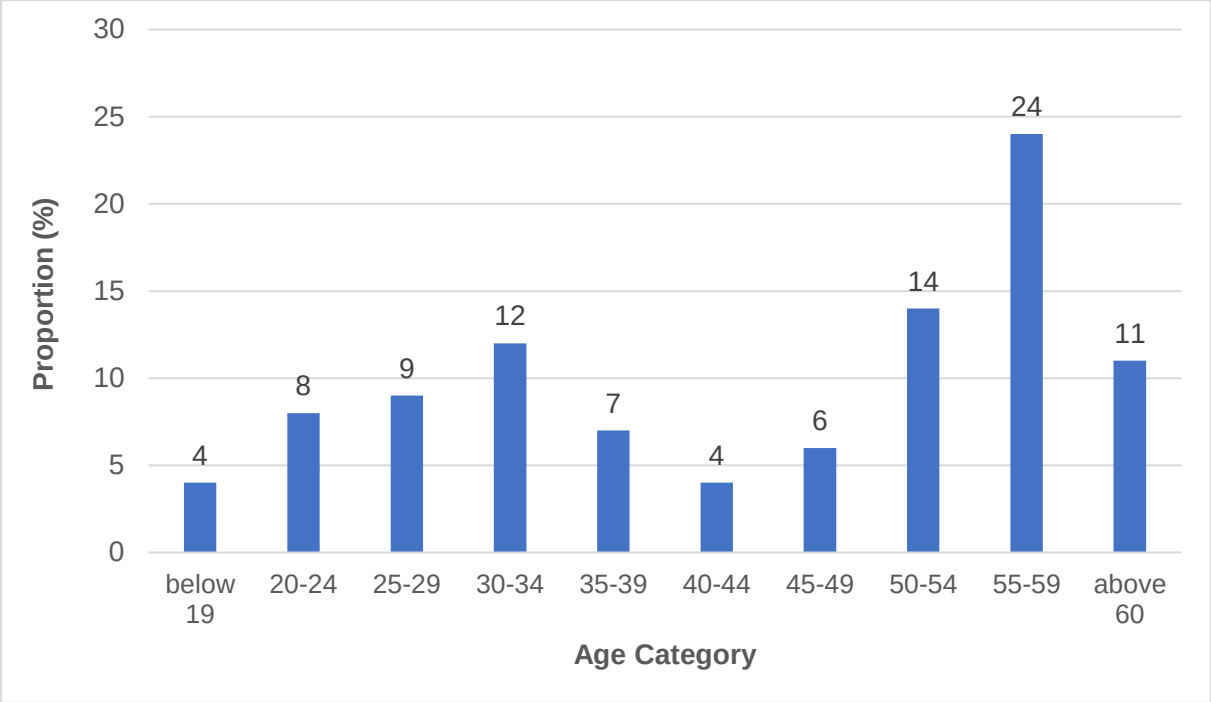

Figure 4.1: Age distribution of LEAG employees in 2017 (according to Schmidt et al., 2018; based on LEAG data)

4.2 Vision for the Region

4.2.1 The path towards decarbonization

As described in the "*Report on social challenges and re-skilling needs of the workforce solutions in the TRACER target regions*" of TRACER (D3.4), in January 2020 the German Federal Government and the Prime Ministers of the Federal States Brandenburg, Saxony, Saxony-Anhalt and North Rhine-Westphalia agreed on the structural strengthening of their lignite regions, an exit path from lignite-based electricity generation and the associated climate protection (Presse- und Informationsamt der Bundesregierung, 2020). The so-called "path of shutdown", where decommissioning dates are defined for each coal-fired plant in Germany (Bundesministerium für Wirtschaft und Energie, 2020a) is a main result of an agreement made between the government representatives and the operating companies of coal power stations. However, this schedule is part of a new special law, which still has to pass the German parliament.

For the Lusatian mining region, the programme provides that all four blocks of the power plant Jänschwalde will be closed at 31.12.2028 the latest, and two blocks of the plant Boxberg may work until 31.12.2029 (Table 3). The decommissioning of the other two blocks in Boxberg and the whole power plant Schwarze Pumpe is scheduled to 31.12.2038. With regard to the decommissioning envisaged after 2030 revision dates in 2026 and 2029 are intended. Then it will be checked whether the decommissioning can be brought forward by 3 years and the closing date of 2038 can be reached.

However, the new German government coalition has already announced in December 2021 that the phase-out should be brought forward, as soon as possible in 2030 (Social Democratic Party of Germany, Bündnis 90 / Die Grünen & Freie Demokraten, 2021). However, it is

currently unclear whether and how this ambitious project can be implemented, without endangering the security of electricity supply.

Table 4.3: Decommissioning dates for the Lusatian power plants, as part of the German coal "phase out" or "path of shutdown"

Block name	Federal State	Latest date of decommissioning
Jänschwalde A	Brandenburg	31.12.2025 (security attendance)
Jänschwalde B		31.12.2027 (security attendance)
Jänschwalde C		31.12.2028
Jänschwalde D		
Boxberg N	Saxony	31.12.2029
Boxberg P		
Schwarze Pumpe A	Brandenburg	31.12.2038
Schwarze Pumpe B		
Boxberg R	Saxony	
Boxberg Q		

Source: Bundesministerium für Wirtschaft und Energie, 2020

4.2.2 New jobs to be created through the decarbonization process

Lusatia is considered a traditionally industry-friendly region, with 150 years of industrial lignite mining and refining (Wirtschaftsförderung Berlin-Brandenburg, 2021). Not only companies in the energy sector represent an important pillar of Lusatia, but also companies in the energy intensive plastics and chemical industries, as well as in the metal sector. In addition, agriculture, food industry, trading and tourism are playing a significant role (Handwerkskammer Cottbus, 2022).

At least for the Brandenburg part of Lusatia, Markwardt et al. (2016) point out that the economy has grown in recent years compared to the 1990s despite a real decline in population, unemployment has fallen and incomes have risen significantly. In other words, the end to lignite-based power generation in Lusatia will not trigger a new mass unemployment, like after the fall of communism and hard structural crash in the early 1990s. Indeed, the number of jobs really affected is too small. As shown before, the average age of workers (> 50 years) is too high. Moreover, the general shortage of skilled workers in the region is too great due to demographic development. Nevertheless, there are several initiatives and many instances in the region to maintain and promote economic strength already during the phase of the coal phase-out. The core issue is to support the development and expansion of future-oriented technologies and business fields and thus to maintain jobs and create new ones (Wirtschaftsregion Lausitz GmbH, 2020).

At the federal level, the Structural Strengthening Act (StStG) with the Coal Regions Investment Act (InvKG) was passed on 8 August 2020. Financial assistance to compensate for differences in economic strength and to promote economic growth (StStG, Chapter 1) is available in the amount of up to €14 billion until 2038. 43% (i.e. up to 6.02 billion) of this will go to Lusatia, which in turn will be divided into 60% for Brandenburg and 40% for Saxony. These funds serve in particular to cope with structural change and to secure employment in the course of the

phase-out of lignite mining and the generation of electricity from lignite. They are granted for investments to improve the economic infrastructure. The law defines in more detail many areas in which these financial aids can come into play.

An additional EUR 26 billion will be made available by the federal government in the three coalfields until 2038 for investments in federal trunk roads and federal railways (StStG, Chapter 4), combined with various other measures, such as the promotion of earmarked science, research, teaching and education in Lusatia, the support of the energy transition and climate protection or the settlement of federal institutions (StSTG, Chapter 5).

The Brandenburg way ….

Lusatia in Brandenburg will receive a total of EUR 10.32 billion in funding until 2038. Of the financial aid from Chapter 1 of the StStG, about EUR 200 million can be allocated annually at the municipal level. Therein, the Wirtschaftsregion Lausitz GmbH (WRL), a state structural development company, was commissioned in the funding guideline Structural Development for the Lusatian Lignite Region Brandenburg of 24 November 2020 to organise and manage projects in structural change in the Brandenburg part of Lusatia. The guideline serves to operationally implement the financial assistance of the Structural Strengthening Act for the Coal Regions in Brandenburg Investment Act part (Staatskanzlei des Landes Brandenburg, 2021). Eligible applicants submit project ideas to WRL.

… and the Saxonian approach

In Saxony's part of Lusatia, EUR 10.49 billion are available until 2038 under the Structural Strengthening Act (Sächsisches Staatsministerium für Regionalentwicklung, 2021). The Regional Monitoring Committee (RMC) of Lusatia in the Saxon Agency for Structural Development (*Sächsische Agentur für Strukturentwicklung GmbH*) is responsible for distributing the funds on the basis of the Directive of the Saxon State Ministry for Regional Development on the Saxon Structural Development Programme in the Lignite Regions of 31 August 2020.

Together, the state governments of Brandenburg and Saxony want to give additional impetus and more dynamism to structural development in Lusatia and develop it into a model region for structural change. At a joint cabinet meeting on 13 June 2017, a policy paper entitled "*Together for the Future of the Lusatian Industrial Region*" was adopted (Ministerium für Wirtschaft, Arbeit und Energie Brandenburg, 2021).

In the *Lusatia Programme 2038* (Staatskanzlei Brandenburg, 2020), which was adopted later, it is pointed out that Lusatia has a regional production and value creation system with diverse challenges, but also starting points and opportunities for future development are highlighted. The programme provides a basis for the assessment of potential projects by WRL. It presents a model that was developed jointly by and with stakeholders from Brandenburg and Saxony. According to this, Lusatia is:

- a European model region for structural change,
- a central, European interdependence area
- an innovative and efficient economic region,
- a modern and sustainable energy region,
- a modern research, innovation and science location, a model region for health that links research, teaching and care in a new way using digitalization,
- a region with a high quality of life, cultural, linguistic, ethnic and sporting diversity and intact natural areas.

Six fields of action are highlighted in the *Lusatia Programme 2038*. They were developed from the debates on the development of the overall concept, various studies and expert opinions as well as cross-state coordination:

- innovation, science and research,
- economic promotion and development, diversification, climate protection
- infrastructure development,
- skilled labour development,
- marketing, art, culture and tourism
- communication and participation.

Some good examples

An example for upgrading and strengthening already existing economic structures / industrial cores is the planned expansion of the railway maintenance plant in Cottbus from 2023, which Deutsche Bahn AG (German Railways) wants to complete by 2026 (Deutsche Bahn, 2020). ICE trains are to be maintained there and diesel locomotives converted to hybrid technology. A total of 1,200 new, highly qualified industrial jobs are expected. So, there is already a joint and trendsetting job initiative between the LEAG and Deutsche Bahn. In addition, the railway lines from Cottbus to Berlin, Leipzig, Dresden and Görlitz are to be upgraded, electrified and adapted to higher speeds. The railways to Forst, Guben and the neighbouring Polish region are to receive a comprehensive modernisation. Just 40 kilometers straight southwest, at BASF's Schwarzheide site, work has begun on the construction of a production plant for cathode materials, which is scheduled to start operations in 2022 (BASF, 2020). The cathode materials are intended to increase the performance of batteries for electric cars. This is expected to create 150 new jobs at least.

Back to Cottbus, there are advanced plans to establish a medical faculty at the Brandenburg University of Technology Cottbus-Senftenberg and to expand the municipal Carl-Thiem-Klinikum Cottbus into a university hospital under state sponsorship and into a "digital leading hospital" (Ministerium für Wissenschaft Forschung und Kultur, 2021). By the time the hospital is fully expanded in 2035, it is expected to have a total of around 1,600 employees. Also, the Federal Institute for Geosciences and Natural Resources (B*undesamt für Geowissenschaften and Rohstoffe*) is setting up a Research and Development Centre for Mining Consequences (FEZB) (Deutsche Presse Agentur, 2020). The FEZB's core tasks and goals are to further expand scientific and technical knowledge on the sustainable design of post-mining landscapes with partners from science and regional industry and to lay the foundations for increased international cooperation between the region and international actors in the field of post-mining consequences. In total, 34 jobs are to be created there.

4.2.3 Reskilling / retraining needs of the local workforce

Further qualification or retraining of workers leaving the coal industry will be necessary if new activities are – or, to a large extent, are - not identical to those previously performed. Qualification measures should also address the motivation of the people concerned to better identify with new activities. Thereby, Knuth (2019) lists examples of promising occupational fields for Lusatia that could be related to activities in lignite mining and in the associated power plants. These include: automation technology, construction electrics, electrical machine technology, line installation and maintenance, information and telecommunications installation, civil engineering, supply and disposal, train driver in railway transport, monitoring and maintenance of railway infrastructure and IT application consulting.

Many employees in the Lusatian lignite sector are already trained for the above-mentioned fields by their basic qualification and daily work. These are therefore occupational fields that correspond to their skill sets and interests, e.g. mechatronics, plant, mechanical and electrical engineering, etc. However, it is questionable to what extent employees with the

aforementioned expertise will be in future demand from companies that are not active in the coal sector.

Finally, Markwardt et al. (2016) point out that the Lusatian region is expected to lose 17% of their inhabitants by 2040. In addition, the average age of the population will continue to rise (to 54 years in 2040). The authors therefore forecast a shortage of about 120,000 labour force members in the medium and long term. Moreover, the regional development strategy 2050 sees Lusatia as (green) energy region with new technologies. Overall, this positioning offers good job perspectives, especially for young workers, even without special training programmes for employees leaving the coal industry. The stepwise transformation process is already underway. Also, in this crucial point for regional development the current situation cannot be compared with the structural and socio-economic break after the German reunification in the 1990s (Wirtschaftsregion Lausitz GmbH, 2020).

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5 Greece, Western Macedonia Region

5.1 Current status of the region's workforce

5.1.1 Regional profile and specialisation

The Region of Western Macedonia covers a total surface of 9,451 km^2 in the northern part of Greece, corresponding to 7.2% of the country's total. Western Macedonia is divided into the regional units of Grevena, Kastoria, Kozani and Florina. The GDP of the region was 3,795 million € in 2019. Although generating only 2.1% of the national GDP, with a GDP/capita of 14,284 € in 2019 (representing 58% of the EU average and 84% of the country's average), the region ranks as 5th among the Greek regions in terms of wealth creation per inhabitant. However, the GDP/capita decreased by -7,9% in 2019 compared to 2018, while Western Macedonia was the only Region with negative change to the Gross Value Added (-8.8%) from 2018 to 2019 (temporary values), a period during which the national GVA increased by 2%.[3]

Western Macedonia is endowed with rich natural resources such as energy and metallic minerals that have shaped its productive identity as one of the most important electric energy production centres in Greece (70% of the country's total power was produced in the Region some years ago). However, the region is also hosting a cluster of firms in traditional sectors, including renowned regional products such as marble, saffron, fruits, local wines, furs and specialized arts and crafts. Western Macedonia is significantly specialized in mining and agglomeration of lignite, dressing and dyeing of fur, manufacture of articles of fur, production and distribution of electricity, mining and agglomeration of hard coal. However, the biggest regional employer is the crop production, market gardening and horticulture.

At the same time, Western Macedonia is one of the Greek regions with lowest R&D intensity, notably in the business sector. The expertise in the scientific sector is limited, though focused essentially on energy technologies. As far as the economic aspect is concerned, the region is characterized by a very strong sectoral specialization in energy and a number of targeted projects have been implemented. Despite this focus, the region has not managed to create a competitive advantage and is trapped in a vicious circle where efforts towards differentiation and development in the energy sector have reinforced the dominance of the public sector.

As regards demographics, in 2021 the estimated population of Western Macedonia Region (WMR) amounted to 262.052 thousand inhabitants, out of whom the 128.754 were men and 133.298 women (the corresponding figure for 2020 was 264.7 thousand). This ranks WMR to the 11th position among the 13 Greek regions, sharing 2.5% of the country's population. The time series for the time period from 2001 to 2021 (as shown in Table 5.1) outline a population

[3] All data provided is sourced from Eurostat and ELSTAT unless stated differently.

decrease in the area, in an even higher pace compared to the respective one for the rest of the country (-10.9%, compared to the national figure of -2.4%). This means that WMR's population has been shrinking at a higher speed than the rest of the country.

Table 5.1: Time series- population in WMR and Greece (2001-2021) [Source: ELSTAT]

Year	2001	2011	2021
Western Macedonia	294,317	283,200	262,052
Greece (entire country)	10,934,097	10,816,286	10,678,632 (est.)

Concerning the distribution of ages, and according to ELSTAT data as shown in Figure 5.1 (for the year 2020), the ages higher than 45 years old are dominating in the Region. The *ageing index*[4], is estimated at 148.4 in 2011 and 188.4 in 2020. The region is ranked in the 3rd (worst) position among Greek regions. It is obvious that young and dynamic population declines at a higher speed than in most other regions.

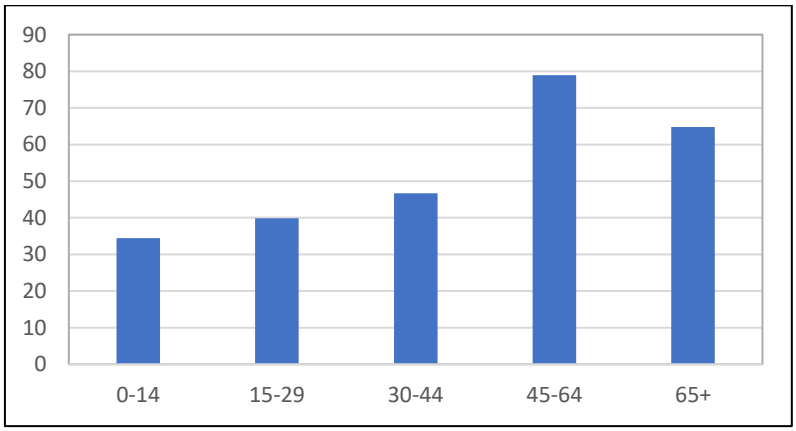

Figure 5.1: Western Macedonia's population ages distribution histogram - 2020

Source: Eurostat: Population on 1 January by age, sex and NUTS 2 region

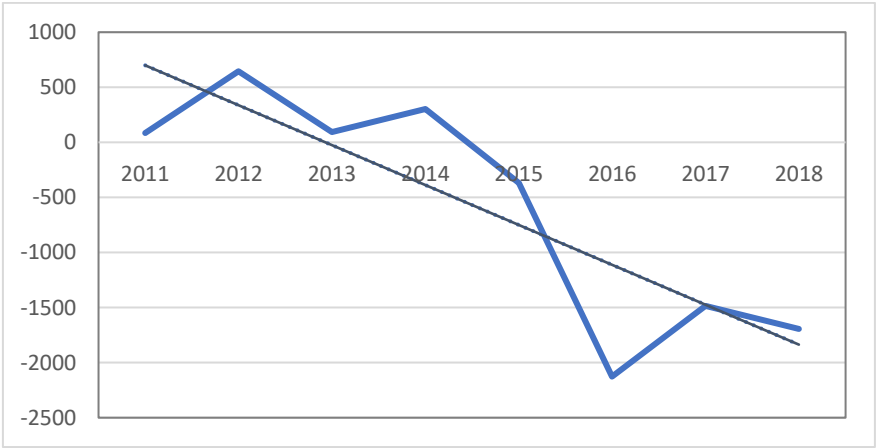

Figure 5.2: Western Macedonia's net immigration (No)

Source: Hellenic Statistical Authority, 2019 www.statistics.gr

Immigration is another important factor that needs to be taken into account. Although it seems that there are not significant residential movements in place, the *immigration balance* (newcomers vs residents leaving the region), is gradually moving to the negative side during the period 2011-2018 (Figure 5.2). It seems that, besides the negative birth/death balance, the

[4] The ratio of the population over 65 to the population under 15

immigration has become an additional factor responsible for the population decrease during the last decade.

The classification of the region's population (> 15 years) according to their education level in 2018 is presented in the following Figure 5.3. It is obvious that the region is characterised by high quality and specialised workforce, while postgraduates have been over-tripled since 2011 (according to the available data provided in Table 5.2). High school / college graduates have increased significantly as well.

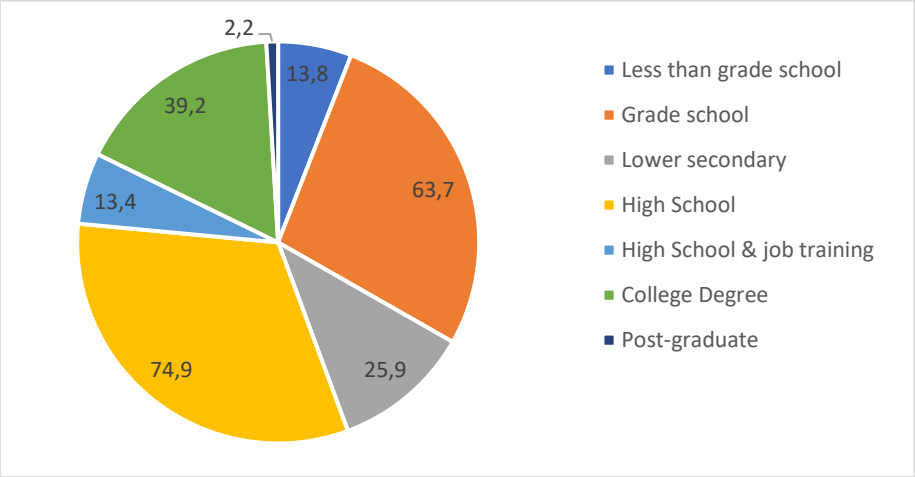

Figure 5.3: Western Macedonia, education level share (%) – 2018

Source: Hellenic Statistical Authority

Table 5.2: Western Macedonia's population by education level (thousands)

	Less than grade school	Grade school	Lower Secondary	High School	High School & job training	College Degree	Post-graduate
2018	13.8	63.7	25.9	74.9	13.4	39.2	2.2
2017	12.8	66.1	30.2	70.4	14.0	39.5	1.8
2016	14.6	67.8	31.5	72.5	13.5	35.2	1.9
2015	16.0	74.0	30.2	71.1	12.8	33.6	1.7
2014	16.7	78.6	29.2	68.1	11.7	34.4	1.6
2013	15.2	82.0	29.8	66.7	13.9	31.8	1.4
2012	13.5	88.1	29.4	65.5	14.4	29.3	1.3
2011	17.0	86.1	27.3	66.7	11.9	31.5	0.6

Source: Hellenic Statistical Authority, 2019 www.statistics.gr

In the following Table 5.3, the average number of employees by economic activities and the average nominal monthly net or gross wages by activity for the years 2011-2018 are presented. This is useful in order to identify the number and the income of employees in the energy industry.

Table 5.3: Western Macedonia region's employment indicators

Category		**Region of Western Makedonia (NUTS 2)**							
Years		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Average number of	Total economy	**90.6**	**80.4**	**77.1**	**82.5**	**81.2**	**84.5**	**84.5**	**86.2**
	Agriculture	16.0	14.0	14.3	15.1	15.4	17.9	17.9	17.8

Category		Region of Western Makedonia (NUTS 2)							
Years		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
employees by economic activities (thousands)	Industry	18.3	16.2	14.6	14.3	14.0	17.8	17.8	17.2
	▪ Hard coal and lignite mining	4.6	3.9	3.4	3.1	2.9	3.6	3.4	3.1
	▪ Electricity. Gas and HAC	3.1	2.9	2.8	2.9	2.9	3.9	4.1	4.1
	Construction	5.6	4.9	4.7	6.1	4.5	3.0	3.0	3.1
	Retail, Accommodation and food services	23.8	19.4	18.2	20.7	20.0	21.0	21.0	19.4
	Financing	5.2	4.5	4.7	5.2	4.6	5.2	5.2	5.2
	Other Professional Scientific and Technical activities	21.7	21.4	20.6	21.2	22.8	19.7	19.7	23.5
Average nominal monthly net or gross wages (€)	Agriculture	750	n/a	n/a	n/a	n/a	584	n/a	607
	Industry								
	▪ Hard coal and lignite mining	1,169	n/a	n/a	n/a	n/a	1,050	n/a	1,140
	▪ Electricity, Gas and HAC	1,179	n/a	n/a	n/a	n/a	1,047	n/a	1,237
	Construction	964	n/a	n/a	n/a	n/a	773	n/a	771
	Accommodation and food services	846	n/a	n/a	n/a	n/a	634	n/a	668
	Financing	1,287	n/a	n/a	n/a	n/a	1,111	n/a	1,151
	Other Professional Scientific and Technical activities	997	n/a	n/a	n/a	n/a	861	n/a	890

Source: Hellenic Statistical Authority, 2019 www.statistics.gr

Regional specialisation can be expressed mathematically by the *Location Quotient* (LQ), which is calculated for a specific sector and region as the ratio of the Regional Employment Share of the sector to the National one. LQ values higher than (>) 1 indicate sectors that are most important for the region (*exporting* sectors), while values lower than 1 indicate sectors that are less important for the region's development. Table 5.4 demonstrates clearly that WMR is specialised in industry (including energy & mining) and agriculture.

Table 5.4: Western Macedonia's Location Quotient (for 2018)

Sector	Regional Share (RS%)	National Share (NS%)	QL (RS/NS)
Primary Sector	20.66	12.27	**1.68**
Industry-Energy	19.93	11.29	**1.77**
Construction	3.57	3.96	0.90
Retail-Accommodation	22.52	33.92	0.66
Financing	6.05	11.20	0.54
Other Services	27.28	27.37	1.00

Examining the numbers provided in Tables 5.3 and 5.4, it can be summarised that:

- Employment in the *Industry-Energy* and *Primary* sectors is dominant, sharing 20% each approximately.

- Employment in *Construction* accounted for approximately 4% in 2018 compared to 6.2% in 2011, thus decreased by more than 40% probably due to the depression in house construction.
- Employment in *Retail & Accommodation* has been decreased slightly from 26.3% in 2011 to 22.5% in 2018, while employment in *Other services* with 24% (2011) and 27.3% (2018) respectively keeps a significant role. Thorough investigation needs to take place in order to define the magnitude of the employment of this category that is related (directly or indirectly) with *Industry*.

The region's specialization in Industry & Energy becomes even more important when the wages offered by each sector are taken into account. As it is clearly demonstrated in Table 5.3, the *nominal wages* in the mining and electricity sectors were estimated in 2018 at 1,140 and 1,273€ respectively, far beyond other sectors (771€ in construction, 890€ in other services and 607€ in agriculture). This fact reveals the important role of industry & mining to the local economy, as they provide high quality jobs contributing significantly to the local income.

5.1.2 Employment and unemployment status of the local workforce

In order to investigate the regional characteristics of the labour force, three basic parameters are used. The *activity rate*, defined as the ratio of the total labour force to the population of working age, the *employment rate*, i.e. the ratio of the labour force in work to the population of working age, and the *unemployment rate*, i.e. the ratio of the unemployed population to the labour force. The basic information source for labour force analysis (see Table 5.5 for the WMR case), is the *labour force quarterly survey*, implemented by the *Hellenic Statistical Authority* (ELSTAT), finalized at a yearly basis. Survey's results may differ slightly from the national census for population and housing that takes place every ten years (the last held in 2021 - not yet finalised). On the other hand, its rolling type and following statistical adjustments, guarantee that a reliable dataset may depict employment structure in detail.

Table 5.5: Western Macedonia region's employment indicators

Category		**Region of Western Makedonia (NUTS 2)**							
Years		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Employment rate (%) of population 20-64		*54.5*	*49.2*	*47.9*	*51.2*	*49.4*	*50.4*	*52.7*	*54.6*
Activity rate of population 15-64 (%)	male	73.24	71.38	70.88	72.13	74.54	77.31	77.31	77.64
	female	58.37	56.77	56.35	57.44	59.38	61.43	61.43	61.40
Activity rate (%)	15-24	20.0	19.5	19.5	20.1	20.7	21.5	21.5	21.3
	25-44	82.1	81.8	82.5	84.8	89.7	96.7	96.7	99.4
	45-64	67.4	64.1	62.5	62.8	63.6	63.6	63.6	62.7
Average number of employees (thousands)		*90.6*	*80.4*	*77.1*	*82.5*	*81.2*	*84.5*	*84.5*	*86.2*
Gender employment gap (%)		69.1%	63.8%	63.5%	64.3%	61.0%	60.7%	63.9%	66.6%
Registered unemployed (per thousands inhabitants)		95.87	119.93	126.07	111.73	128.85	133.50	127.04	118.14
Unemployment rate (%)	male	26.8	28.6	29.1	27.9	25.5	24.3	22.7	22.4
	female	41.6	43.2	43.7	42.6	40.6	39.7	38.6	38.6
Total		*23.1*	*29.7*	*31.6*	*27.6*	*30.7*	*31.3*	*29.1*	*27.0*
Persons in households having all members unemployed (thousands)		24.3	28.7	32.5	28.2	31.7	29.2	26.7	21.9
Long term un-employment rate (%)	male	6.7	10.9	12.9	10.5	12.5	12.9	12.8	11.5
	female	8.7	12.1	13.4	10.9	13.7	15.3	16.0	15.4

Category	Region of Western Makedonia (NUTS 2)							
Years	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Youth unemployment rate (%) 15-24	6.2	8.9	8.2	8.0	9.5	8.7	6.7	7.5

Source: Hellenic Statistical Authority, 2019 www.statistics.gr

According to Table 5.5, the *employment rate* of the part of population aged between 20 and 64 in the region was 54.6% in 2018 compared to 54.5% in 2011. A slight negative variation was observed during the years of Greek's economy depression (2012–2016), picked down to 49.4% in 2015. During the same period, the national figures accounted to 59.5 and 59.6% respectively, presenting a similar variation over time. By comparing the regional and national figures, it can be concluded that the *regional employment rate is constantly lower than the national one*. The opposite stands for the *unemployment rate*, which is constantly higher in WMR in comparison to the corresponding one at the national level (see figure 5.4).

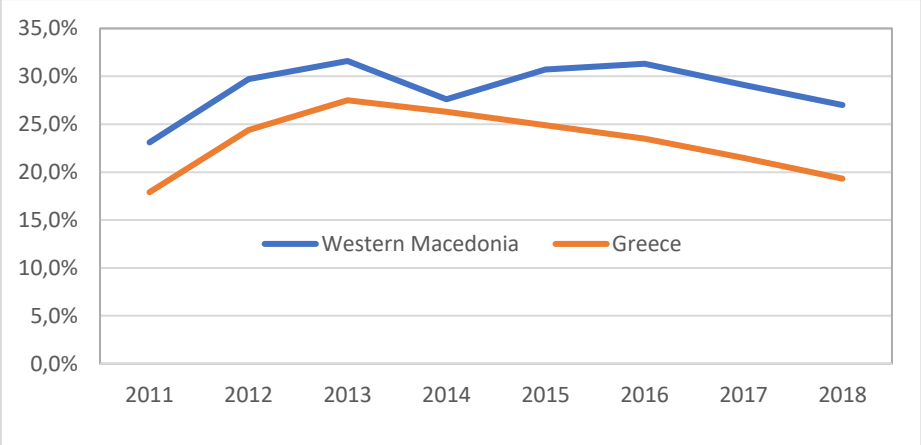

Figure 5.4: Unemployment rate in WMR and in the country

As regards the *employment rate*, the region was ranked in the 12th position (out of 13) in the country for the year 2018. The most recent available employment – unemployment data of the Region are those covering the 3rd semester of 2021, which are shown in the following Table 5.6. The unemployment rate was the highest of Greece, however it was lower than the one corresponding to the same semester of the year 2020.

Table 5.5: Western Macedonia's employment–unemployment indicators (3rd semester of 2021)

Employed (in thousands)	Unemployed (in thousands)	Non- workforce (in thousands)	Unemployment rate (%)	Workforce rate (%)
88,8	21,9	121,1	19.8	47.7

5.2 Vision for the Region

5.2.1 The path towards decarbonization

The decarbonization of the area of Western Macedonia constitutes a part of the National Energy and Climate Plan (NECP, 2019) and has started in the early 2010s, with the gradual reduction of lignite activity which is planned to be completed by 2023. There is the exception of the new Ptolemaida 5 unit, which is expected to operate until 2028 with lignite and/or a mixture of fuels.

An important issue resulting from this path is the fact that lignite, except for power production is used in parallel for district heating, covering the needs of about 42 thousand households and businesses in many towns of the region, corresponding to a total demand of ~600 GWh (IENE, 2020a). It is planned that during the transitional period the district heating for the area will be provided through the interconnection of Amyntaio, Ptolemaida and Kozani with a network of hot water pipes, as well as a connection with a new CHP unit, supplied with natural gas. The final plan is to create a *thermal hub* of total available thermal power which will initially rise to 400-420 MW_{th}, having a system backup to approximately 120-140 MW_{th}. This will be produced by 5 units, namely from the modification of an existing unit and the construction of 4 new, using natural gas, electricity and a mixed biomass combustion with a small amount of lignite.

To secure the provision of gas in order to cover the thermal needs of the area, the 10-year investment plan of DESFA for the period 2020-2029 includes the development of the gas transmission network in Western Macedonia by creating three new metering and regulating stations. From these three measuring/regulating stations it will then be possible to construct the medium and low-pressure network, which will transport the natural gas to the cities of the region.

Additionally, there is a plan for growth of the RES installations in the region's area. Besides the excising installations, there is a number of projects that have submitted applications for granting of a Production License. More specifically, wind energy projects (existing ones and in the licensing procedure) are expected to rise to approximately 2,132 MW of capacity. The total capacity of all solar thermal units to be installed in in the (abandoned) lignite mines of Western Macedonia rise up to 102 MW. Small hydroelectric projects (SHPP) being in the licensing stage are of total capacity of 9.14 MW, while the mature biomass projects in the area are counting to six (6) with a total capacity of 40.67 MW. (IENE, 2020b)

It should be further noticed that there is a theoretical potential for residual biomass in the Region (500,000 tons of dry biomass/year, with a fuel energy content of 2,600 GWh / year), which could be exploited and supply up to a 25 MW_e power plant, creating at least 50 jobs (Academy of Athens, 2020). Finally, absolute priority is given to the development of energy crops in the mines soils in order to produce biomass as a fuel and for advanced biofuels. This is an activity that matches the specialties of the human resources of the region, has a great leverage of economic activity and employment, utilizes the restoration of lands that is required by PPC and is of great energy and environmental importance.

The installation of photovoltaic parks of more than 2 GW capacity in Western Macedonia (basically from PPC, but also from another state-controlled company, Hellenic Petroleum - ELPE) is a main priority of the state. Some of the - already licenced - projects are to be located in the areas of lignite mines, and it could be made possible that these are functioning by 2030. In connection with the increase of the generated power from RES, a number of projects concerning the installation of storage facilities (batteries) are planned in the region of Western Macedonia, such as the 250 MW capacity project of Eunice and the 6 projects for which PPC Renewables has received Electricity Production Licenses. Also, Sunlight is considering the creation of a battery production facility in the region.

Finally, an Important Project of Common European Interest (IPCEI) on HYDROGEN, named the "White Dragon" is about to start in the region. The "White Dragon" project will use large-scale renewable electricity (500 MW of PVs will be connected directly to the electrolytes) for the production of green hydrogen by electrolysis. The hydrogen will then be stored directly (short-term hydrogen storage) and indirectly (piped to the main gas pipeline) and, through high temperature fuel cells, will supply the country's electricity system as a stable unit for green power and heat. The generated heat, as a by-product of green electricity production, could initially have a complementary use to the district heating networks of West Macedonia, as well as in other applications that require heat and / or cooling in the future (industries, data centres,

greenhouses, etc.). In addition, a complete Hydrogen Industrial Research Center will be developed, within the Hydrogen High Technology, Research, Development & Innovation Node that will be created in Western Macedonia. The project is expected to have a hydrogen production of 250,000 tons/year for energy and 58.000-71.000 tons/year for other uses (DEPA, 2021).

5.2.2 New jobs to be created through the decarbonization process

The decarbonization process of WMR has concerned local and national institutions and there have been studies, analysis and reports made, of which a brief reference is made in the following. However, a more specific and updated (according also to the projections made and all other findings of the TRACER project) analysis on the new jobs that can be created through the decarbonization process in Western Macedonia is presented herein.

General overview of previous work related to job loss/creation in the region

According to an analysis of the Technical Chamber of Greece-Western Macedonia (TCG-WM, 2012) "*the withdrawal of 2,400 MW of power from WMR would lead to 12,468 jobs and a local income of approximately €670 million to be lost as a result of the multiplying effects*". On the other hand, in the report of Greenpeace (Greenpeace, 2006) on the transition in the new energy era, it is mentioned that "*RES create more jobs than lignite, both per unit of installed capacity and per unit of energy*".

Kozani's Ecological Group (Ecological Movement of Kozani, 2009) proposed that "*RES equipment could be manufactured in units allocated in the Regional Units of Kozani and Florina, with large-scale and craft industries manufacturing wind turbines, PV equipment and solar thermal systems […] retaining its energy centre profile and being environmentally sustainable at the same time*", with "*1,730, 630 and 560 jobs created between 2009-2020 in the wind turbine, PV and solar sectors, respectively*" (data and projection of 2009).

WWF has proposed in 2016 a "Roadmap for the transition of the Western Macedonia Region to a post-lignite era" (WWF, 2016) where a detailed analysis is presented including local data, international best practice examples, and the study of scenarios. This Roadmap also proposes the idea of creating jobs in alternative areas, for example in the primary sector, increasing jobs for the cultivation of saffron, of aromatic plants, energy crops and forestry.

Furthermore, the WMR's Regional Framework for Planning and Sustainable Development (MEECC, 2015) examines the development of Renewable Energy Sources (RES), energy savings, waste management, the processing of fly ash, and the processing of aromatic and pharmaceutical plants. Other areas with strong development potential that may balance the jobs and income lost by the coal extraction termination are: Construction & Infrastructure development, Tourism, Education, Research & Innovation.

Finally, in a recent publication of JRC (Kapetaki et al., 2020), and regarding specifically the decarbonization of WMR it is mentioned that "*the jobs created may not be as significant as counting for one to one compared to the previously estimated coal related jobs".* In this report it is moreover mentioned that: "… *the remarkable coal related jobs of almost 6 000 FTE […] surpasses the decarbonizing employment potentially mobilized. The biomass related jobs will cover most of the near 2 000 FTE potential employment by 2050"*.

Jobs in wind energy sector

As mentioned previously, wind energy projects being in various stages of the licensing procedure in WMR (including those with Operation License) rise to a capacity of 2,133 MW. The projection of expected created jobs in the wind energy field is calculated according to the respective European projection for 2030, as presented from WindEurope based on the EU Member States NECPs. More precisely, for 286 GW of (onshore) wind energy projects

approximately 250,000 jobs are expected to be created. The jobs related to manufacturing (wind turbines and components) represent the 46.1% of the total (Pineda I., 2020).

According to a tailored to the Greek status analysis elabourated a few years ago by the Greek Association of Renewable Electricity Producers (GAREP), the wind energy projects can result to the creation of 1 permanent job/MW, divided as follows: 0.49 permanent jobs/MW at wind investors/owners (development, construction, operation), 0.32 permanent jobs/MW at wind turbine generators manufacturers (sales, O&M), and 0.19 permanent jobs/MW at towers manufacturing. Taking into account that all these jobs are provided in the national scale, and following another relevant analysis from the Hellenic Wind Energy Association (ELETAEN) as regards the case of south Evia, where it is stated that 0.3 jobs/MW from the wind farms are created locally (ELETAEN, 2019), the corresponding figures are shown in the below Table.

Source of information	**Created positions (jobs- total)**	**Created positions (jobs- manufacturing not included)**
WindEurope (2020)	1864	1005
GAREP (and ELETAEN)	2113 (from which 634 locally)	1035

Jobs in small hydropower projects

According to a research report provided in cooperation with Welfare Wealth Work for Europe (Meyer, 2014) the employment factors used in global analysis for small hydro projects are different for the manufacturing, construction and installation, and operation & maintenance phases, varying from 5.5 jobs/MW, 15 job-years/MW and 2.4 jobs/MW respectively. Taking this assumption, the projection of created jobs for the foreseen new SMPP in the area (of 9.14 MW capacity) are calculated and presented in the following Table.

Created positions, jobs (Manufacturing)	**Created positions, job-years (Construction & Installation)**	**Created positions, jobs (Operation & maintenance)**
~50	~137	~22

Jobs in the PV industry

According to SolarPower Europe, a total capacity of 479 GW PV is expected in Europe for 2030, which would result in 741.871 solar jobs (131.949 for manufacturing and the rest 609.922 for deployment, operation & maintenance, and decommissioning & recycling). This is equivalent to 1,549 or 1,273 jobs per GW, depending on whether or not manufacturing is included. (SolarPower Europe, 2021)

According to the Hellenic Association of Photovoltaic Companies (HELAPCO), in 2019 in Greece 2828 MW_p of PV were installed, giving 9000 FTE (direct, indirect and implied). The calculation of direct jobs per installed MW is done *using the methodology developed on behalf of the International Trade Union Confederation, the results of which are confirmed by corresponding calculations of the International Organization for RES (IRENA) and the methodology followed in the US. These jobs are created both locally (at the site of the power plant installation) and supra-locally (especially for the production of equipment).* Therefore, for the calculation of jobs at the country level, the percentage of equipment produced at national level and not imported from a third country was taken into account (HELAPCO, 2019). This is translated to 3183 jobs FTE per 1 GW.

However, the Academy of Athens claims that for the projects in the Western Macedonia Region the ratio should be 1 FTE job for 1 GW, since the parks are going to be concentrated in the old mines area, and not scattered in the Region (Academy of Athens, 2020). Using this

information, the expected created jobs FTE for the foreseen ~2.2 GW PV in all three (3) sources / assumptions are calculated, as shown in the Table below.

Source of information	Created positions – total, FTE	Created positions-manufacturing not included
SolarPower Europe	3,408	2,800
HELAPCO	7,000	-
Academy of Athens	2,200	-

Jobs in the biomass sector

As mentioned in the JRC "Employment in the Energy Sector" 2020 Status Report (Czako, V., 2020) and according to (Rutovitz et al., 2015) the world average Operation & Maintenance jobs related to a 1 MW biomass plant is 1.5. Taking this into account, for the mature biomass projects in the area of WMR of a total capacity of 40.67 MW the created job positions (FTE) for Operation & Maintenance are expected to be more than 60. Furthermore, the exploitation of part of the total residual biomass potential of the region and the set-up of a 25 MW_e power plant giving approximately 50 jobs, as mentioned in the Academy of Athens' press release (Academy of Athens, 2020), should also be taken into consideration.

Jobs in the solar thermal power plants sector

In the above-mentioned research report of Welfare Wealth Work for Europe (Meyer, 2014), for solar thermal projects for power generation (i.e. Concentrating Solar Power – CSP – plants) 4 jobs/MW are created during Manufacturing, 8.9 job-years/MW are requested for Construction and Installation and 0.5 job/MW for Operation and Maintenance.

The European Solar Thermal Electricity Association (ESTELA), Greenpeace International and SolarPACES published a joint report on the present and future of solar thermal electricity (ESTELA 2016), analyzing various scenarios (growth under current policy, moderate market growth and advanced market growth). In all scenarios, the jobs created in this sector are considered as a crucial factor to take under consideration for policy making, since "*any technology which demands a substantial level of skilled and unskilled labour is of considerable economic importance*". In order to conclude to the number of jobs created, "*a number of assessments of the employment effects of solar power have been carried out in Germany, Spain and the US. The assumption made in our analysis is that for every MW of new capacity, the annual market for STE will create 10 jobs through manufacturing, component supply, project development, installation, and indirect employment* (*as production processes are optimised, this level will decrease, falling to eight jobs by 2030 under the Reference scenario). In addition, employment in regular operations and maintenance work at solar farms will contribute a further one job for every MW of cumulative capacity."*

Thus, for the solar thermal units to be installed in the former lignite mines of WMR of 102 MW_e capacity, the following estimations are made (according to the above two sources):

Source	Created positions, jobs (Manufacturing)	Created positions, jobs-years (Construction & Installation)	Created positions, jobs (Operation & maintenance)
WWWforEurope (2014)	408	908	51
ESTELA et al (2016)	1,020 (*816 if development will take place after 2030*)		102

Jobs in the hydrogen sector

The “White Dragon” project (briefly described in the previous section) started in 2022 and is expected to be completed by 2029, including the R&D, First Industrial Deployment (FID) and Environmental, energy or transport (EET) activities/phases. A total number of 9,700 direct and 29,000 indirect jobs are considered as needed during the development phase of the project - until 2029 - for the WD JV, while after that (i.e. from 2030 onwards) there are going to be 2,970 permanent direct jobs only in hydrogen production with at least 10,400 indirect, as foreseen in the approved proposal (DEPA, 2021).

Jobs created in other energy related domains

There are other sectors that are expected to create jobs, during the decarbonisation procedure. Since the target is less CO_2 emissions, funding schemes and support polices for Energy Efficiency and Savings are also expected to be implemented in the area (as in the entire country). Furthermore, the decommissioning of the mines and the former energy production from lignite facilities is also expected to employ engineers, technicians and workers. The projected numbers of created positions are presented in the following Table, as calculated: (1) in the JRC report (Kapetaki et al., 2020) for the region and (2) in the Strategic Plan “A Practical Guide for the smooth transition of regions with high dependence on solid fossil fuels in a new productive model of Macedonia - The case of Western Macedonia” (Karlopoulos and Spyropoulos, 2020).

Other domains	**Created positions**
(1) Energy savings (efficiency)	0.2 FTE/year for the equipment and 0.3 FTE/year for construction
(2) Decommissioning Engineering	3000 jobs for 8 years appr.

5.2.3 Reskilling / retraining needs of the local workforce

The Lignite Centre of Western Macedonia employed about 3200 people in September 2020, while about 2000 job positions were maintained by the satellite companies that are active in the region and which cover the operational needs of Public Power Corporation (PPC) SA on a constant basis. Obviously, after the year 2023, these jobs will experience a state of high uncertainty, while significant losses are already recorded in satellite companies with high dependence on the lignite value chain. According to other relevant estimations, the lignite phase-out in Western Macedonia by 2028, or even earlier (by 2025), is expected to lead to a significant decline of the regional GDP, to a loss of 21,000 both direct and indirect jobs (as more than 25% of the local jobs are directly or indirectly related to the lignite industry), as well as to a loss in the total income of €9 billion in the period 2018–2028.

With the implementation of all - or most of - the abovementioned projects, which will ensure the smooth transition of the region in the post-lignite era, while retaining the character of the region as the “energy centre” of Greece, most of which are further included/described in the Master Plan for the Just Development Transition (JDTP) and in the Western Macedonia’s Just Transition Territorial Plan (ESDIM) that has recently been put up for consultation (SDAM TC, 2020), it is estimated that the new jobs that will be created by 2028/2030 shall be able to compensate for the jobs to be lost in PPC and for those of the contractors, while they may also cover the short-term unemployed persons of the region. This will also result in an inflow of a new high-skilled workforce, e.g., specialized scientists and executives, combined with the absorption of the affected human resources in the affected areas.

The professional specialization of the human resources in Western Macedonia concerns mainly the technical experience and skills related to the production of electricity and lignite mining, earthworks, and machine management, and this existing specialization could consist

of the competitive advantage of the area. The majority of the newly created jobs will be targeted to cover the activities and needs related to the restoration of the former mine lands and to the development of clean energy projects (e.g., PV plants). The construction phase of these investments will last until at least 2030, and will absorb the lost job positions of the technical staff of the region, as it requires similar skills and qualifications. Following this procedure, a smooth transition of the regional labour market to the post-lignite era shall be enabled

The demand for professional skills may however become differentiated as the operation phase of the projects succeeds their construction. The operation of new companies in the area will increase the demand for specialized personnel (researchers, managers), while the further diversification of the economic activities will born a new demand for skills characterising professions such as the ones of agronomists, winemakers, farmers, tourism professionals, as well as administrative employees (SDAM TC, 2020). Taking into consideration the existing skill set/scenery of the region, it is estimated that about half of the PPC workforce and the short-term local unemployed may need reskilling to be absorbed by new economic activities.

The background concerning the human resource requirements for RES technologies is very efficiently reflected in a respective recent analysis (IRENA and ILO, 2021), according to which the majority of the existing workforce needs minimal formal training. In the following Figure 5.5, it is shown that regarding the solar and wind energy projects, a degree in Science, Technology, Engineering and Mathematics (STEM) is required by around the 30% of the workforce, while the 60% of the employees occupied in these activities/sectors may meet the job requirements possessing even a lower certification. Other highly qualified non-STEM professionals (such as lawyers, logistics experts, marketing professionals, experts in regulation and standardisation) cover the 5% of the needed personnel, while the administrative staff stands for the smallest share (1- 4%). This could be a reassuring fact, since the new needed workforce in the RES projects should be relatively easy to get trained.

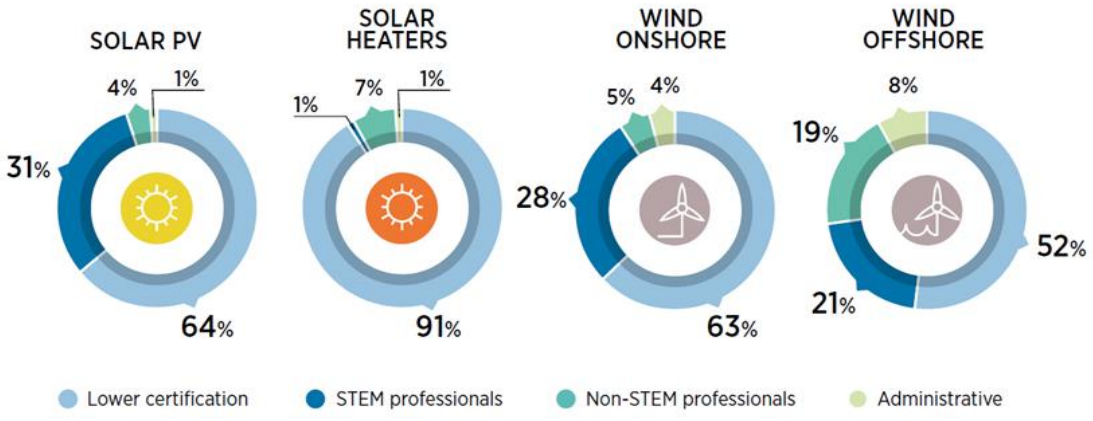

Figure 5.5: Human resource requirements for workers in solar PV, wind energy (onshore and offshore), and solar water heaters

Source: IRENA & ILO, 2021

In the frame of the EU Erasmus+ project RES-SKILL (*Reskilling coal industry workers for the renewables energy sector*), a skill-matching analysis was developed summarizing both the skills and the competences needed for the successful transition of the workforce of the coal industry to RES (PROMEA, 2021). In order to identify the required training as well as the time needed, the *occupation profiles* for coal industry and RES sectors and the *essential skills* for coal and RES workers were defined. A synthesis of the above was made, resulting to the development of the "*transition profiles*", while the occupation profiles and skills of workers in the coal industry and RES sectors were matched. The results are schematically presented in the following Table:

	Coal industry	RES sector
Occupation profile	Mining machine operators	Machinist of road construction machinery (PV) and machine operators (wind)
Justification	Even though mining machine operators have a similar set of skills to machinists of road construction machinery and machine operators (wind), workers in the RES sector operate with heavy machines	
Time of training needed	6 months to learn how to operate heavy machinery and be retrained to machinists of road construction machinery (PV) and machine operators (wind).	
Occupation profile	Fitters in the coal industry	PV fitter/installers and HVAC system installers
Justification	Fitters can transition to PV fitters/installers and HVAC system installers with a low retraining	
Time of training needed	1 month in enough, as they already have the skillset required.	
Occupation profile	Maintenance and repair workers	PV operation and maintenance technicians
Justification	Maintenance coal workers have extensive experience on maintenance	
Time of training needed	1 month to transition to the RES sector.	
Occupation profile	Construction equipment operators	Machinist of road construction machinery (PV), Machine operators (wind)
Justification	Construction equipment operators have significant knowledge in handling construction machinery	
Time of training needed for transition	~1 month to transition to PV ~6 months to transition to machine operators (wind) as they will have to adapt to new equipment	
Occupation profile	Heavy vehicle & mobile equipment service technicians & mechanics	PV operation and maintenance technicians, Maintenance and repair electricians
Justification	Heavy vehicle technicians and mechanics are already experienced in maintenance and repair	
Time of training needed	~1 month	
Occupation profile	Mining electricians	PV electricians, Electricians (wind), Maintenance and repair electricians (wind)
Justification	Mining electricians can easily transition to PV electricians as they already have the skillset required. However, they will need some more time to acquire the skills needed to transition to electricians (wind) and maintenance and repair electricians (wind).	
Time of training needed for transition	~1 month to PV electricians ~3 months to wind electricians	

In addition to what mentioned regarding the workforce, it is worth mentioning that in some cases it is difficult to find highly qualified STEM or non-STEM professionals possessing expertise in the RES technologies/projects. Qualified design engineers with specific knowledge in particular RE technologies are especially needed. More specifically, in the wind energy sector not only engineers but also specialized turbine technicians are needed. An engineering and technical skills gap appears in the hydropower sector (especially in emerging countries), while a lack of qualified engineers and appropriately trained technicians has been identified in the bioenergy sector. Last, but not least, a widespread shortage of qualified trainers with RES specific skills has also been identified (PROMEA, 2021).

The role of a reskilling program that may be offered for a number of reasons is to provide the necessary conditions to the potential trainees/employees so as to be able to update their professional characteristics and status in order to meet the current needs of the labour market. Thus, a reskilling program must offer to the participants the opportunity to improve their skills and knowledge and gain practical experience, while also developing wider, necessary skills

for the modern economy, such as professional PC operation, new teleworking technologies, etc.

The existence of a reskilling program should be coupled though with a series of integrated and coherent policy measures that combine training with work employment subsidy. This way a fair transition with limited negative impacts on the income of local population could be achieved. The combination of employment programs with reskilling ones will enable local workers to be absorbed quickly by the labour market, while it will also contribute to attracting new investment challenges/opportunities.

Taking into consideration the data provided in section 5.1, it is a fact that the current status of the workforce in Western Macedonia Region is characterised by high quality and specialised workforce, while the increasing index in the number of the university degree and post-graduates consists of a very encouraging trend towards a continuous improvement of the educational/expertise level of the local workforce. Thus, the general status as far as the current needs for retraining is quite satisfactory. A considerable number of a part of the workforce is already possessing a significant specialization level in relation to RES technologies. On the other hand, another part of the people actually occupied in the region will have to undergo a more long lasting and specialized reskilling, in order to be able to acquire all the necessary new and related to RES technologies skills that will enable their absorption and incorporation in the newly raised and created job positions in the after-lignite era.

The procedure of an efficient retraining/reskilling planning requires a number of specific preconditions. Thus, after the diagnosis on the current needs' status in the region of Western Macedonia related to the availability or not of adequately specialised workforce in view of the new after-coal era activities and market, an investigation on the necessary efforts made as well as on the possibilities for the provision of the necessary training has to be put in place. As described in section 5.2, the region offers a good number of skilled human resources together with a good back end in technical education and long-life learning (as it is shown in Figure 5.3 above) and this fact provides an opportunity for further creation of jobs in the training sector.

This is a crucial parameter that paths the way towards the potential for an effective and appropriately enriched reskilling/retraining background. A number of seminars and/or courses could be designed and implemented either at university level, or in the continuous and/or initial technical and vocational education & training (CVET / ITVET) and apprenticeships in technical disciplines. In addition to the retraining of the workforce in the coal industry, up-skill training for engineers or technicians or even for new RES professionals could be a useful upgrade to the labour market.

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6 Poland, Upper Silesia Region

6.1 Current status of the region's workforce

6.1.1 Regional profile and specialisation

The Śląskie Voivodeship is classified as a region with great economic potential, apparent in the high value of its gross domestic product (GDP). In 2020, the Śląskie Voivodeship generated 11.6% of Poland's GDP. In that year, the value of GDP per capita of the voivodship amounted to PLN 60,091, slightly lower than the average GDP per capita in Poland (PLN 60,663) and more than 2 times lower (PLN 133,368) than the average GDP per capita in the Warsaw region (GUS, 2021).

However, the value of GDP has been increasing more slowly than in the country's less developed voivodeships, which means that the region is slowly but steadily losing its strong position. The GDP in the years 2001–2018 was continually increasing, while the trend of GDP growth rate in 2001–2018 decreased, both for the entire country and for the voivodeship. However, the pace of this downward trend is greater for the region. As a result, the position of the Śląskie Voivodeship in terms of GDP per capita is characterized by a gradual decline, despite being one of the highest in the country. The Śląskie Voivodeship is also losing its advantage in terms of GDP per capita compared to the national average. In 2004, GDP per capita in the region was over 11 percentage points (pp) higher than the national average, while in 2018 this advantage was only 3.9 pp (Województwo Śląskie, 2021a).

The Śląskie Voivodeship is the second region in the country following the Mazowieckie Voivodeship in terms of creating Gross Value Added (GVA). In 2018, the GVA of the Śląskie Voivodeship amounted to PLN 228.1 billion, while the region's share in generating the country's GVA was 12.28%. Approximately 42.3% of GVA created in the Śląskie Voivodeship came from the industry sector, increasing by approximately 2.3 pp compared to 2000. The services sector plays a dominant role in generating GVA in the region, as is the case in the rest of the country, with services being of greater importance in the country as a whole than in the region. GVA per capita in 2018 exceeded the average for Poland by 3.9 pp, and the GVA produced in the Śląskie Voivodeship after conversion per 1 working person exceeded the national average by 8.6 pp. It is worth noting that the GVA in relation to the number of inhabitants shows a smaller advantage over the country's average than the GVA expressed in relation to the number of employed persons. This may indicate an additional problem faced by the Śląskie Voivodeship, namely the low economic activity of its inhabitants (Województwo Śląskie, 2021a).

The Silesian Voivodeship is inhabited by 4,492.3 people, which accounts for 11.7% of the Polish population (Urząd Statystyczny w Katowicach, 2021). In terms of population, the voivodeship ranks second in the country after Mazowieckie (14%). As a result of economic changes and the corresponding social changes they have generated, the phenomenon of depopulation has been apparent in the Śląskie Voivodeship for a long time. The number of inhabitants in the voivodeship is decreasing year by year (in the period from 2000 to 2018, the decrease was 4.74%). In terms of negative percentage changes in voivodeship populations, the region ranks third, after Opolskie (-7.9%) and Łódzkie (-6.1%).

When analysing the phenomenon within the spatial structure of the Śląskie Voivodeship, the decline in population is clearly noticeable in the central (Upper Silesian Metropolitan Area) and in the north-eastern part of the voivodeship. However, an increase in the number of people appears in the southern part of the region. Unfavorable demographic trends in the Śląskie Voivodeship are compounded by poor results in the natural movement of the population. In the years 2000–2018, the number of deaths recorded in the Śląskie Voivodeship was higher than the number of live births. Only in 2010 did the number of births exceed the number of deaths. At the same time, the region has one of the worst population growth rates per 1,000 inhabitants in Poland, amounting to -2.1.

The Śląskie Voivodeship is characterized by a significant population outflow from cities to rural areas. For 13 years (since 2005), the intra-voivodeship migration balance for the Śląskie Voivodeship amounted to over 61,000 people to the benefit of rural areas. Therefore, measures are necessary to counteract depopulation of cities and the phenomenon of suburbanization. According to the forecasts of the Central Statistical Office, by 2050 the population in the Śląskie Voivodeship will have decreased by 18.8% compared to 2018, i.e. by over 850 thousand people. In absolute values, this is the highest in the country, and it will have serious and multifaceted socio-economic consequences (Województwo Śląskie, 2021b).

In the Śląskie Voivodeship, women have steadily outnumbered men for years. At the end of 2018, women accounted for 51.8% of the voivodeship's population, with this share increasing

slightly between 2014 and 2018 (by 0.1 pp). Similarly, the feminization rate did not change significantly in the analyzed period and amounted to 107.4 in 2018 (compared to 107.3 in 2014).

At the end of 2018, in the Śląskie Voivodeship, people aged 65 and above accounted for 18.6% of the total population, 2.5 pp more than in 2014. In Poland, this group represented 17.5% of the national population in 2018, a number which remains the same today. The demographic aging rate was higher in urban areas (19.3%) than in rural areas (16.0%). At the end of 2018, the old age index in the Śląskie Voivodeship was 128 people (115 people in the entire country), i.e. there were on average 128 grandparents per 100 grandchildren. The pre-working age population at the end of 2018 in the Śląskie Voivodeship was 772.1 thousand persons, an increase of 0.1% in comparison to 2014. The share of the population from this age group in the total population in the voivodeship was 17.0% (in the country, it was 18.1%).

The working age population was 2,735.1 thousand persons, 5.6% less than in 2014, and its share in the total population was 60.3% (in Poland, it was 60.6%). The mobile age population decreased by 5.4%, and the immobile age by 6.0%. The post-working age population increased significantly by 12.0%. The share of this group in the total population at the end of 2018 was 22.6% (21.4% in Poland). At the end of 2018, the demographic dependency ratio in the Śląskie Voivodeship reached the value of 65.8 (in the country, it was 65.1), and in 2014–2018 it increased by 7.6 pp. Taking into account the partial coefficients, in 2018 there were 28 pre-working aged people per 100 people of working age and 38 people of post-working age. (Urząd Statystyczny w Katowicach, 2019).

The Śląskie Voivodeship is further characterized by a low economic activity in the population. In 2019, the number of economically inactive people in the region amounted to 1,707 thousand, which was the second highest number in Poland after the Mazowieckie Voivodeship (1,726 thousand people). The vast majority of the economically inactive, as high as 73.2%, were people aged 50 and above. In the economically inactive group, the most numerous categories are people with the lowest education levels: lower secondary and below (25%), basic vocational (30%), and post-secondary and secondary vocational (23%). In 2019, 1,911 thousand people were classified as professionally active, which placed the Śląskie Voivodeship among the Czech regions characterized by a lower share of professionally active people in the total population. The largest share of the economically active group was recorded among people aged 30–39 (29.1%) and 40–49 (27.3%), while the share of economically active people aged 50+ was 24.3%.

The professional activity rate in the Śląskie Voivodeship has for years been one of the lowest in the country. In 2019, the indicator was at 52.8% (3.4 pp less than the national average) and was the penultimate result in relation to other regions. Over the last decade, since 2010, the professional activity rate has increased by 0.5 pp. At the same time, the employment rate in 2019 was 51.5%. This value of the index placed the Śląskie Voivodeship below the national average by 2.9 pp, among the regions with the lowest employment rate values (only two regions had a lower value for this indicator). However, the value of the employment rate in the period 2010–2019 increased by 4 pp (Województwo Śląskie, 2021b).

6.1.2 Employment and unemployment status of the local workforce

The most up-to-date data available on employees show that as of December 31, 2019, 1,777,243 people worked in the entire Śląskie Voivodeship, which constituted 11.3% of the total number of employees in the country, 13,534 people more than at the end of 2018. In annual terms, the number of employed persons increased by 1.1% in Poland, and by 0.8% in the region (Wojewódzki Urząd Pracy w Katowicach, 2021).

On the other hand, the number of unemployed people registered in district labour offices in the Śląskie Voivodeship at the end of December 2019 was 66,521. In annual terms, the

unemployed group decreased by 13,558 people (the dynamics of decline was -16.9%). It was the sixth consecutive year showing such high dynamics of decline in unemployment. Compared to the situation from the prior year, the intensity of the phenomenon, measured by the level of the unemployment rate, has decreased significantly. As of December 31, 2019, the unemployment rate in Silesia was 3.6% (5.2% nationally). In annual terms, the value of this indicator decreased by 0.7 pp in the voivodeship (4.3% in December 2018). At the end of the year, Śląskie was second on the list of voivodeships with the lowest unemployment rate, following Wielkopolska (2.8%). Regardless of the reporting year, the intensity of registered unemployment in the region is one of the lowest in the country (Wojewódzki Urząd Pracy w Katowicach, 2020).

The main features differentiating the unemployed are gender, place of residence (city or village), age, level of education and the type of activity performed in the most recent job. In 2019, women's unemployment was falling both in Poland and in the Śląskie region. As of December 31, 2019, 37,626 women were registered at the employment offices of the Śląskie Voivodeship, which constituted 56.6% of the total number of unemployed (in the country, this share was lower and amounted to 55.3%). In Silesia, most of the unemployed live in cities (50,165 people, i.e. 75.4%). At the end of December 2019, only every fourth unemployed person registered in district labour offices of the voivodeship was a resident of rural areas (16.4 thousand people, i.e. 24.6%). In terms of age, the situation of the unemployed in the labour market has changed somewhat in annual terms. In 2019, there was a decrease in the number of registered unemployed in all age groups. The largest drop in the number of unemployed was recorded in the 25–34 age group. Nevertheless, every fourth unemployed person still comes from this age category (26.0%).

In 2020, the education structure of the unemployed did not change significantly. As in the previous year, in the Śląskie Voivodeship over half of the registered unemployed were people with an education level below secondary. In 2019, there was a decrease in the number of unemployed in all categories distinguished by level of education. The highest dynamics of decline were recorded in the group of people with a lower secondary education level and below (-19.6%). People with professional experience accounted for the vast majority of unemployed (as of December 31, 2019, this figure was 59,417 people, i.e. 89.3% of the total). Others (7,104 people), 10.7% of the total number, do not have any professional experience. For several years, among the previously employed and now unemployed people, the highest number of people were those that had worked between one and five years (15.3 thousand at the end of December 2019) (Wojewódzki Urząd Pracy w Katowicach, 2020).

It is estimated that the lack of one job in mining means a reduction of 4–5 jobs in mining-related industries. Other estimates indicate that for each place in Poland's hard coal-mining industry, there are indirectly at least 1.16–1.35 jobs in other sectors of the economy, which means 96.3–112 thousand people are employed in industries related to mining. The projected scale of people dependent on the operation of mines is much higher if the families of employees are taken into account. According to estimates from the Institute for Structural Research (IBS), by 2030 in the Śląskie Voivodeship, the process of decommissioning the mining sector will require the creation of 28–31 thousand new jobs, 13 thousand in connection with the reduction of jobs in the mining industry and 15–18 thousand for people working in activities directly related to mining (Urząd Marszałkowski Województwa Śląskiego, 2021a).

6.2 Vision for the Region

6.2.1 The path towards decarbonization

The National Energy and Climate Plan (NECP) for 2021–2030 (Ministerstwo Aktywów Państwowych, 2019) assumes a 7% reduction in greenhouse gas emissions compared to 2005 levels in sectors not covered by the EU Emissions Trading System (ETS): a 21–23% share of renewable energy sources in gross final energy consumption (the 23% target will be possible

to achieve if Poland is granted additional EU funds, including those allocated for a just transition), an increase in energy efficiency by 23% compared to the PRIMES2007 forecasts, as well as a reduction to a 56–60% share of coal in electricity production. Śląskie Voivodeship, by implementing inter alia provisions of the Territorial Just Transition Plan - TJTP (Urząd Marszałkowski Województwa Śląskiego, 2021a), will directly contribute to the achievement of the objectives set out in the NECP in the areas of energy security, emission reduction, increased energy efficiency, and the development of the R&D sector, thus contributing to economic innovation.

As a region with a high production and consumption of electricity (respectively ranked third and second in relation to other voivodeships in Poland), measures taken in Śląskie Voivodeship under transformation are necessary to achieve the targets set at national level. The measures to be implemented in Upper Silesia will include the gradual closure and restructuring of mines, the phasing out of obsolete power units (built in the 1970s and 1980s), and replacing them with modern infrastructure that is friendly to the environment and residents.

It should be noted that the shutdown of coal-fired power plants will be in line with the schedule developed by the government party in agreement with the trade unions and will translate into the level of hard coal output that will allow the energy sector to cover demand. According to information obtained from the Ministry of State Assets, two power plants located in the area under transformation are to conclude their operation by 2030, namely the Łaziska Power Plant by 2028 and the Rybnik Power Plant by 2030.

Renewable energy sources will play a key role in the energy system. TJTP provides support for this type of investment as an important element in the diversification of generation sources for regional energy. The implementation of the indicated measures will contribute to achieving the national target of 21–23% of renewable energy sources (RES) in the final gross energy consumption. The implementation of TJTP will also contribute to the reduction of emissions at the national level, including greenhouse gas emissions. Among the main transformational challenges is improving air quality, including implementing measures that will enable the transition to a zero-emission economy.

Bearing in mind that the Śląskie Voivodeship in recent years has been the largest hard coal consumer in the country (16,460 thousand tons in 2019, i.e. 24.1% of consumption at the national level) – using it in the industrial, municipal, and housing sectors – the measures planned in the document are also aimed at supporting entrepreneurs and natural persons, enabling the replacement of minerals with renewable energy sources. In addition, support for the energy sector in the region is key to achieving climate goals such as reducing the share of coal in electricity production to 50–60% by 2030.

According to the forecasts made in the “Polish Energy Policy until 2040” (Ministerstwo Klimatu i Środowiska, 2021), hard coal mining (excluding coking) by 2030 will gradually decrease from 59.6 million tons in 2015 to 41.6 million tons in 2030 (a decrease of 30.2%). Due to the fact that approximately 80% of hard coal output in Poland occurs in the Śląskie Voivodeship, the above-mentioned decrease in raw material extraction will primarily concern mining municipalities located in this region. Limiting the production of the indicated raw material is associated with a decrease in its demand in all sectors of the economy.

Due to the Śląskie Voivodeship being the largest mining region in the EU, the area undergoing transformation has a completely different and more difficult starting point than other regions. Transformational activities should mainly focus on mitigating the negative socioeconomic effects of the process of closing hard coal mines. Reducing greenhouse gas emissions will be an indirect effect of the transformation activities executed and will be given priority in the longer term, in accordance with the provisions of the Low-Emission Economy Policy for the Śląskie Voivodeship. In the regional energy policy until 2030, including the Energy Balance prepared on the basis of expert analysis, it is assumed that the consumption of hard coal for electricity

and heat production will be reduced by 28%. On this basis, greenhouse gas emissions as a result of transformation activities should decrease at a similar percentage level.

TJTP will also support activities aimed at increasing the level of innovation in the economy, including the development of the R&D sector in the field of regional smart and technological specializations (in accordance with the project of the Regional Innovation Strategy of the Śląskie Voivodeship 2030 and the Technology Development Program of the Śląskie Voivodeship for 2019–2030). Financial support for the indicated sector will directly contribute to the achievement of national goals, i.e. an increase in expenditure on research and development in Poland (from 0.75% of GDP in 2011 to 1.7% of GDP in 2020 and 2.5% of GDP in 2030).

The Śląskie Voivodeship is an industrialized region characterized by a high level of urbanization. Both industry and housing have been undergoing a steady process of transformation for over 20 years. In 2021–2030, the demand for energy efficient solutions in industry, construction, generation of energy from renewable sources, and the integration of electromobility infrastructure in the building infrastructure will continue. This will contribute to the development of new technologies and implementations by IT companies, producers of RES equipment and systems, service providers for professional energy, and companies in the construction sector.

6.2.2 New jobs to be created through the decarbonization process

The Śląskie Voivodeship is the region most dependent on coal in both Poland and the European Union, with the highest number of people employed in the mining industry. According to the data of the Central Statistical Office, 84 thousand people worked in the mining and quarrying sector in the Silesian Voivodeship in 2019, representing 56.1% of the total number of people working in this sector of the economy in Poland and 4.5% of the total working age population in Silesia (Wojewódzki Urząd Pracy w Katowicach, 2021).

Since the beginning of the 1990s, coal production in Poland has decreased by half (from almost 150 million tons to approximately 73 million tons), and employment in the mining sector has decreased by four times (between 1990 and 2015 from approximately 388 thousand tons to approximately 98 thousand). However, the Śląskie Voivodeship remains characterized by the largest number of people employed in the mining industry (approximately 74 thousand people, data for 2019, IBS). This situation is the greatest challenge related to the Just Transition process.

Mining jobs are highly concentrated geographically. The vast majority of these are communes located in the area of the Rybnik Agglomeration and its surroundings, the Upper Silesian Metropolitan Area, and on the border with the Małopolskie Voivodeship. These are large clusters of medium-sized cities in the most urbanized and densely populated region of the country. Mines and other plants related to the coal industry are located in close proximity to city centers and directly beside housing estates. In addition to the mining sector itself, various businesses and branches of the economy related to this industry are also crucial to consider. First of all, these are entities directly related to mining which are suppliers for the sector, including enterprises producing and supplying mining machinery and equipment as well as specialized mining support services.

Another group is the direct recipients of coal products who require the basic raw material to be used in power plants, combined heat and power plants, and coking plants. The last group are suppliers who are indirectly related to the industry with services and products connected to other industries as well, such as transport services or producers of non-specialized machinery, equipment, and materials. These companies and institutions surrounding the mining environment directly feel the effects of restructuring the industry and the difficult situation faced by coal companies.

According to the expert opinion prepared by the University of Economics for the Mining Chamber of Industry and Commerce, the number of employees directly related to the mining industry is 120,000 people. It is assumed that the expected scale of people dependent on the functioning of the mines is much higher if the indirect impact on trade and service enterprises or workers' families is taken into account. Estimates including this aspect, according to the economic self-government, amount to as many as 400 thousand people (Ministerstwo Klimatu i Środowiska, 2021).

Based on the above analysis and the schedule adopted for closing mines, it should be assumed that by 2030, due to the liquidation of employment in the mining sector, it will be necessary to provide almost 20,000 jobs, including almost 15 thousand for people working in mining-related companies. In 2030–2049, the scale of job losses will be much higher, approximately 145 thousand people, including 105 thousand in the mining-related sector. This means that in the next 9 years, it is also necessary to provide the foundation for a modern and dynamically developing economy, which will be able to handle the next, much larger wave of job losses due to the transition to a low-emission economy.

A key issue in the area of mining sub-regions is the overlapping of negative social and spatial effects, resulting from the first wave of the region's economic transformation in the 1990s and continuing with the transformational activities that the region's community will face in the years 2030 and 2049. In this context, building a social consensus for conducting transformational activities and monitoring social phenomena are important in order to avoid mistakes similar to those made at the beginning of the transformation of the region in the 1990s.

Transformational activities must also include the social sphere to avoid exclusion of certain social groups, particularly those most sensitive to the effects of transformation. Additionally, the indicated transformation challenges will be combined with the region's unfavorable demographic trends and the negative consequences of the economic crisis caused by the pandemic. It should be emphasized that, as a result of the COVID-19 pandemic, the situation of Polish enterprises has deteriorated, which will lead to further layoffs of employees in various sectors, including collective redundancies (Ministerstwo Klimatu i Środowiska, 2021).

6.2.3 Reskilling / retraining needs of the local workforce

Education, particularly vocational training, directly affects the preparation of young people to begin work. It is often indicated that available education is not adapted to the changing conditions and needs of the labour market, and achieving climate goals will require a closer link between education and the requirements of the new economy. The cooperation of educational institutions with employers and the continuous process of monitoring the demand for new professions will be important in this respect. A positive trend is apparent in relation to the growing interest in vocational education. However, a potential problem is the aging of the teaching staff. At the same time, an important issue is the quality of the equipment and infrastructure of educational institutions, which also requires additional investment (Urząd Marszałkowski Województwa Śląskiego, 2021b).

The development of innovation and technology requires an efficiently functioning higher education system, e.g. the proposed courses of study – requiring courses designed to respond to demand – as well as improving the quality of the base and infrastructure of universities, ensuring the possibility of education at the highest level. All activities in this area will ensure not only high-quality human capital for the developing economy, but also an increase in the competitiveness of academic centres on a national and European scale.

The Śląskie Voivodeship is a key centre for research and academic study in the country. Its universities account for 8.5% of all universities in Poland and educated 9.5% of students in 2019. Still, however, the ratio of students to the number of inhabitants is significantly lower than the corresponding rate for the country and puts the voivodship in the ninth position.

Additionally, it should be noted that the share of the population aged 15–64 with higher education in relation to the total number of people at that age was below the national average (27.5% versus 28.2% nationally), ranking seventh in the country (Urząd Marszałkowski Województwa Śląskiego, 2021b).

According to the expertise of the Marshal's Office of the Śląskie Voivodeship, by 2030, the consumption of hard coal in the energy sector will decrease by approximately 28% compared to 2017 and, by 2050, by approximately 65%. On this basis, it can be assumed that employment in the hard coal-mining industry will decline at a similar pace. Forecasting changes in the mining industry is difficult, primarily due to the use of coal for additional purposes beyond energy. For example, in the Śląskie Voivodeship there are also deposits of metallurgical (coking) coal, which is strategic not only for Poland, but also for the EU. Therefore, it can be assumed that the employment structure in these mines will not change. From the perspective of regional development policy, sectors with a high level of innovation should be the main drivers of changes. Therefore, the demand for highly qualified employees is likely to grow.

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7 Romania, West Region / Jiu Valley

7.1 Current status of the region's workforce

7.1.1 Regional profile and specialisation

Coal regions (Oltenia, inside NUTS2 region RO41 and Jiu Valley included in RO42 / Vest Region) can and will play an active role in the Romanian energy transition, by moving from a mono- to a multi-industry model.

In Jiu Valley micro-region hard-coal mining dates back to the mid-19th century, and since then communities were formed and developed around this industry. Petroşani was the first community to become a town in 1923, followed by Petrila, Lupeni, Vulcan (1956), Uricani (1968), and Aninoasa (1989). The population grew exponentially from 5 000 inhabitants in 1868 to over 165 000 by the '90s, together with the hard-coal mining industry. After Romania's transition to a market-based economy, the coal mining industry declined, mass lay-offs and overall demographic decline took place, the Jiu Valley facing a shrinking phenomenon, with population contraction by around 25% from its peak in the '90s. Today other local economic activities start being competitive, including tourism and eco-tourism, textiles and leather, wood and furniture, automation and microelectronics, energy and environmental management.

The status of Jiu Valley micro-region, as regard to its current socio-economic profile, was analysed based on the followings:

- the "Strategy for the transition from coal of Jiu Valley" for the period 2021-2030 (MIPE, 2021), developed with the financial and technical support of the EC – DG Reform, through the Structural Reform Support Service within the European Commission (SRSS) under the Ministry of European Investments and Projects (MIPE) coordination;
- the draft Report of START (Secretariat's Technical Assistance to Regions in Transition) assistance services, accessed in 2019 by all 6 Jiu Valley's Mayors through Coal Regions in Transition (CRIT) initiative of the EC - DG Ener;
- Eurostat regional statistical data and the National Institute of Statistics, Romania;
- previous TRACER deliverables.

At the national and regional level (NUTS2 and NUTS3) the GDP decline from the first pandemic year 2020 was recovered in 2021 (Table 7.1). Yet, the CNSP (National Strategy and Forecast Commission) estimates are a little too optimistic, knowing also the decline of the extractive and energy sector in Hunedoara (NUTS3/RO423) - HD which led to the economic collapse of the county.

Table 7.1: Population and economic indices, national – NUTS2 and NUTS3 levels and Jiu Valley

Category	Romania				West Region (RO42)				Hunedoara County (of which Jiu Valley)			
years	2018	2019	2020	2021	2018	2019	2020	2021	2018	2019	2020	2021
Population (thousands)	19,533.5	19,425.9	19,328.8	19,201.7	1,784.3	1,777.7	1,771.5	1,758.6	388.61 135.79	383.79 134.17	380.10 132.29	373.77 130.25
GDP per capita (euro)	10.500	11.500	11.400	11.904	10.800	11.900	11.700	11.908	7.905	9.081	8.880	9.526
Total economically active population (thousands)	9,068.2	9,033.7	8,972.8	NA	754.7	754.4	748.5	NA	172.2	171.6	171.0	NA

Source: INS (POP105A, POP107D, CON103H, FOM102A); EUROSTAT (nama_10r_2gdp, lfst_r_lfp2act); (CNSP, 2021)

Regarding the demographic aspects in Romania (national, regional, local) the constant decline, due to both the aging population and the migration to the west (especially of the young population), was increased during the COVID-19 pandemic. Additionally, the new geo-political context aggravated by the Russian-Ukrainian conflict, will negatively influence national, regional and local economic development.

The analysis of the average number of employees by economic sectors (Table 7.2), carried out only up to NUTS3 level, highlights a recovery at national and regional level in 2021 compared to 2020 estimated by CNSP. Unfortunately, the situation is not similar in HD and Jiu Valley micro-region where the downward trend is maintained, except for the construction, services & trade and public sectors (administrative, health, education, social), where there are timid growth trends.

Table 7.2: Employees by economic activities, national – NUTS2 and NUTS3 levels and Jiu Valley

Category		Romania				West Region (RO42)				Hunedoara County (of which Jiu Valley)			
years		2018	2019	2020 ↓	2021 ↑	2018	2019	2020 ↓	2021 ↑	2018	2019	2020 ↓	2021 ↓
Average number of employees (thousands)	**Total economy**	5,068.1	5,164.5	5,031.8	5,158.0	526.9	527.8	509.6	511.4	105.4 25.0	104.2 24.3	101.4 22.8	99.8 NA
	Agriculture	123.8	126.5	123.6	NA	14.7	15.6	15.0	NA	2.9	3.1	2.8	NA
	Industry ↓	1,409.1	1,398.7	1,316.9	NA	192.9	187.6	174.5	NA	36.6	36.0	33.5	NA
	Construction	375.0	395.7	407.2	NA	33.4	34.9	33.8	NA	8.7	8.6	8.7 ↑	NA
	Wholesale and retail trade, transport, accommodation and food service activities	1,325.9	1,364.4	1,317.2	NA	128.0	129.2	126.2	NA	27.8	27.9	28.1 ↑	NA
	ICT	182.3	193.9	200.0	NA	16.4	17.2	18.6 ↑	NA	0.72	0.73	0.67	NA
	Financial and insurance activities	90.5	88.9	87.2	NA	5.4	5.1	4.7	NA	1.1	1.0	0.9	NA
	Real estate activities ↓	29.1	29.9	28.5	NA	2.5	2.8	2.6	NA	0.3	0.3	0.2	NA
	Professional, Scientific and Technical activities ↓	472.2	484.6	472.7	NA	37.2	38.0	36.3	NA	6.2	5.7	5.6	NA
	Public administration, defence, education, human health and social work activities ↑	935.0	951.4	956.1	NA	86.4	86.9	88.0	NA	19.5	19.8	19.8 ↑	NA
	Arts, entertainment and recreation; other service activities	125.0	130.4	122.3	NA	9.9	10.5	9.9	NA	1.6	1.6	1.6	NA

Source: INS (FOM104F); (CNSP, 2021)

At the level of the local business environment, SMEs role should be emphasized - a real 'force' in the development of Jiu Valley and its transition to a sustainable economy. Thus, according to data from the Hunedoara Chamber of Commerce and Industry (CCI-HD, 2022) (Table 7.3),

in 2020 in Jiu Valley activated a number of 2,541 enterprises (22% out of HD), out of which 99.92% are SMEs and only 2 are large (ApaServ – water & sewerage management operator) and very large enterprises (CEH – Hunedoara Energy Holding).

Table 7.3: Type of enterprises by number of employees in Jiu Valley micro-region and HD, 2020

Enterprise type	Jiu Valley (no.)	HD / RO423 (no.)
Micro-enterprises (0-9 emp.) / SME	2,357	10,630
Small-enterprises (10-49 emp.) / SME	160	734
Middle-enterprises (50-249 emp.) / SME	22	121
Large-enterprises (250-999 emp.)	1	15
Very large-enterprises (over 1000 emp.)	1	3
Total	**2,541**	**11,503**

Source: TRACER data collecting and processing, March 2022; (CCI-HD, 2022)

The total number of employees (Table 7.4) was 13.5 thousand, representing about 60% of the total average number of the micro-region employees, registered by INS – National Statistical Institute (Table 7.2), and 23% out of HD/RO423. All enterprises had a cumulative turnover of around 323,276 mil. EUR, with gross operating profits between 9% up to 18%.

Table 7.4: Business environment in HD and Jiu Valley, 2020

Category	Enterprises (no.)	Annual turnover (mil. EUR)	Gross operating profit (mil. EUR)	Employees (no.)
Aninoasa City	73	13,078	2,279	361
Lupeni Municipality	412	28,528	5,162	1,074
Petrila City	336	32,094	3,579	1,231
Petrosani Municipality	1,102	198,715	19,371	9,170
Uricani City	213	17,466	3,057	697
Vulcan Municipality	405	33,394	2,981	1,034
Total Jiu Valley	**2,541**	**323,276**	**36,428**	**13,567**
Total Hunedoara	*11,503*	2,660,924	261,118	*58,759*
Jiu Valley share	22.09%	12.15%	13.95%	23.09%

Source: TRACER data collecting and processing, March 2022; (CCI-HD, 2022)

The analysis of Jiu Valley business environment by economic activities (Table 7.5) shows a concentration in numbers of companies around the wholesale and retail activities (39%), followed by transportation & ICT, services and manufacturing (10%), with the highest annual turnover in retail, electricity-gas-steam and manufacturing summing up around 66% of the total enterprises' annual turnover. As for employees, the top 5 economic sectors with enterprises attracting most of the jobs in Jiu Valley (84%) are mining-electricity-gas-steam (still), retail and manufacturing followed by construction and services activities.

Table 7.5: Business environment by economic activities in Jiu Valley, 2020

Economic activities	Enterprises		Annual turnover	Employees	
	(no.)	(%)	(mil. EUR)	(no.)	(%)
Agriculture (crop and animal production), hunting and forestry	35	1.4	12,722	340	2.5
Fishing and aquaculture	1	0.0	0	0	0.0
Manufacturing	243	9.6	45,158	1,969	14.5
Mining and Quarrying; Electricity, Gas, Steam, AC supply; Water and Sewerage	13	0.5	47,106	4,578	33.7
Construction	218	8.6	37,539	1,100	8.1
Wholesale and retail trade	996	39.2	123,409	3,135	23.1

Economic activities	Enterprises		Annual turnover	Employees	
	(no.)	(%)	(mil. EUR)	(no.)	(%)
Accommodation and food service activities	203	8.0	9,946	599	4.4
Transportation, storage and ICT	256	10.1	17,455	512	3.8
Financial and insurance activities	73	2.9	1,905	90	0.7
Real estate activities	49	1.9	1,615	78	0.6
Services activities (professional, scientific, technical, administrative etc.)	252	9.9	16,892	644	4.7
Education	23	0.9	1,217	82	0.6
Human health and social work activities	53	2.1	3,039	127	0.9
Other public services activities	126	5.0	5,274	313	2.3
Total	**2,541**		**323,276**	**13,567**	

Source: *TRACER data collecting and processing, March 2022;* (CCI-HD, 2022)

7.1.2 Employment and unemployment status of the local workforce

The low unemployment rates at NUTS3 level, which do not show the “on site” reality, also do not reflect absorption through jobs created because of the county's economy diversification, but a massive internal and external human resources migration.

Table 7.6: Employment and unemployment, national – NUTS2 and NUTS3 levels and Jiu Valley

Category	Romania				West Region (RO42)				Hunedoara County (of which Jiu Valley)			
years	2018	2019	2020	2021	2018	2019	2020	2021	2018	2019	2020	2021
Total employment (thou pers.)	8,407.5	8,492.6	8,440.8	NA	829.9	826.6	819.4	NA	166.4	166.4	165.3 ↓	NA
of which female (%)	46	46	45	NA	44	44.5	45	NA	47	47	46	NA
Total registered unemployment (thou pers.)	288.9	257.9	296.0	234.7	15.0	13.9	18.4	14.2	5.8 1.7	5.2 1.4	5.7 ↑ 1.4	6.2 ↑ 1.8 ↑
of which female (%)	45	46	48	46	50.5	51	54	49.8	53 51	52 52	55 56	48 48
Unemployment rate (%)	3.3	2.9	3.4	2.7	1.8	1.7	2.2	2.2	3.4	3.0	3.4 ↑	3.6 ↑

Source: INS (FOM103D); (ANOFM, 2021)*;* (AJOFM-HD, 2021)

The decrease in the number of employees and increase of unemployment (Table 7.6) are generated by several factors with negative impact at NUTS2 and national level, such as the economic crisis due to the COVID-19 pandemic, population aging and migration. This situation is more prominent at NUTS3 and local level, considering coal energy industry decline (CEH Subsidiaries - Deva/Mintia TPP complete closure and Lonea - Lupeni mines in full ongoing closure process), which lead to the constancy of layoffs and layoffs in the Jiu Valley.

Thus, after a slight recovery in 2019 (Table 7.7), the 2021 values for Jiu Valley unemployment exceeded the 2020 figures by 23%, the most affected cities being Aninoasa (64%), Lupeni (47%) and Vulcan (36 %).

Table 7.7: Registered unemployment by localities and gender categories in Jiu Valley

Total registered unemployment, of which female	Gender	Total (pers.)			
years		2018	2019 ↓	2020 ↑	2021 ↑
Jiu Valley total	**Total (M+F)**	**1,680**	**1,373**	**1,439**	**1,773**
	F	**863**	**730**	**782**	**856**
Vulcan Municipality	Total (M+F)	433	354	362	492
	F	206	189	180	220
Lupeni Municipality	Total (M+F)	270	257	238	351
	F	159	141	142	175
Petrosani Municipality	Total (M+F)	497	376	427	431
	F	283	212	244	221
Aninoasa City	Total (M+F)	76	54	45	74
	F	35	27	23	40
Petrila City	Total (M+F)	310	275	252	332
	F	146	130	146	147
Uricani City	Total (M+F)	94	57	115	93
	F	34	31	47	53

Source: (AJOFM-HD, 2021)

The employment status in the coal industry, since TRACER project started (2019), shows Hunedoara Energy Holding (CEH) with a reduction of 15% (Table 7.8), slightly more pronounced for male category. SNIMVJ – the public entity managing 4 underground mines closure, which is under cessation process, has a rest of 30 employees, being the staff in charge of the entire liquidation procedure 2021-2022 (figure not included in the following three tables).

Table 7.8: Employees by gender category, in the coal industry in Jiu Valley

Employees - annual average (no.)	Female			Male			Total		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
CHPP Paroseni	94	84	74	221	219	193	315	303	267
Mining Division	601	602	530	2,265	2,299	1,929	2,866	2,901	2,459
CEH administration	112	112	95	62	62	50	174	174	145
TOTAL	**807**	**798**	**699**	**2,548**	**2,580**	**2,172**	**3,355**	**3,378**	**2,871**

Source: *Hunedoara Energy Holding (CEH)*

In terms of age categories (**Table 7.9**), employment was made for 15-24y category (17% ↑), retirements and lay-offs being felt strongly in the 55-65y group (29% ↓).

Table 7-.9: Employees by age, in the coal industry in Jiu Valley

Employees - annual average (no.)	15-24y			25-54y			55-65y			over 65y			Total		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
CHPP Paroseni	3	4	3	236	228	201	72	67	61	4	4	2	315	303	267
Mining Division	55	56	67	2544	2514	2167	267	331	225	0	0	0	2866	2901	2459
CEH administration	0	0	0	128	128	117	46	46	28	0	0	0	174	174	145
TOTAL	**58**	**60**	**70**	**2,908**	**2,870**	**2,485**	**385**	**444**	**314**	**4**	**4**	**2**	**3,355**	**3,378**	**2,871**

Source: *Hunedoara Energy Holding (CEH)*

The analysis on education levels (Table 7.10) highlights an issue difficult to recover. Thus, in the perspective of a final decision related to Paroșeni CHPP technical solution for transition from coal to green biomass, the retirement/reduction of the staff with higher education in key positions (top and middle management), such as technical chief engineer in boilers, turbines, operation and maintenance (O&M) of RE facilities, may affect the proper operation of the entire installation. It is also necessary to carefully analyse the expertise and specialisations of the personnel with secondary education, in the area of mining operations, and correlate it both with the labour market demand and with the professional conversion courses programs for re- and upskilling.

Table 7.10: Employees by level of education, in the coal industry in Jiu Valley

Employees - annual average (no.)	**Higher education**			**Secondary education**			**Others** (qualification course; foremen's school; technicians; vocational school)			**Total**		
	2019	**2020**	**2021**	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**
CHPP Paroseni	NA	75	68	NA	100	86	NA	128	113	NA	303	267
Mining Division	NA	323	268	NA	2,512	2,119	NA	66	72	NA	2,901	2,459
CEH administration	NA	134	100	NA	40	38	NA	0	7	NA	174	145
TOTAL	**NA**	**532**	**436**	**NA**	**2,652**	**2,243**	**NA**	**194**	**192**	**NA**	**3,378**	**2,871**

Source: Hunedoara Energy Holding (CEH)

7.2 Vision for the Region

7.2.1 The path towards decarbonization

Several steps towards a sustainable energy transition have already been made in Jiu Valley micro-region:

- Promoting cooperation and collective actions via local authorities MoU (signed in Brussels, 2019);
- Deploying an EDP (Entrepreneurial Discovery Process) and defining a common just transition vision of the micro-region having as result two complementary Strategies (2021):
  - "Strategy for the transition from coal of Jiu Valley" for the period 2021-2030 (MIPE, 2021);
  - "R&I Strategy in the field of energy for Jiu Valley / West (RO42) target region, Romania" (TRACER, 2022);
- Identifying of a portfolio of projects:
  - Action Plan for implementing the "Strategy for the transition from coal of Jiu Valley" for the period 2021-2030 (MIPE, 2021);
  - START Report "From Strategy to Action - Delivering a Just Transition in the Jiu Valley, today and tomorrow" (EC-START, 2022) - Secretariat's Technical Assistance to Regions in Transition of the EC (DG Ener - CRIT);
  - TRACER D6.4 Report "R&I Roadmap in the field of energy for Jiu Valley / West (RO42) target region, Romania", under preparation.

- Formalising the local governance structure, as the "Association for Integrated Territorial Development" (Asociatia ITI Valea Jiului).

At the end of 2021, once the National Recovery and Resilience Plan – PNRR (MIPE, 2021) was approved, Romania officially announced coal phase-out by year 2032, but in the current geo-strategic context on Romania's borders, with the Russian war on Ukraine shaking energy security across Europe, this target is being questioned (TRACER, 2022).

In Romania coal (hard-coal and lignite) is exploited mainly in Hunedoara/HD (underground hard-coal mines) and Gorj/GJ (lignite open pits) counties (NUTS3 regions), summing about 90% of the entire coal mining and energy industry labour force in the country, representing 11,140 jobs (2020) (TRACER, 2021). Today, Hunedoara County (NUTS3/RO423) counts around 3,000 jobs, including only Jiu Valley employees since July 2021 when Deva/Mintia TPP Subsidiary was shut down, after 54 years of operation. Both coal-intensive regions are considering decarbonisation plans. Then, CE Oltenia within GJ/NUTS3 (RO412) replace lignite-based electricity production with electricity produced from natural gas and renewables (solar and hydropower), thus improving its environmental footprint and reducing the operating costs. To this aim, the EC approved for Oltenia Energy Holding a restructuring aid of up to around €2.7 billion. The CEH – Hunedoara Energy Complex, in HD (RO423), is under a restructuring program during its insolvency, which splits the holding in 2 (two): the former Mintia Subsidiary (Deva TPP hard-coal based 1x235 MW_e, to be replaced with 1x800 MW_e on natural gas) and Jiu Valley Subsidiaries (Paroseni CHPP, hard-coal based 1x150 MW_e, together with 4 underground mines – 2 under closure procedure and 2 active).

Regarding the Jiu Valley micro-region within HD (RO423), the recommended forecast scenario following the analysis performed in the deliverable D6.1 (TRACER, 2021) is the SCENARIO "with RES and alternative energy sources":

2022-2025-2030

- Mines' closure and reclamation procedure to be updated and R&I oriented;
- A new green biomass based CHPP unit (25 MWe and 50 MWth) in Paroșeni;
- Thermal energy storage in former underground mines, associated with mine water heat pumps systems;
- WPP on unproductive lands (2 x 3 MWe);
- Ground PVP on unproductive lands (1 x 25 MWe), including e-storage facility;
- New MHPP Baleia (2 MW);
- Building's renovation campaign through EE in existing public buildings and residential individual households or collective dwellings;
- Thermal RES in public buildings and residential individual households;
- Roof-PV for public buildings, individuals and SMEs (around 1.5 MWe) – future prosumers, including e-storage;
- Small insulated retrofitted DHS with former DHS Thermal Stations (TS) transformation (around 1.5 MWth) into: TP or micro-CHP on RES and/or natural gas;
- UCG (syngas recovery) and/or micro-CHP running on mine methane captured (MMC).

2030-2040

- Additional PVP on unproductive lands (1 x 25 MW_e) and electricity storage;
- Building's renovation campaign through EE in existing public buildings and residential individual households or collective dwellings;
- Thermal RES in public buildings and residential individual households
- Small insulated retrofitted DHS with former Thermal Stations (TS) transformation (1.5 MW_{th}) into: (a) TP with heat pumps systems (heat recovery of the groundwater or/and mine water thermal potential), and/or (b) green biomass-based TPs (wood wastes resulting from wood industrial processing and agricultural wastes);
- It is recommended that until 2035-2040, population supply with firewood for heating purposes to be switched to green biomass - pellets and wheat/straw briquettes, through the

development of an integrated collecting and processing mechanism of wood wastes, resulting from wood industrial processing, and agricultural wastes, for the entire Jiu Valley.

2040-2050

- Other alternative energy sources, as the development of a green hydrogen plant, the natural gas still used for heating purposes being gradually replaced by hydrogen, once the National Strategy on Hydrogen will be approved and start to be implemented.

Considering this recommended path towards decarbonisation, the 2030-2050 forecasts for the energy mix and electricity production in Jiu Valley micro-region is presented in Table 7.11. It has to be mentioned that in the absence of a renewable potential assessment study for Jiu Valley micro-region, RES capacities proposed to be installed are purely indicative.

Table 7.11: Projections of the installed capacities in Jiu Valley (MW)

Categories		MU	2020	2025	2030	2040	2050
ETS sources – Paroseni CHPP							
Installed capacity	electric	MW_e	150	150	25	25	25
	thermal	MW_t	174	174	50	50	50
Combustion fuel used hard coal/natural gas/green biomass		%	95/5/0	50/5/45	0/0/100	0/0/100	0/0/100
RES							
Total RES installed capacity, of which	electric	MW_e	5.69	**6.30**	**64.60**	**89.60**	**89.60**
	thermal	MW_t	0.44	**1.94**	**53.44**	**53.44**	**53.44**
MHPP		MW_e	4.91	4.91	6.91	6.91	6.91
PVP (ground PV Plants) and roof PV		MW_e	0.67	1.01	26.31	51.31	51.31
WPP		MW_e	0.00	0.00	6.00	6.00	6.00
Biogas	electric	MW_e	0.38	0.38	0.38	0.38	0.38
	thermal	MW_t	0.44	0.44	0.44	0.44	0.44
Solar thermal / Biomass / HPs	electric	MW_e	NA	0.00	0.00	0.00	0.00
	thermal	MW_t	NA	1.50	3	3	3

Source: (TRACER, 2021)

In addition to the above, on the same background of the Russian war on Ukraine, the energy committee of the Romanian Senate (Romanian Parliament chamber) approved a legislative proposal that could allow the completion of the works on the controversial project of Jiu River Hydropower Development (Bumbești - Livezeni - Dumitra), which has been in conservation since 2017. This investment, considered strategic from the point of view of national energy security, would cause the ecosystems in the Jiu Natural Park, an area included in Natura 2000 Sites and the list of protected areas in Romania, a lasting adaptation, but at the same time would generate approx. 100 MW of hydroelectric power and new jobs opportunities for Jiu Valley communities.

The main interconnected sectors lacking of measures for sustainable resources use, RES integration and increasing energy efficiency are the transport and buildings sectors, which according to HD TJTP (Grupul de lucru PTTJ Hunedoara, 2021) are the major contributors to the GHG emissions in HD (RO423), after the industrial processes (manufacturing and processing industries). In HD (RO423) buildings' heat supply was one of the public utilities strongly impacted by the decline of the coal industry. The last urban centres with operational DHSs were Deva (DHS connection degree 68.52%, thermal energy supply services stopped

in winter 2020/2021); Brad (connection degree still 36.7%); and Petrosani, in Jiu Valley (connection degree 9.24%, last winter with thermal energy supply services 2018-2019).

The gradual transition to individual natural gas heating systems and the maintenance of a large number of firewood- stoves or individual thermal installations has a significant impact on air quality. To this aim, revitalising the existing centralised DHSs or transforming them into decentralised small-micro DHSs with RES integration is a “must”. In Jiu Valley micro-region, there are 1,068 collective dwellings and there is a huge need for renovation works for increasing both the buildings energy efficiency and RES share. By 2023, only 5.4% of all households in collective housing in HD (RO423) were or will be renovated or thermally insulated, and for 2021-2027, HD local councils are considering 1,015 (44%) collective dwellings proposed for thermal renovation.

7.2.2 New jobs to be created through the decarbonization process

The deployment of renewable energy technologies in post-mining communities can provide economic value and sustainable jobs, benefiting from the industrial heritage already in place. According to the Joint Research Centre (Kapetaki, Z., R., 2020), depending on the regions’ size and degree of dependence on the coal sector and potential resilience, considering the expected level of clean energy technologies and energy efficiency growth, Vest Region (RO42) was included, in terms of employment, in the category Regions that show Slow Decarbonizing Employment Potential (SDEP), meaning that they have significant decarbonisation potential, but by 2030 jobs created would be below 90% of the coal related ones. This potential could only be fully realised by 2050.

The assessment of the future employment in RE (renewable energy) is performed in various studies. For the estimation of the green and sustainable jobs that could be created during the transition to a sustainable energy system, the selected methodology was developed by the Millennium Institute on behalf of the International Trade Union Confederation (Millennium Institute, 2012). This methodology was chosen also for Jiu Valley micro-region. According to (Malamatenios, 2016), the RE industry includes 4 major sectors that can generate jobs:

- manufacture and distribution of RE equipment, including the necessary R&D;
- project development;
- construction and installation works for the development of RE projects;
- operation and maintenance (O&M) of RE facilities

Considering the estimated energy mix for Jiu Valley micro-region (Table 7.11), the assessment of labour years (direct jobs) created per new MW installed, based on the above methodology, is presented in the table below.

Table 7.12: Estimated jobs in the RE industry in Jiu Valley, 2040-2050

Estimated labour years in 2040/2050	MU	Total of which	Biomass	PV	Wind	microHydro	largeHydro*
Total RES additional installed capacity, of which	MW_e	89.62	25.00	50.00	6.00	2.00	100.00
	MW_t	51.50	51.50	-	-	-	
Total labours years per MWi, of which	labour years/MWi	-	43.20	33.50	19.30	16.10	
equipment production		-	0.40	6.40	11.60	0.50	
development and installation		-	3.70	20.50	2.70	11.10	
operation & maintenance		-	39.10	6.60	5.00	4.50	

Estimated labour years in 2040/2050	MU	Total of which	Biomass	PV	Wind	microHydro	largeHydro*
Total labour years (for direct jobs)	**no.**	**6,737.80**	**3,304.80**	**1,675.00**	**115.80**	**1,642.20**	

* *new potential development on the background of Russia war on Ukraine*

In a realistic scenario in Jiu Valley (Table 7.12), given the current geo-political and economic context in Eurasia, the micro-region could count on approx. 5,100 jobs generated locally (without labour dislocation) by the renewable energy industry. To these, another 1,610 jobs could be added, if the hydro-technical works on the Jiu River, related to an additional 100 MW_e, will be resumed and completed.

In the same time, future buildings' energy efficiency projects should not be neglected. According to the "Strategy and Action Plan for the transition from coal of Jiu Valley" (MIPE, 2021) it was estimated that until 2027-2028, 6 mil. EUR plus 10 mil. EUR will be invested for increasing energy performance for both public and residential buildings. According to JRC Report on Clean energy technologies in coal regions: Opportunities for jobs and growth (Kapetaki, Z., R., 2020), 5,400 FTE (Full Time Employments) were estimated up to 2050 for NUTS2 – Vest Region (RO42). Thus, for Jiu Valley it will be possible to add other approx. 150-200 jobs up to 2040/2050, taking into account also the transformation of the existing centralised DHS into decentralised district/zonal heating micro-grids, based on thermal RES.

So, finally through the decarbonisation process in Jiu Valley micro-region, until 2040/2050 could be created a number of about 5,300 jobs. At the level of the entire economy in Jiu Valley, other job-generating projects should be quantified, as in the tourism industry, social and health services, road and railway infrastructure, or other investments in existing SMEs (i.e. electricity, electronics, textiles, wood processing industries, automation and robotics) and new SMEs related to the circular economy.

7.2.3 Reskilling / retraining needs of the local workforce

According to the data provided by CCI-HD, both Hunedoara County and Jiu Valley have deficiencies in providing skilled and medium-skilled labour force. In HD (RO423) there are 22 high-school education units with a technical profile, necessary resources and services, offering the following specialisations: technical (mechanical, electrical) or services (tourism, catering). Out of these, in the Jiu Valley there are 6 technological high-schools, of which 3 with a technical profile (electrical, electronics, automation and mechanics) and 3 with a services sector profile: trade, economics, tourism and food. Only 1,825 people graduated in 2020 from vocational and post-secondary and foremen education, who are human resources able to adapt to the new labour market requirements, which is a very low percentage compared to the potential needs to be generated by future economic diversification.

According to Hunedoara County Agency for Payments and Social Inspection, there are 51 authorized providers, offering 167 up- or re-skilling trainings (2020), but unable to meet the future requirements of the labour market during socio-economic transition. Over 51% of the training programs are offered by private companies, followed by specialised public authorities (about 25%), the remaining 24% being covered by professional associations and NGOs. In the last 4 years 16,515 CVET programs beneficiaries were registered, with a maximum number of 5,351 students in 2018 and a minimum number of 2,324 students in 2020, trainings not being online adapted during COVID-19 pandemic.

Knowing that HD (RO423) has a high unemployment rate, a significant migration and a low living standard, the development of CVET programs customised on the labour market needs will ensure a revival of the economic activities with long-term positive effects, such as increasing the number of employees, enhancing attractiveness, diversification and economic resilience. All this effort needs to be complemented by measures related to job search

counselling and assistance, and support for employers to integrate also vulnerable or elderly people.

Given the local potential in the Jiu Valley regarding the IVET and CVET offer, investments and a proactive attitude are needed from the representatives of this sector, to take advantage of all European funding opportunities dedicated to up- and re-skilling programs in the coal regions in transition. This sector needs to be more vocal and to be promoted by the mass media in the area.

In Jiu Valley micro-region coal related jobs will not, necessarily, be directly substituted by clean energy technologies jobs, these new created jobs not being as significant as estimated in the previous section (7.2.2). However, besides the future RE (renewable energy) sector, the process of economic and social transition from coal will boost also other industries as construction renovation and development, tourism industry, social and health services, road and railway infrastructure, or other high-tech industries in electronics, automation and robotics.

Table 7.13: Employees by type of occupation, in the coal industry in Jiu Valley

Employees - annual average (no.)	**Leaders in industrial units**		**Specialists in various fields of activity** (i.e. technical, economic, legal, HR, etc.)		**Technicians and other technical specialists** (i.e. foremen, team leader, etc.)		**Administrative**		**Skilled and assimilated workers** (i.e. miner, locksmith, mechanic, electrician, electro mechanic, etc.)		**Operators of installations and machines, assemblers of machines and equipment** (i.e. wagon driver, signalman, etc.)		**Unskilled workers**		**Total**	
Years	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
CHPP Paroseni	19	19	55	47	106	96	5	5	118	100	0	0	0	0	303	267
Mining Division	19	19	304	249	66	72	4	4	2,226	1,871	136	127	146	117	2,901	2,459
CEH administration	11	9	123	91	0	7	2	1	38	37	0	0	0	0	174	145
TOTAL	**49**	**47**	**482**	**387**	**172**	**175**	**11**	**10**	**2,382**	**2,008**	**136**	**127**	**146**	**117**	**3,378**	**2,871**

Source: Hunedoara Energy Holding (CEH)

Considering the level of unemployment, the current status and structure (Table 7.13) of the coal industry employment (direct and indirect jobs, including also recent layoffs related to Deva/Mintia TPP closure in July 2021), the analysis summarised in Figure 7.1 shows a good absorption of the necessary jobs by the new and/or existing industries in full development. It is to be mentioned that no indirect jobs were assessed related to the RE industry value chain, value that would further favour the prospect of future jobs possible to be created in the Jiu Valley micro-region, by 2050.

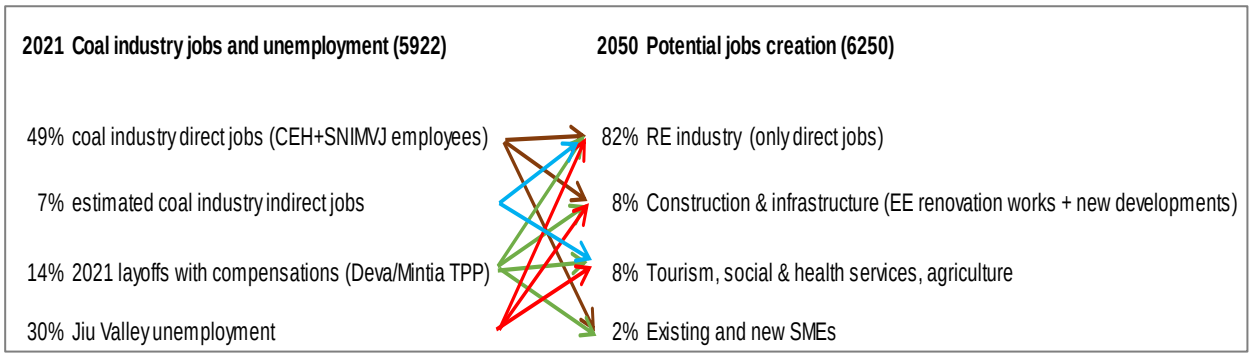

Figure 7.1: Absorption of coal industry jobs by clean energy and other industries

In the coal industry in Jiu Valley the most numerous employees' category are the skilled and assimilated workers 70% (i.e. miner, locksmith, mechanic, electrician, electro-mechanic, etc.) followed by specialists in various fields of activity (i.e. technical, economic, legal, HR, etc.) 13% and technicians 6%. Technicians have the key role in the RE industry, followed by other needed occupational profiles presented in the table below (Malamatenios, 2016).

Table 7.14: RE industry job descriptions and occupational profiles

Technicians	ensure that RE products are manufactured to high standards, plants are assembled according to the drawings, and RE devices are installed properly in buildings, or they may work in the day- to-day O&M of RE facilities
	electricians, HVAC technicians, plumbers, drilling technicians, construction specialists, manufacturing processes operators, wind farm O&M technicians, PV modules installers, logistics operators, automation & control technicians, chemical laboratory assistants, etc.
Technical Designers and Consultants	spot technical opportunities, come up with new ideas, solve problems, do the planning and ensure that new RE developments are sustainable in terms of society needs, economics and environmental protection; also specialise in R&D
	engineers from mechanical, electrical, civil, power systems and software back-grounds, process or manufacturing engineers, landscape architects, geotechnical engineers, measurement & control engineers, environmentalists, material scientists, biochemists, hydrologists, geologists, physicists
Energy advisors	provide knowledge for individuals and companies involved in RE; advise on national and/or regional policies related to RE planning and operation, as well as on energy management and efficiency; ensure training and accreditation;
	planning consultants, land development advisors, environmental legal consultants, policy developers/local development officers, teachers/trainers, energy officers, energy advisors, health & safety consultants
Business Development Executives	spot new business opportunities, create proposals, negotiate with potential customers and ensure customer's needs are met all along the renewable energy supply chain; creating marketing and media campaigns to help increase the uptake of RES
	business developers/analysts, marketing executives, financial, human resources and administration managers, technical sales representatives, public relations officers
Non-technical	legal advisors, sales specialists, inspectors, and economists

Source: (Malamatenios, 2016)

In order to avoid skills shortage, it is recommended for the existing providers of up- and re-skilling trainings and CVET programs, in NUTS3 (RO423) region and Jiu Valley micro-region, to focus in advance, once the TJTPs – Territorial Just Transition Plans are approved, on the above occupations specific to the clean energy industry, including also buildings' energy efficiency renovation works. To this aim, RES-SKILL – an Erasmus+ project (RES-SKILL,

2021) recommends the development of "transition" profiles by matching the occupation profiles and skills of workers in the coal industry and RES sector according to Table 7.15.

Table 7.15: Transition occupational profiles from coal to RES industry

Current occupation profile	New recommended occupation profile	Estimated retraining needs
Mining machine operators	Machinist of road construction machinery (PV) Machine operators (wind)	6 months
Fitters in the coal industry	PV fitter/installers HVAC system installers	1 month
Maintenance and repair workers	PV operation and maintenance technicians	1 month
Construction equipment operators	Machinist of road construction machinery (PV) Machine operators (wind)	1 month 6 months
Heavy vehicle & mobile equipment service technicians & mechanics	PV operation and maintenance technicians Maintenance and repair electricians	1 month 1 month
Mining electricians	PV electricians Electricians (wind) Maintenance and repair electricians (wind)	1 month 3 months 3 months

Source: (RES-SKILL, 2021)

Whether it is about accredited trainers for up- and re-skilling courses (i.e. CCI-HD, AJOFM-HD, University of Petrosani, INSEMEX, Euro Jobs, Interlog Com, etc.) or vocational education units (i.e. Lupeni Technological High School, "Retezat" Uricani Technological High School, "Mihai Viteazu" Vulcan Technological High School, "Hermes" Petroșani Economic College, "Dimitrie Leonida" Petroșani Technological High School and "Constantin Brâncuși" Petrila Technical College) and apprenticeships in technical disciplines, they must diversify their offer. They must be prepared for clean energy technologies, energy audits, renovation in buildings to increase energy efficiency, nZEB standard construction, and constantly synchronise the labour market needs with the existing occupational profile in the coal industry.

The University of Petrosani courses had to be flexible and market needs oriented. Several 'best practices' examples exist with regard to the anticipation of educational needs (Malamatenios, 2016): upper secondary vocational education as a RE technician specialized in solar systems offered by INETE in Portugal; and Newcastle University (UK) with its flexible degree program focused on RES. Also, for postgraduate studies level, the European Master in RE developed by the Association of European RE Research Centres (EUREC), together with leading European universities, allows students to study in one of 4 different EU countries and then practice in another area of EU, as the qualifications requirements are standardised.

The University of Petroșani could become the link between the young workforce and the business environment, both in the Jiu Valley and in HD (RO423) by adapting its educational curricula to the new requirements and technologies on the labour market.

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8 Serbia, Kolubara region

8.1 Current status of the region's workforce

8.1.1 Regional profile and specialisation

The Kolubara coal basin with its related sectors (mining supply chain – coal fired power plants) belongs to Šumadija and Western Serbia region [RS21] (municipalities: Lajkovac, Ub and Aranđelovac) and Belgrade region [RS11] (municipalities: Obrenovac and Lazarevac). According to their availability, data for some indicators are given for the Republic of Serbia (RS) as a whole, while for some other categories data are given by regions and municipalities.

The 2020 mid-year population of the Republic of Serbia was estimated to be 6,899,126. Table 8.1 shows the total resident population in the Republic of Serbia by age and region, together with the available data for the concerned municipalities.

Table 8.1: Resident population in the Republic of Serbia, total and by age, 2020

Category	Resident population (no.)	Age distribution (no.)		
		<15years	15-64years (working age)	>65years
Republic of Serbia	*6,899,126*	*984,675*	*4,458,276*	*1,456,175*
Lajkovac	14,553	2,037	9,439	3,077
Ub	26,976	3,662	17,574	5,740
Aranđelovac	42,766	5,554	27,807	9,405
Obrenovac	71,953	11,107	46,069	14,777
Lazarevac	56,125	8,931	36,863	10,331

Source: Municipalities and regions, 2021, Statistical Office of the RS

The rate of the working age population in the total number is around 65% in all municipalities. The percentage of population older than 65 is higher (around 20%) than the percentage of population younger than 15, which is in line with the negative trend of population movement in the Republic of Serbia.

Table 8.2 shows the total population of the Republic of Serbia older than 15 years by education level. The highest participation rate is for the population with secondary education (52%) and the lowest participation is for the population with higher education (higher schools, faculties and art academics), which is 20%.

Table 8.2: Population by education, 2020

Category	Total (in thousand)
No formal education	61.9
Low education	1,562.0
Secondary education	3,095.5
Higher education	1,174.7
Early school leavers (18-24)	27.7
Persons aged 15-24 who are not employed and not attending educational or training courses (NEETs)	112.4

Source: Bulletin - Labour Force Survey in the RS, 2020, Statistical Office of the RS

When presenting the basic economic indicators achieved in 2020 and 2021, it should bear in mind that they were largely created under the influence of the global pandemic (COVID-19). In 2020, gross domestic product (GDP) at current prices amounted to EUR 46.79 million. When compared to the previous year, GDP increased by 1.5% in nominal terms, and fallen by 0.9% in real terms. The region's share in gross domestic product is 42.1% for Belgrade region, and 18.1% for the Šumadija and Western Serbia region, respectively.

The total economic activity of the Republic of Serbia in 2021, measured by the real terms in the GDP, was estimated to present an increase of 7.5% in relation to 2020. The industrial production in the Republic of Serbia, in December 2021, was higher by 3.3% compared to the same month in 2020. Industrial production in the period January - December 2021, compared to the same period last year was higher by 6.3% (Table 8.3).

Table 8.3: Industrial production indices

Observation period Category	December 2021 December 2020	Months I-XII 2021 Months I-XII 2020
Total	**103,3**	**106,3**
Energy	93,4	101,6
Intermediate goods except energy	112,3	113,1

Capital goods	90,9	111,0
Durable consumer goods	96,0	97,0
Non durable consumer goods	110,7	103,4
Mining and quarrying	140,6	127,6
Mining of coal and lignite	78,3	92,0
Manufacturing	102,3	105,5
Electricity, gas, steam and air conditioning supply	92,5	100,7

Source: Industrial production indices, December 2021, Statistical Office of the RS

If observed by sectors, in the period January-December 2021, compared to the same period in 2020, industrial production in mining and quarrying sector was increased by 27.6%, while industrial production in manufacturing sector was increased by 5.5%, and the production in the electricity, gas, steam and air conditioning supply sector was also increased by 0.7%. In the same period, the industrial production in mining of coal and lignite was decreased by 8%.

The realized investments in total fixed assets in the Republic of Serbia in 2020 decreased by 0.6% when compared to 2019, while the realized investments in new fixed assets in 2020 indicate a fall of 0.7%. If observed by regions, 48.6% of the total investments was realized in Belgrade region and 10.5% in Šumadija and Western Serbia region.

Observed by activities, at the level of the Republic of Serbia, the largest share in total realized investments in fixed assets was noted as follows: manufacturing (20.4%); public administration and defence, compulsory social security (18.8%); transportation and storage (11.8%); electricity, gas, steam and air conditioning supply (9.9%); mining and quarrying (6.9%) and wholesale and retail trade, repair of motor vehicles and motorcycles (6.8%).

Prices of goods and services used for personal consumption in January 2022 increased on average by 0.8% in relation to December 2021. Consumer prices in January 2022 increased by 8.2%, in relation to January 2021.

Table 8.4: Consumer price indices

Observation period Category	January 2022 December 2021	January 2022 January 2021
Total	**100,8**	**108,2**
Food and nonalcoholic beverages	101,4	113,5
Alcoholic beverages, tobacco and narcotics	100,1	106,6
Clotnihg and footwear	99,5	103,2
Housing, water, electricity, gas and other fuels	100,4	105,5
Furnishings, household equipment and routine household maintenance	101,1	105,5
Health	100,4	103,2
Transport	101,0	113,1
Communications	100,1	101,2
Recreation and culture	101,6	104,3
Education	99,9	100,9
Restaurants and hotels	100,4	106,2
Miscellaneous goods and services	100,4	103,5

Source: Consumer price indices, January 2022, Statistical Office of the RS

Observed by main groups according to the destination of consumption in January 2022, in relation to the previous month, increase of prices was noted in the groups Recreation and culture (1.6%), Food and non-alcoholic beverages (1.4%), Furnishings, household equipment and routine household maintenance (1.1%), Transport (1.0%), as well as in the groups of

Housing, water, electricity, gas and other fuels, Health, and Restaurants and hotels (by 0.4% each), Alcoholic beverages and tobacco, and Communications (by 0.1% each). Decrease of prices was noted in the groups Clothing and footwear (-0.5%) and Education (-0.1%).

However, when comparing the consumer prices of January 2022 with those of Janaury 2021, the situation is a little different. The highest increase of prices was registered in Food and non-alcoholic beverages (13.5%) group, followed by Transport (11.1%), Alcoholic beverages and tobacco (6.6%), Restaurants and hotels (6.2%), Housing, water, electricity, gas and other fuels (5.5%), Furnishings, household equipment and routine household maintenance (5.5%). The smallest increase of prices was recorded in the Education group (0.9%).

8.1.2 Employment and unemployment status of the local workforce

The total number of employed persons in the Republic of Serbia in 2020 amounted to 2,215,475 which is an increase of 1.9% compared to 2019. In comparison with the year 2019, the number of employed persons increased in all regions. In 2020 the employment rate was equal to 49.1% at the level of the Republic of Serbia. The highest employment rate was recorded in the Belgrade region (51.3%), while for Šumadija and Western Serbia region it was 50.4%. In both cases, the employment rate is above the national average. Table 8.5 shows the average number of employees by economic activities and regions/ municipalities.

Table 8.5: Average number of employees in 2020 by economic activities and regions / municipalities

Region / Category	Republic of Serbia	Belgrade region	Lazaervac	Obrenovac	Šumadija and Western Serbia region	Lajkovac	Ub	Aranđelovac
Total economy	2,215,475	759,044	22,599	21,853	514,148	3,372	6,587	11,763
Agriculture, forestry & fishing	30,345* 66,376**	3,166* 2,320**	10* 73**	17* 480**	5,452* 31,039**	30* 120**	138* 1,481**	40* 133**
Mining and quarrying	28,969	9,948	**8,678**	9	5,789	**1,323**	107	105
Electricity, gas, steam and air conditioning supply	24,643	8,850	689	**1,846**	5,886	18	19	79
Construction	115,291	44,212	751	756	28,119	122	353	447
Manufacturing	476,040	70,401	2,918	4,606	147,099	433	1,126	4,226
Wholesale and retail trade; repair of motor vehicles and motor cycles	348,027	127,834	2,001	2,484	76,941	336	1,180	2,192
Transport and storage	122,868	46,004	578	1,154	27,426	65	408	582
Accommodation and food services	85,840	31,071	739	420	21,129	64	175	435
Professional, Scientific and Technical activities	108,902	58,254	368	463	15,690	53	171	2,354
Administrative and support service activities	101,644	68,278	1,950	5,782	8,699	14	21	1,233
Public administration and defence; compulsory social security	157,733	79,848	530	558	26,964	171	249	2,665

Human health and social work activities	155,240	48,805	617	982	36,075	125	184	5,113
Education	151,217	44,796	1,205	972	37,109	278	481	4,545

* Employees at legal entities (companies, enterprises, cooperatives, institutions and other organizations) and entrepreneurs, persons individually running business and their employees

** Registred individual agricultural workers

Source: Statistical release, Employees in the Republic of Serbia, 2020, Statistical Office of the RS

A large number of employees, particularly in Lazarevac and Lajkovac, is from the mining and energy sector. In both municipalities, the share of employees in these sectors in relation to the total number of employees in these municipalities is about 39%. In the municipality of Obrenovac that percentage is lower and amounts to 8%, while in the municipalities of Ub and Aranđelovac a small number of people are employed in the mentioned sectors.

In 2020 the unemployment rate was 9.0% at the level of the Republic of Serbia, which is 1.4 percentage points lower compared to 2019. The lowest unemployment rate recorded for Belgrade region (7.5%) while in Šumadija and Western Serbia region it was equal to 9.8%. The highest decrease in the unemployment rate compared to the previous year was recorded in Šumadija and Western Serbia region (1.7 percentage points). Table 8.6 shows the number of unemployed persons in the Republic of Serbia, by regions and municipalities, as well as the number of persons unemployed per 1000 inhabitants.

Table 8.6: Unemployed in the Republic of Serbia, by regions and municipalities, as of 31st December 2020

Area	Number of unemployed	Unemployed per 1000 inhabitants
The Republic of Serbia	***491,347***	***71***
Belgrade region	**64,717**	**38**
Lazarevac	2,161	39
Obrenovac	3,398	47
Šumadija and Western Serbia region	**173,210**	**92**
Lajkovac	709	49
Ub	1,060	39
Aranđelovac	3,535	83

The number of unemployed persons in the Šumadija and Western Serbia region is amounted to 35% of the total number of unemployed in the Republic of Serbia. This percentage is much lower when the municipalities themselves are taken into account.

The number of employees in “Kolubara” Mining Basin (including those in the thermal power plants) will decrease over time due to the natural outflow of labour force (retirement), as well as due to reduced workload (either due to shutdown of coal-fired power units or due to the switching of some power units to gas as alternative fuel). However, although this reduction is expected to reach a level of 40%, a significant number of currently employed persons will remain active until the end of the operating life of the mine.

The process of decarbonization will significantly affect the employment in municipalities and their related regions. The consequences will be felt not only by those who will lose their jobs, but also by those employed in other economic sectors, and primarily those closely connected with coal mining. Loss of employment decreases the purchasing power of an individual, which is reflected in the reduction of the purchase of various products (clothes, shoes, household appliances), in addition to the necessary foodstuff. The use of some services (purchase of books, visits to cinemas, theatres, traveling…) will be reduced or will not be used. All this will have a negative impact on the development of municipalities and regions, particularly if it is

taken into account that the average salaries of employees in these economic sectors significantly exceed the national average salaries.

8.2 Vision for the Region

8.2.1 The path towards decarbonization

Baseline data and conditions

As a country that is negotiating for acceptance in the EU, Republic of Serbia is dedicated to follow EU energy policy in the maximum acceptable way. On the other hand, the main objective of the government is to provide sufficient and safe energy supply for all country's needs in the future period, bearing in mind the required high level of environmental protection and climate change threats.

So far, Serbian energy demands mostly relied on the own fossil fuel resources, mainly low-quality coal (lignite) and hydropower. Energy consumption based on liquid fuels and gas was provided with imports. As explained in the previous deliverables of TRACER (D5.3 & D6.1), fossil fuels usage for energy generation is followed by the releases of harmful pollutants in the air, water and soil, which results in serious damage to people's health and the environment. Moreover, a huge amount of carbon dioxide, which is the main cause of the greenhouse effect, is also emitted in the atmosphere.

Serbia is determined to minimize these effects to the maximum possible. The first step in this path is the adoption of few important regulatory documents. Namely, in April 2021, the Republic of Serbia amended the complete legislative framework in the field of energy and mining, with the aim of providing conditions for energy independence, as well as the need for further harmonization with the regulations of the Third Energy Package of the EU energy legislation and certain provisions of the EU Clean Energy Package for all Europeans. The following laws have been adopted:

- Amendments to the Law on Energy,
- Law on Energy Efficiency and Rational Use of Energy,
- Law on the Use of Renewable Energy Sources,
- Amendments to the Law on Mining and Geological Research.

In addition to the stated legal framework, the Law on Climate Change was adopted, while the low-carbon development strategy of the Republic of Serbia is expected to be adopted soon. The Republic of Serbia has also begun drafting a National plan for Energy and Climate (NECP), which will define measures to reduce greenhouse gas emissions and set targets for increasing the share of RES and energy efficiency for 2030, with projections until 2050.

Apart from the above-mentioned activities related to legislation improvement, Serbia has shown its commitment to European energy policy by accepting and ratifying some important documents in the field of energy transition and green energy development, such as: the Paris Agreement, in 2015, EC Green Deal, in 2019, Podgorica - Joint statement on the transition to clean energy, in 2019, Sofia Declaration on the Green Agenda of the Western Balkans, in 2020.

Kolubara coal basin has been the biggest energy generation resource in Serbia in the past decades: the mine facilities in the basin have produced up to 30 million tons of coal per year, while power plants generated up to 18,000 GWh of electricity (net), per year. Given the above new trends in energy sector development, in aim to harmonize with the country's future energy policy, Electric Power Industry of Serbia (EPS) is forced to create the transition plan for Kolubara coal basin, taking into account the following major leading issues:

- Investment decisions to build new thermal power plants became very unpopular in the EU countries and international financial organizations no longer support projects that are directly or indirectly related to dirty, fossil fuels.
- Carbon dioxide emissions are being taxed in an increasing number of countries and it is only a matter of time before this will be the case in Serbia as well.
- In the last 10 years, the prices of electricity production from solar and wind power plants have been reduced significantly.
- Changing the structure of Serbia's energy mix by introducing more energy generation from renewable sources may improve the rate of energy independence and reduce the need for imports in the future.

Foreseen main steps

Respecting all relevant above said facts, as well as the projections described in the Report D6.1 of TRACER, the main steps that are foreseen or still examined for future Kolubara basin transition process are briefly discussed as follows:

- Phase out of coal fired power plants: as defined in the National Emission Reduction Plan (NERP), TPP Kolubara A and TPP Morava will be closed up by the end of 2023, while TPP Nikola Tesla A and B will continue operation up to 2038/40, with power upgrading and introduction of new environmental protection measures, in line with EU regulation.
- Assessment of technical and economic feasibility for the construction of new natural gas fired power plants at the locations of existing coal power plants, based on more efficient combined electric and heat energy production.
- Improvements in energy supply for existing and new open pit mines by installing natural gas fired boiler plants instead of coal ones. Already constructed new boiler plant in Baroševac has the capacity of 10 MW.
- Change of district heating energy supply, which was so far provided from TPP Kolubara A, by the new energy source based on natural gas fired boilers. The planned capacity of this heating plant is 30 MW.
- Expansion of the natural gas network in the settlements in Kolubara region for usage in households for heating and other needs.
- Increase the usage of renewable energy in individual households by installing solar panels and biomass stoves.
- Construction of wind farms on the closed open pit mines areas.
- Increase the energy efficiency of buildings by installation of insulation in the frontage walls, ports and windows.

All the above-mentioned activities will lead to a gradual decrease of CO_2 emissions in the energy sector, as well as to environmental protection improvement in the target region and the wider area. However, the decarbonization process in Kolubara region will be a slow and long-lasting process, bearing in mind the actual local economy status, lifestyle and population perceptions to accept new habits. It will be the challenge of the local government to ensure the citizens that the proposed changes are opportunities for better and healthier living on the own properties.

8.2.2 New jobs to be created through the decarbonization process

The implementation of the energy transition process includes, among others, the analysis of developing renewable energy sources. In this case, solar PV power plants, wind power plants and, eventually, bioenergy power plants may be built on the considered locations. Solar power plants may be installed on former ash disposal sites, as well as small ones on the building roofs and other suitable structures. Wind power plants may be installed on the exhausted open pit mines, depending on the terrain characteristics (geology profile) and reclamation plans. The

advantage of these locations is the existing energy infrastructure for the transmission and distribution of electricity.

The construction of renewable energy sources will provide conditions for the creation of new jobs, both those directly related to the operation and maintenance of RE facilities, and those related to the design, manufacturing of equipment parts (cables, transformers etc.) and construction of RE facilities. Furthermore, bioenergy provides new opportunities for additional jobs in e.g. agriculture (planting and harvesting of biomass).

To consider the effects of construction of renewable energy sources on the employment, it is necessary to undertake activities in order to determine the type and strength of renewable sources that can be built at the location of open-pit mines and TPPs Nikola Tesla A and Nikola Tesla B. Only after that, it will be possible to determine the effects that the construction of renewable energy sources will have on solving the issue of employment of those who will lose their jobs in the process of decarbonization.

In this regard, the impact that the construction of renewable energy technologies / projects has on employment (locally – at the location of the power plant, and hyper-local, e.g., for the production of equipment) in Greece has been analysed (C. Malamatenios, 2016). It should be taken into account that, in this analysis, it was assumed that 15% of RE equipment is produced domestically, meaning that it is not imported from a third country. The results obtained by this analysis are shown in Figure 8.1.

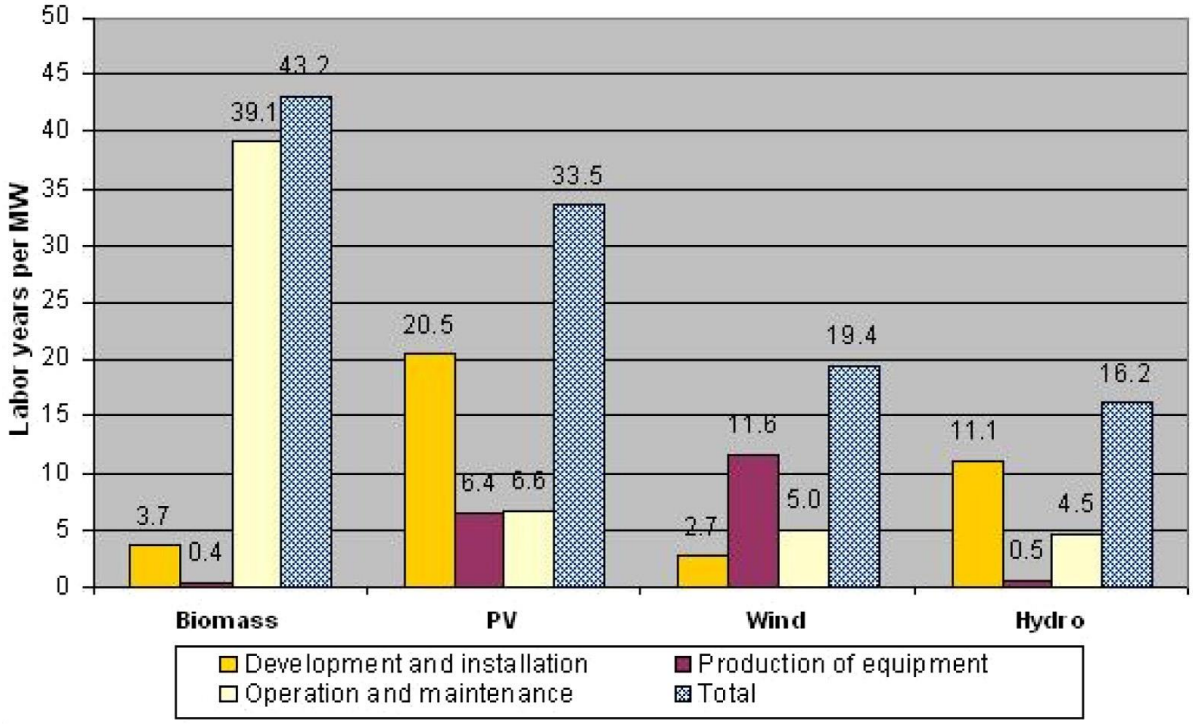

Figure 8.1: Labour years (direct in 20 years) per MW of new RES investments

Source: C. Malamatenios (2016)

According to the above analysis, which resumes the situation in Serbia, the development and installation of solar PV will produce more jobs than the development and installation of other technologies. In the case of equipment production, most jobs are provided by wind energy, while considering the long-term operation of the facilities, biomass has the best result.

The process of decarbonisation will provide opportunities for the development of agricultural production, forestry, wood industry, sports tourism and trade. The development of these activities will increase or create the need for the following occupations: agricultural technician,

forestry technician, hunting and fishing technician, agricultural machinery operator, food and beverage processor, biotechnology technician, food technician, food technologist, agricultural engineer, expert organic food production, tourism specialist, forestry engineer, wood processing engineer, etc.

8.2.3 Reskilling / retraining needs of the local workforce

The occupations and skills of mining employees, as well as the occupations and skills needed to work on renewable energy plants and facilities have been analysed in the report prepared in the frame of the RES-SKILL Erasmus+ Project (PROMEA, 2021). The main purpose of the analysis was to consider which existing occupations and skills are common to both sectors, which occupations require additional training and how much time does it take to implement such training.

Table 8.7 shows the current occupations that coal workers have, the occupations needed for the new technologies, and the training needed for reskilling.

Table 8.7: Transition profiles

Current Occupation	New Occupation	Training Requirements	Estimated retraining needs
Mining machine operators	Machinists of road construction machinery (PV)	Original duration of training: min. 4 months	6 months
	Machine operators (wind)	Original duration of training: min. 300 hours of apprenticeship & min. 3,000 hours of paid on-the job training	6 months
Fitters in the coal industry	PV fitter / installers	Original duration of training: min. 24 hours	1 month
	HVAC system installers	Original duration of training: min. 6 months	1 month
Maintenance and repair workers	PV operation and maintenance technicians	Original duration of training: 1-year on-the-job training	1 month
Construction equipment operators	Machinist of road construction machinery (PV)	Original duration of training: min. 4 months	1 month
	Machine operators (wind)	Original duration of training: min. 300 hours of apprenticeship & min. 3,000 hours of paid on-the job training	6 months
Heavy vehicle & mobile equipment service technicians & mechanics	PV operation and maintenance technicians	Original duration of training: 1-year on-the-job training	1 month
	Maintenance and repair electricians	Original duration of training: 2-3 years	1 month
Mining electricians	PV electricians	Original duration of training 1-year on-the-job training	1 month
	Electricians (wind)	Original duration of training: 2 years	3 months
	Maintenance and repair electricians (wind)	Original duration of training: 2-3 years	3 months

Source: RES-SKILL 02-T1: Skills matching analysis and development of transition profiles

In order to carry out retraining as successfully as possible, it is necessary to consider whether and to what extent the skills and qualifications possessed by employees in the coal industry of

certain qualifications can be used to work on renewable energy plants and facilities. Based on that, it is necessary to consider which training is necessary to conduct, as well as its duration.

The same procedure should be carried out for occupations from other economic sectors for which there is potential for development in the areas covered by the decarbonisation process, which include: agriculture, forestry, wood industry, trade, tourism, hunting and fishing. Some occupations, e.g. truck driver and car driver, will not require additional training, while some others, such as economists or lawyers, will need a brief introduction to the new business and alignment with regulations and rules that apply to it. Some occupations will take longer to retrain, e.g. for performing activities in the field of tourism, wood industry, agriculture.

The Table 8.8 shows the number of employees in MB “Kolubara” and the "Nikola Tesla" power generating branch according to organizational unit(s) in 2020.

Table 8.8: Number of employees in branches MB “Kolubara” and “Nikola Tesla” TPPs, 2020

Organizational unit	Number of employees
Branch MB Kolubara	**11,593**
Open Pit Mines	6,647
Processing Print	1,442
Metal	1,877
Headquarter	1,542
Project	85
Nikola Tesla TPPs	**2,269**
Joint services	350
TPP Nikola Tesla A	677
TPP Nikola Tesla B	355
TPP Kolubara	314
TPP Morava	114
Railway transport	459

Source: 2020 Environmental report, Electric Power Industry of Serbia

As can be seen, more than half of the MB "Kolubara" mining branch of EPS employees (6,647) are employed in the organizational unit "Surface mines" that works directly in the coal mining. The "Processing" unit has a total of 1,442 employees, the "Metal" unit has a total of 1,877 employees, the "Project" has a total of 85 employees, and the Main office has a total of 1,542 employees. The production process in "Kolubara" mainly includes employees with the third, fourth and fifth level of the Serbian Education system (three and four-year secondary education and master’s or specialist education). Among the employees with university degree, engineers of technical sciences - mining-geological, mechanical and electrical - are prevailing.

Respectively, the "Nikola Tesla" power generating branch of EPS (TPP "Nikola Tesla A", TPP "Nikola Tesla B", TPP "Kolubara A" and TPP "Morava") employs 2,269 people (2020 data). Out of the total number of employees, 53.9% have secondary education, 14.4% are high-skilled workers, and 13.2% have university degree.

It is difficult to predict the exact number of employees who will lose their jobs at the time of closing Kolubara coal basin. This can only be done on the basis of certain assumptions and estimates, which include, among others:

- About 30% of employees will be retired until 2050;
- Some coal power plant will become gas power plant, which means that about 30% of current employees in Nikola Tesla TPPs branch will continue to work;
- About 50 employees will continue to work on renewable sources (solar and wind).

Taking into account the above-mentioned assumptions, it is estimated that about 9,200 people will lose their jobs after the closure of the Kolubara basin. They will need retraining and / or assistance in starting their own business. It should be borne in mind that retraining will be a long-term process, which requires significant financial resources, and which should therefore be well thought-out in order to make the best use of skills and qualifications of employees in the Kolubara coal basin and thermal power plants.

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9 United Kingdom, Wales

9.1 Current status of the region's workforce

9.1.1 Regional profile and specialisation

Wales is the third-largest of the four constituent countries that comprise the UK in terms of population, with a population of approximately 3.17 million in 2020. Its population density (153 inhabitants per km^2 in 2020) is higher than that of Northern Ireland, and Scotland, and also than the European average. Nevertheless, the average population density for the UK overall (274) is higher due to highly populated England (434). There are population concentrations along the Southern coast, including the cities of Cardiff (369,000), Swansea (247,000) and Newport (145,700), and in the North-Eastern industrial areas of Flintshire (150,000) and Wrexham (133,000), which have close cross-border links with North-West England. Similarly to the UK overall, Wales shows a constant population growth over the last few decades (Table 9.16). Since 1971, the country's population has increased by around 430,000 (300,000 since 1991), with the Welsh population passing the 3 million mark for the first time in 2007 (Statista, StatsWales).

Table 9.16: UK's and UK's countries population (in millions); 1991, 2001, 2011-2020

	UK	England	Scotland	Wales	Northern Ireland
1991	57.44	47.88	5.08	2.87	1.61
2001	59.11	49.45	5.06	2.91	1.69
2011	63.29	53.11	5.30	3.06	1.81
2012	63.71	53.49	5.31	3.07	1.82
2013	64.11	53.87	5.33	3.08	1.83
2014	64.60	54.32	5.35	3.09	1.84
2015	65.11	54.79	5.37	3.10	1.85
2016	65.65	55.27	5.40	3.11	1.86
2017	66.04	55.62	5.42	3.13	1.87
2018	66.44	55.98	5.44	3.14	1.88
2019	66.80	56.29	5.46	3.15	1.89
2020	67.08	56.55	5.47	3.17	1.90

Source: Authors' own elaboration based on data from https://statswales.gov.wales

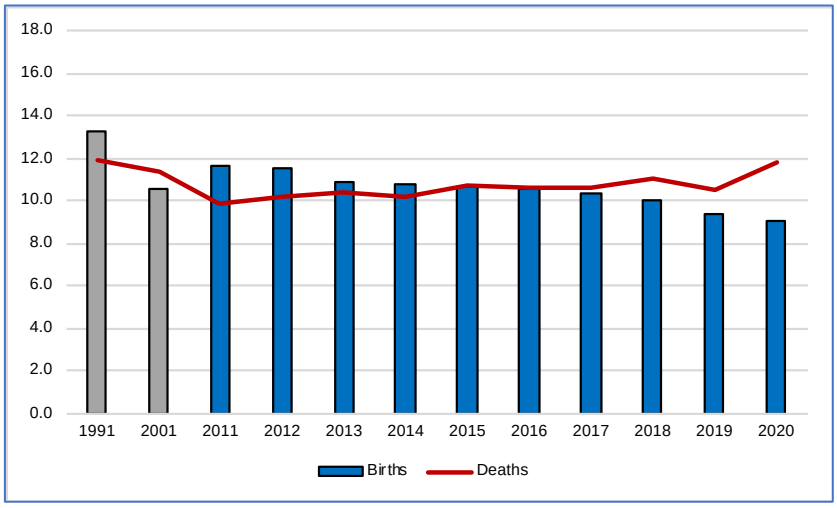


Figure 9.2: Crude birth and death rate in Wales (per 1000 population)

Source: Authors' own elaboration based on data from https://www.ons.gov.uk

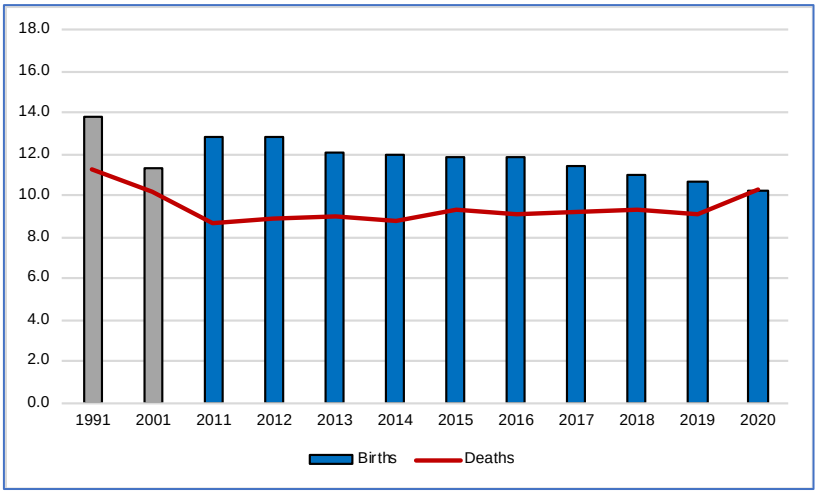


Figure 9.3: Crude birth and death rate in United Kingdom (per 1000 population)

Source: Authors' own elaboration based on data from https://www.ons.gov.uk

Population growth in Wales has been a result of both natural population growth and international migration (Office for National Statistics). However, since 2016, Wales has had a negative natural population balance and population growth has been sustained by migration only. Figure 9.2 and Figure **9.3** illustrate crude birth and death rates per 1,000 inhabitants in Wales and in UK as a whole.

Aligned with European and UK's trends, Wales shows an aging model of society. As of 2020, just over 222,000 people in Wales were aged between 55-59, the largest of any age group quintile in that year (Statista). The country has a gender balanced population, with more male births, but longer life expectancy of females (Office for National Statistics). Figure 9.9.4 illustrates how the age structure in Wales has changed over three decades. The pre-active group (aged between 0-15) and post-active group (age >64) have switched proportions, which shows the population is aging faster than this process occurs in the UK in general.

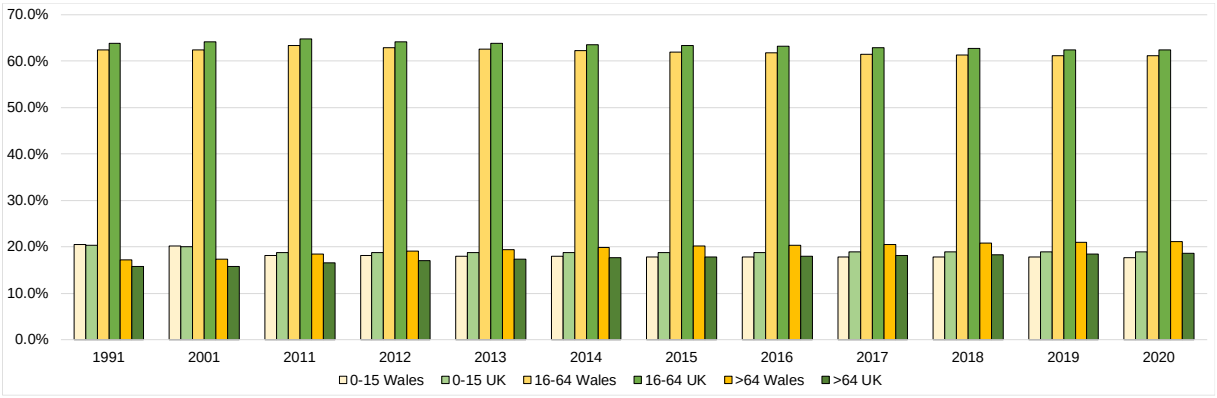


Figure 9.4: Age groups percentage share in Wales and UK: pre-active (0-15), active (16-64) and post-active (<64) in 1991, 2001 and 2011-2020

Source: Authors' own elaboration based on data from https://statswales.gov.wales

Population projections are subject to uncertainty and are based on assumptions on future trends in fertility, mortality and migration. In addition, the impacts of the coronavirus pandemic on demographic behaviour are not yet clear and this contributes to greater uncertainty (Office for National Statistics). Welsh Government National 2020-based population projections foresee that:

- Between mid-2020 and mid-2030, the population of Wales is projected to increase by 2.6% from 3.17 million to 3.25 million.
- Between mid-2020 and mid-2045, the population of Wales is projected to increase by 4.2% from 3.17 million to 3.30 million.
- It is projected that there will continue to be more deaths than births, with a total of 77,000 more deaths than births between mid-2020 and mid-2030.
- The projected population growth is driven by migration, with total net migration of 159,000 between mid-2020 and mid-2030.

In 2019, according to OECD and Eurostat data, gross domestic product (GDP) in Wales was £77.5 billion, an increase of 3.3 per cent from 2018. GDP per head in Wales in 2019 was £24,586, an increase of 0.7 per cent on 2018 and just under 75% of the UK GDP per capita figure (Table 9.17 and Table **9.18**).

Table 9.17: Welsh GDP (£ billion)

	GDP	GDP growth	GDP real growth	Share of UK's GDP (including Extraregio)
2001	£41,266	3.0%	1.8%	3.6%
2002	£43,252	4.8%	2.6%	3.6%

2003	£46,073	6.5%	3.9%	3.7%
2004	£48,678	5.7%	3.5%	3.7%
2005	£50,841	4.4%	1.9%	3.6%
2006	£53,715	5.7%	2.6%	3.7%
2007	£55,709	3.7%	1.1%	3.6%
2008	£55,905	0.4%	-2.9%	3.5%
2009	£54,874	-1.8%	-4.0%	3.5%
2010	£56,740	3.4%	3.0%	3.5%
2011	£59,479	4.8%	4.3%	3.6%
2012	£61,365	3.2%	0.6%	3.6%
2013	£63,676	3.8%	2.1%	3.6%
2014	£65,590	3.0%	1.3%	3.5%
2015	£67,863	3.5%	1.7%	3.5%
2016	£70,667	4.1%	1.5%	3.5%
2017	£72,607	2.7%	0.9%	3.5%
2018	£75,505	4.0%	2.0%	3.5%
2019	£77,517	2.7%	0.7%	3.5%

Source: Author's own elaboration based on data from https://www.ons.gov.uk

Table 9.18: Welsh GDP per capita (£)

	GDP per capita	GDP per capita growth	GDP per capita real growth	Comparison to UK's GDP per capita
2001	14,180	3.0%	1.7%	73.6%
2002	14,798	4.4%	2.2%	74.0%
2003	15,683	6.0%	3.4%	74.5%
2004	16,460	5.0%	2.8%	74.9%
2005	17,122	4.0%	1.5%	74.3%
2006	17,991	5.1%	2.0%	74.4%
2007	18,531	3.0%	0.4%	73.5%
2008	18,476	-0.3%	-3.5%	71.9%
2009	18,057	-2.3%	-4.4%	72.6%
2010	18,603	3.0%	2.6%	72.7%
2011	19,414	4.4%	3.9%	74.0%
2012	19,962	2.8%	0.3%	74.3%
2013	20,658	3.5%	1.9%	74.4%
2014	21,212	2.7%	1.0%	73.5%
2015	21,898	3.2%	1.4%	74.3%
2016	22,700	3.7%	1.1%	74.7%
2017	23,233	2.7%	0.9%	74.2%
2018	24,057	4.0%	2.0%	74.6%
2019	24,586	2.7%	0.7%	74.2%

Source: https://www.ons.gov.uk

Following the general trend for all UK countries in last decades, there is an upward trend in GDP per capita, last interrupted at the end of '00s (Figure 9.5).

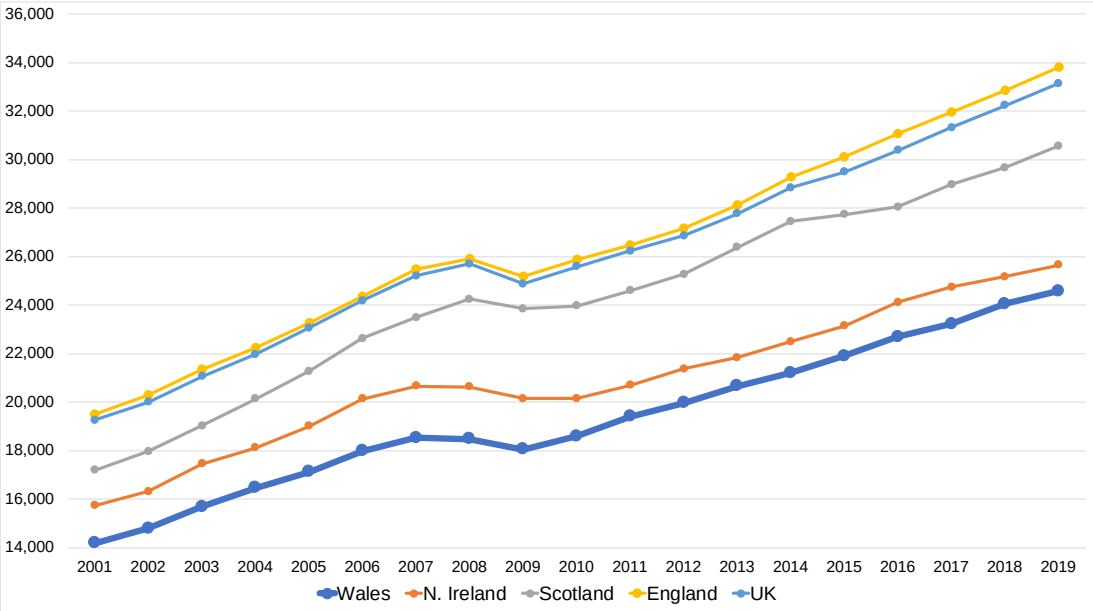


Figure 9.5: GDP per capita in UK by country 2001-2019, by country

Source: https://www.statista.com

Education in Wales is compulsory up to age 16. A curriculum and qualifications reform is currently underway, with a new national curriculum under development, with a timeline for rollout up to 2026.[5] The average PISA science score for Wales in 2018 was 488, 17 points lower than the average in 2006 (505) but 3 points higher than in 2015 (485). There was no statistically significant difference between Wales and Northern Ireland, Scotland, and the OECD average.[6] The proportion of 25-64 years olds progressing through tertiary education in Wales has risen in the last decades, as shown by data on percentages of 25-64 years olds whose highest level of education successfully completed is primary, secondary or tertiary education (Figure 9.6), although the percentage is lower than for the UK as a whole.

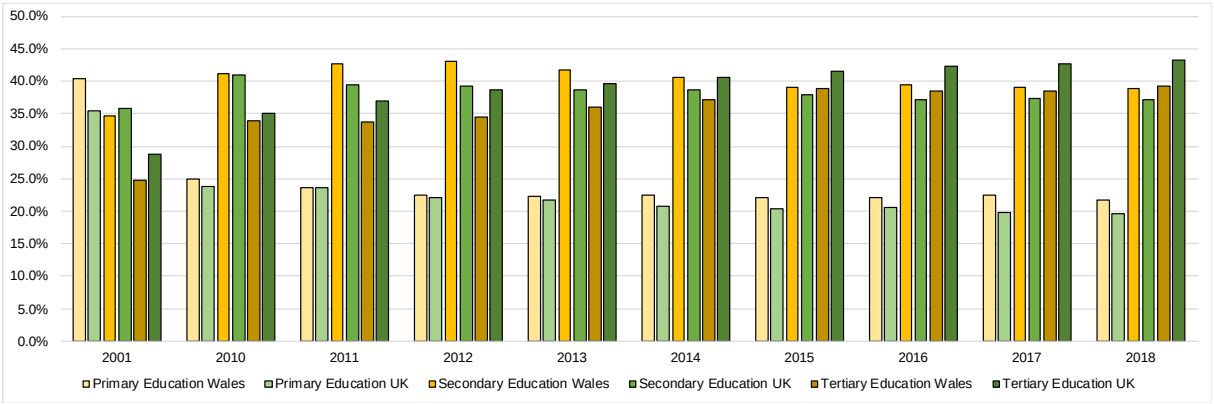


Figure 9.6: Educational attainment for ages 25 to 64, primary, secondary and tertiary education, total per cent. Comparison: Wales and UK 2001-2018

Source: Authors' own elaboration based on data from QoG Institute

Since the 1950s, the service sector has accounted for the majority of jobs in Wales, with c.10% in manufacturing, 7.4% in construction and only 0.4% in electricity and gas (Table 9.19).

[5] https://gov.wales/sites/default/files/publications/2018-03/education-in-wales-our-national-mission.pdf
[6] https://gov.wales/achievement-15-year-olds-program-international-student-assessment-pisa-national-report-2018

Table 9.19: Workforce Jobs by Industry (SIC 2007) seasonally adjusted, September 2021

Industry	Wales		UK	
	number	%	number	%
A: Agriculture, forestry and fishing	25,358	1.7	363,644	1.0
B: Mining and quarrying	2,752	0.2	58,064	0.2
C: Manufacturing	147,754	10.2	2,526,287	7.2
D: Electricity, gas, steam and air conditioning supply	5,864	0.4	142,960	0.4
E: Water supply; sewerage, waste management and remediation activities	14,255	1.0	236,248	0.7
F: Construction	107,212	7.4	2,224,865	6.3
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	173,225	11.9	4,799,527	13.7
H: Transportation and storage	56,530	3.9	1,803,194	5.1
I: Accommodation and food service activities	126,351	8.7	2,403,486	6.8
J: Information and communication	38,326	2.6	1,521,254	4.3
K: Financial and insurance activities	28,831	2.0	1,088,825	3.1
L: Real estate activities	19,859	1.4	634,117	1.8
M: Professional, scientific and technical activities	74,715	5.1	3,221,486	9.2
N: Administrative and support service activities	108,015	7.4	3,065,109	8.7
O: Public administration and defence; compulsory social security	94,815	6.5	1,621,267	4.6
P: Education	134,404	9.3	2,954,784	8.4
Q: Human health and social work activities	216,696	14.9	4,583,648	13.0
R: Arts, entertainment and recreation	42,886	3.0	955,462	2.7
S: Other service activities	33,812	2.3	864,320	2.5
T: Activities of households as employers; undifferentiated goods-and services-producing activities of households for own use	1,129	0.1	62,172	0.2
Total	**1,452,789**	**100.0**	**35,130,719**	**100.0**

Source: Nomis official labour market statistics

9.1.2 Employment and unemployment status of the local workforce

Although the labour market in Wales was the most affected among UK countries by the crisis in the late '00s, it bounced back, and in 2019 the unemployment rate of 4.0% was very close to the UK average. A further decrease in 2020 to 3.6% gave Wales the second lowest unemployment rate in the UK, higher only than Northern Ireland (**Error! Reference source not found.**). It was also the lowest in the 21st century for Wales, at 0.7% lower than the UK average. Figure 9.7 illustrates changes in the unemployment rate 1999–2021 in Wales and other UK countries.

In December 2020, 72.7% of working-age adults were employed, compared to 75.2% across the UK as a whole. At both UK and Wales levels, work has been carried out (and is ongoing) on setting out the pathways and targets for economies to achieve net zero, including in terms of employment and skills requirements. There is still a fair degree of uncertainty and unknowns associated with these processes, with many at an early stage. As the independent Green Jobs Taskforce report to the UK Government in 2021 noted, "*There are still gaps across a variety of sectors. Further clarity of the UK's decarbonisation pathways, investment timelines and location are required*". The Taskforce found consensus among stakeholders that skills gaps can ultimately be met. However, it also highlighted that this would require "the diverse timelines

for green job creation and skills demands across the economy and country [to be] matched with those for training and education provision, infrastructure and technology build and roll-out time, the transitioning of the workforce from one sector to the other, and local capacity" (Green Jobs Taskforce 2021).

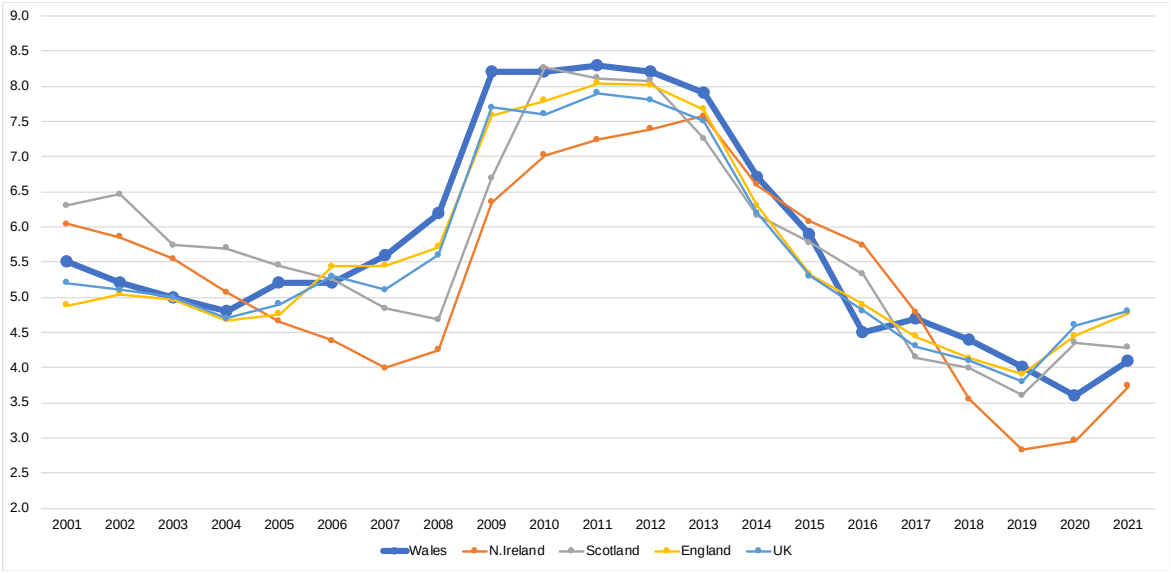


Figure 9.7: Unemployment rate (%) in UK 2001 – 2021[7], by country.

Source: Authors' own elaboration based on data from www.ons.gov.uk

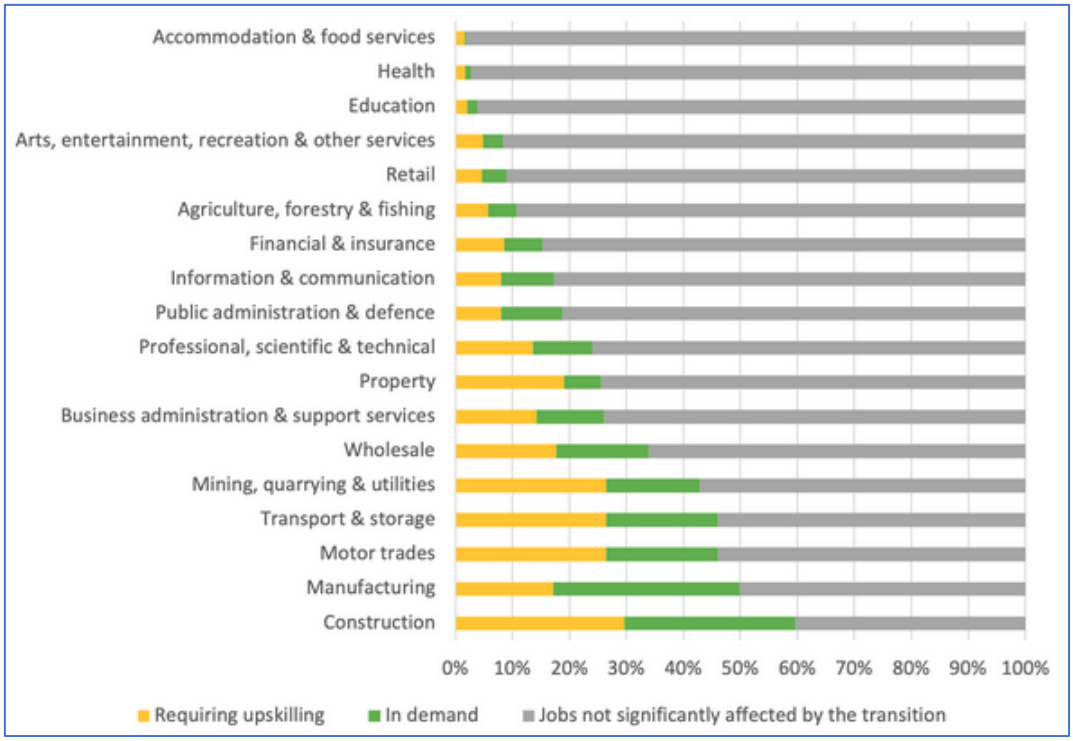


Figure 9.8: UK Jobs requiring upskilling, jobs in demand, and jobs not significantly affected by the transition, by sector

Source: Robins N, Gouldson, A, Irwin W and Sudmant A (2019) Investing in a just transition in the UK How investors can integrate social impact and place-based financing into climate strategies. London

[7] Based on data until September 2021

School of Economics. Available from: https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/01/Investing-in-a-just-transition-in-the-UK.pdf

The UK's Place-Based Climate Action Network (PCAN) tracker estimates that around 20% of existing UK jobs (c. 6.3 million workers) will be affected by transition, with around 3 million workers requiring upskilling and around 3 million in high demand.[8] The PCAN tracker identifies the construction industry, followed by manufacturing and transport, as the sectors where most focus is needed (see Figure 9.8). They estimate that as many as 25% of workers in these sectors are likely to require upskilling, with a similar proportion in high demand (Robins et al 2019).

A significant amount of retraining is expected to be required among the workforce in high carbon industries, but just 11% of high carbon workers participate in adult learning currently (Green Jobs Taskforce 2021).

Recent analysis highlights the skills transformation expected in the automotive (including EVs) and heating and cooling sectors (Green Jobs Taskforce 2021). For example, in the automotive sector, 50,000 will require reskilling in manufacturing by 2025, increasing to 100,000 by 2035/2040. Skill gaps could be partially filled by current energy workforce who are estimated to have high-medium skills transferability e.g. pipe fitters and designers, leak test technicians, and offshore barge operators in the oil and gas industry could be retrained for CCUS (Green Jobs Taskforce 2021). The Green Jobs Taskforce reported a reasonable level of interest by oil and gas workers in moving to offshore wind (53%), wider renewables (51%), and decommissioning (38%), if provided access to the right education and training. Increased demand is also expected for the cross-, multi- and interdisciplinary skills required by decarbonisation projects such as whole house retrofitting.

As a caveat to the potential for skills transferability, however, it is worth noting that labour mobility in the UK currently tends to occur *within* rather than *between* regions. The Confederation of British Industry found that only 3% of the working age population moved to another region within the country in a given year (Green Jobs Taskforce 2021). A regional breakdown of data on the expected impact of transition on UK jobs finds that in Wales, while most jobs will not be significantly affected by the shift to a green, zero-carbon, economy, c.127,000 existing jobs may require upskilling, with c.134,000 existing jobs being in high demand (see Table 9.).

Table 9.5: Impact of transition on existing UK jobs, by country

Country	Jobs requiring upskilling	Jobs in demand	Jobs not significantly affected by the transition	All jobs
England	2,802,943	2,739,876	20,765,181	26,308,000
Wales	**127,022**	**134,439**	**1,007,539**	**1,269,000**
Scotland	254,906	245,819	2,001,275	2,502,000
Great Britain	3,185,040	3,120,114	23,773,846	30,079,000

Source: Robins, N, Gouldson, A, Irwin, W and Sudmant, A (2019) Investing in a just transition in the UK How investors can integrate social impact and place-based financing into climate strategies. London School of Economics. Available from https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/01/Investing-in-a-just-transition-in-the-UK.pdf

This data is also referenced by the 2021 report for the Future Generations Commissioner of Wales (Chapman & Kiberd 2021) which suggests that of the 20% of jobs in Wales which are directly affected by transition: "*an estimated 150,000 jobs (10.3%) are 'transition aligned' and*

[8] https://pcancities.org.uk/tracking-local-employment-green-economy-pcan-just-transition-jobs-tracker

as such are already well positioned to capitalise on the green transition. An estimated 140,000 (9.6%) are thought to require some form of reskilling. This does not necessarily imply a sector shift or redundancy, only the need to adjust to new and unfamiliar working requirements. The sectors most affected by the green transition include construction (30%), transport (26%) and manufacturing (17%), which together account for 73% of the jobs in need of reskilling".

The impact on employability and skills needs will vary within the Welsh regions. At regional level, Regional Skills Partnerships (RSPs) play a key role in the skills ecosystem.[9] The RSPs were set up between 2007-2014 and tasked by Welsh Government with identifying the skills needed in the workforce at regional level. The four RSPs are:

- North Wales Regional Skills Partnership (NWRSP)
- South East Wales Cardiff Capital Region Skills Partnership (CCRSP)
- South West Regional Learning and Skills Partnership (RLSP)
- Mid Wales Regional Skills Partnership.

The RSPs are voluntary non-statutory bodies chaired by private sector employers; members include local employers, local government, employers' organisations, public sector bodies, higher and further education representatives and the third sector. The RSPs produce regular Regional Employment and Skills Plans, which are refreshed every three years and provide recommendations to Welsh Government to influence the prioritisation and deployment of skills funding, including apprenticeship courses and further education allocations. Current plans cover the period 2019-2022.

The RSPs reflect existing regional arrangements, including City and Growth Deals and cross-border collaborations (SQW, 2019). The City and Growth Deals, joint UK/Welsh Government funding programmes in which local government, the higher and further education sectors and the private sector are key partners, also provide a key focus for skills, for example, by implementing skills programmes related to the requirements of green transition investment projects. Other specific regional initiatives in Wales (e.g. the Energy Island initiative in North Wales, and the Tech Valleys initiative in the South Wales former coal mining valleys) also provide a focus for local government skills and training activities.

9.2 Vision for the Region

9.2.1 The path towards decarbonization

The decarbonisation pathway in Wales will require a combination of measures at UK and Wales levels, and to this end Welsh Government and UK Government (Department for Business, Energy and Industrial Strategy (DBEIS)) issued a joint call for evidence on decarbonisation readiness in July 2021.[10] The decarbonisation pathway for the energy sector reflects this dual approach (see Table).

Table 9.6: Decarbonisation of the energy sector pathways

Vision and objectives for 2030	Vision and objectives for 2050
UK level	

[9] Welsh Government is the main body involved in developing, implementing and monitoring skills-related policies in Wales, working with UK Government, local government, the further and higher education sectors, apprenticeship training providers, work-based learning providers, the third sector and the private sector. The higher education sector consists of eight universities, funded by Welsh Government through the Higher Education Funding Council for Wales; the further education sector consists of c.15 colleges, which provide mainly vocational studies and work-based learning courses.

[10] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1001949/decarbonisation-readiness-call-for-evidence.pdf

• Remove coal from electricity mix by 2025, and no more new direct support for UK thermal coal mining or coal-fired power plants; • At least one new large-scale nuclear project; • Support the deployment of Carbon Capture and Storage in four industrial clusters; • Phase out use of fossil fuels in off-grid homes, businesses and public buildings; • No new unabated gas plants to be built after 2030; • Hydrogen grid conversion trials in the 2020s; • 5 GW low-carbon hydrogen production; • End of the sale of new petrol and diesel cars in the UK.	• Hydrogen grid conversion from gas; • Patchwork large-scale conversions starting from 2030 to 2050 near industrial clusters, with some buildings in these areas switching to hydrogen; • Build a commercially viable fusion power plant by 2040; • Create the world's first net zero emissions industrial zone by 2040; • Unabated gas-fired electricity generation to end by 2035.
Wales level	
• 70% of electricity consumption from renewable energy (51% in 2019); • 1 GW of renewable energy capacity to be locally owned (83% achieved by 2019); • All renewable energy projects to have an element of local ownership from 2020; • Establish at least one renewable hydrogen production site by 2023-24, preparing for scale-up and commercial deployment from 2030; • Reducing consumption of high-carbon meat and dairy products by 20%; • Halving avoidable food waste by 2025 and 60% reduction by 2030; • Electric/low-carbon cars, vans and boiler replacements; • Target of 43,000 hectares of new mixed woodland; • Net zero public sector; • Clean Air Wales Bill to ban indoor burning of solid fuels (house coal and wet wood) after 2023; • Phase out of sales of oil boilers by 2028 in residential homes and by 2025-26 in commercial properties. • Piloting smart, flexible and digitalised systems to help reduce demand.	• Net zero emissions; • Increase housing and energy performance standards achieve at least a 95% decarbonisation target for power sector; • Target of 180,000 hectares of new mixed woodland.

Source: Authors' elaboration based on UK and Welsh Government strategy documents (HM Government, 2020; UKCCC, 2020; Welsh Government, 2020a; Welsh Government 2019a; Welsh Government, 2021).

Fossil fuels will play a declining role in the energy mix in Wales in future. At UK level, the UK Government has committed to removing coal from the country's electricity mix by 2024.[11] In Wales, the last coal-fired power plant for commercial energy generation closed in March 2020, making Wales coal-free four years ahead of the UK target. An estimated 2% of the 1.35 million homes in Wales use solid fuel (coal, wood or biomass) as the main heating fuel, particularly in rural areas that are off the gas grid.[12] The UK Government launched a consultation in 2021 on proposals to phase out the installation of fossil fuel heating systems in homes off the gas grid.[13]

[11] https://www.gov.uk/government/news/end-to-coal-power-brought-forward-to-october-2024
[12] Data from the Welsh Housing Conditions Survey 2017.
[13] https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid

In Wales, the proposed Clean Air (Wales) Bill would ban the indoor burning of solid fuels (traditional house coal and wet wood) after 2023 (Welsh Government 2020b). Decarbonisation of these homes would require use of options such as heat pumps and smart storage heating (UKCCC 2020). The 2030 energy mix is projected to include installation of increasing numbers of heat pumps (a recommended 52,000 heat pump installations per year in Wales by 2030, rising to 75,000 by 2050 (UKCCC 2020)).

The UK is expected to continue to rely on natural gas for 'some years' (HM Government 2020).. In Wales, gas fuelled power stations accounted for almost 70% of electricity generated in 2019 (Welsh Government 2020a). UKCCC recommend that Welsh Government work with the UK Government to deliver a phase-out of the burning of unabated gas for electricity generation by 2035, ensuring that existing gas plants in Wales are given opportunities to switch to low-carbon hydrogen or fit CCS within their economic lifetime (UKCCC 2020). Natural gas is prominent in fuelling gas boilers in households and other buildings.

A gradual move away from fossil fuel boilers is planned through a combination of energy efficiency measures and lower carbon replacement boilers. UKCCC recommends the phase out of sales of oil boilers in Wales by 2028 in residential homes and by 2025-26 in commercial properties, and of gas boilers by 2033 in residential homes, and by 2030-33 in commercial properties. Further, the UK Government has also announced the end of the sale of new petrol and diesel cars in the country by 2030.

In terms of renewable energy and other energy generation technologies, Welsh Government has a target of meeting the equivalent of 70% of Wales' electricity demand from Welsh renewable electricity sources by 2030. Offshore and onshore wind are likely to continue to play an important role in renewable energy generation in Wales; they accounted for 29% and 38% of renewable generation respectively in 2019. On marine and tidal energy, two demonstration zones have been assigned in Wales to test wave and tidal stream technologies.[14] Planning policy in Wales is explicitly supportive of renewable generation. Additionally, the Welsh Government has developed an energy efficiency strategy for the period up to 2026 (Welsh Government 2016).

Hydrogen is seen as a vital component of Wales' shift to the net zero goal. To facilitate the development of hydrogen activities and opportunities, Welsh Government set out a pathway for hydrogen development during the current carbon budget period (2021-25). The next stage is to develop a long-term plan to make hydrogen zero-carbon, after which hydrogen could also play a role in decarbonising the power system (Welsh Government, 2021b). The UK Government also published a UK Hydrogen Strategy in 2021, with an ambition of 5 GW low-carbon hydrogen production at UK level by 2030.[15] Additionally, UK Government plan to support the deployment of CCUS in four as yet unspecified industrial clusters to be operational by 2030.

The UK Government aims to bring at least one new large-scale nuclear project to the point of Final Investment Decision (FID) by the end of the current UK Parliament term and aims to build a commercially viable fusion power plant by 2040. Investment (up to £385m) has been promised to develop Small Modular Reactor (SMR) design and Advanced Modular Reactor (AMR) demonstration. There are no nuclear power stations currently operating in Wales, but the potential nuclear site at Wylfa Newydd is regarded as the best in the UK for large new nuclear. In addition, a site development company (Cwmni Egino) is being created by Welsh Government to unlock the potential of the former nuclear Trawsfynydd station site in North-West Wales (Welsh Government 2020a).

[14] https://www.wavehub.co.uk/our-projects/pembrokeshire-wave-zone; https://www.morlaisenergy.com/
[15] https://www.gov.uk/government/publications/uk-hydrogen-strategy

Welsh Government's second Low Carbon Delivery Plan (Net Zero Wales Carbon Budget 2) outlines the path to decarbonisation for Wales (see Figure 9.9) (Welsh Government 2021b).

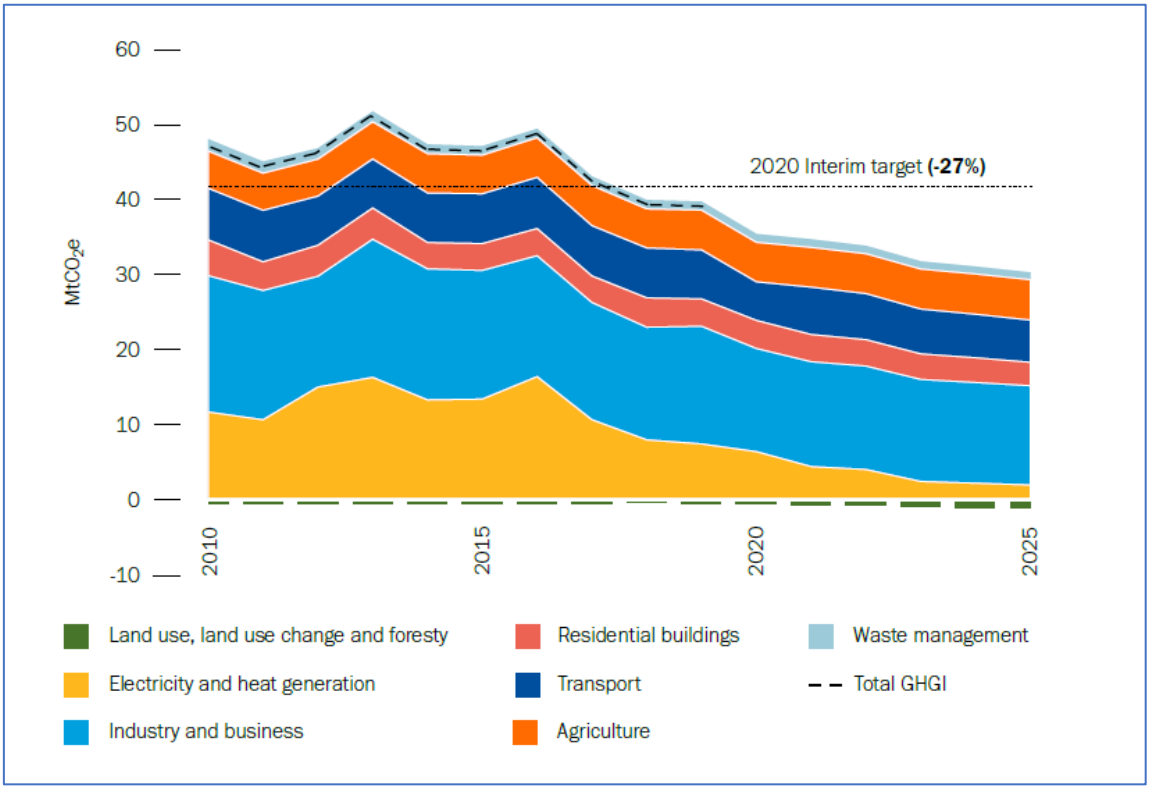


Figure 9.9: Welsh Government Carbon Budget 2 Pathway

Source: Welsh Government (2021b) Net Zero Wales Carbon Budget 2 (2021-25). Wales' commitment to tackling climate change. OGL. Digital ISBN 978-1-80391-158-8. https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-carbon-budget-2-2021-25.pdf

The plan seeks to take a "whole-system" approach to approach to net zero carbon transition, and sets out 123 policies and proposals to achieve decarbonisation in Wales. This includes achieving a decarbonisation target for the power sector of at least a 95%. A framework and pathways supported by specific planned policy interventions are set out for each sector (see Figure 9.10 for the framework for the electricity and heat generation sector).

Ambition statements and policy interventions are similarly outlined for transport, residential buildings, industry and business, agriculture, land use land use change and forestry, waste management and the public sector (see **Figure 9.11** for examples for transport and residential buildings). Decarbonisation of the public sector encompasses local government, health and social care, Welsh Government, higher education, tourism, culture and natural resources. Areas emphasised in the decarbonisation of this sector include:

- Mobility and transport, particularly aiming towards an integrated sustainable transport system that can reduce emissions and improve connectivity;
- Buildings, namely regarding housing retrofit, the implementation of energy saving measures and the reduction of the carbon footprint of buildings, particularly aimed at more disadvantaged communities;
- Land use, with carbon sequestration, natural resources and touristic potential of land;
- Procurement, with criteria and rules having the potential to help drive emissions reductions by requesting suppliers for low carbon options in several areas.

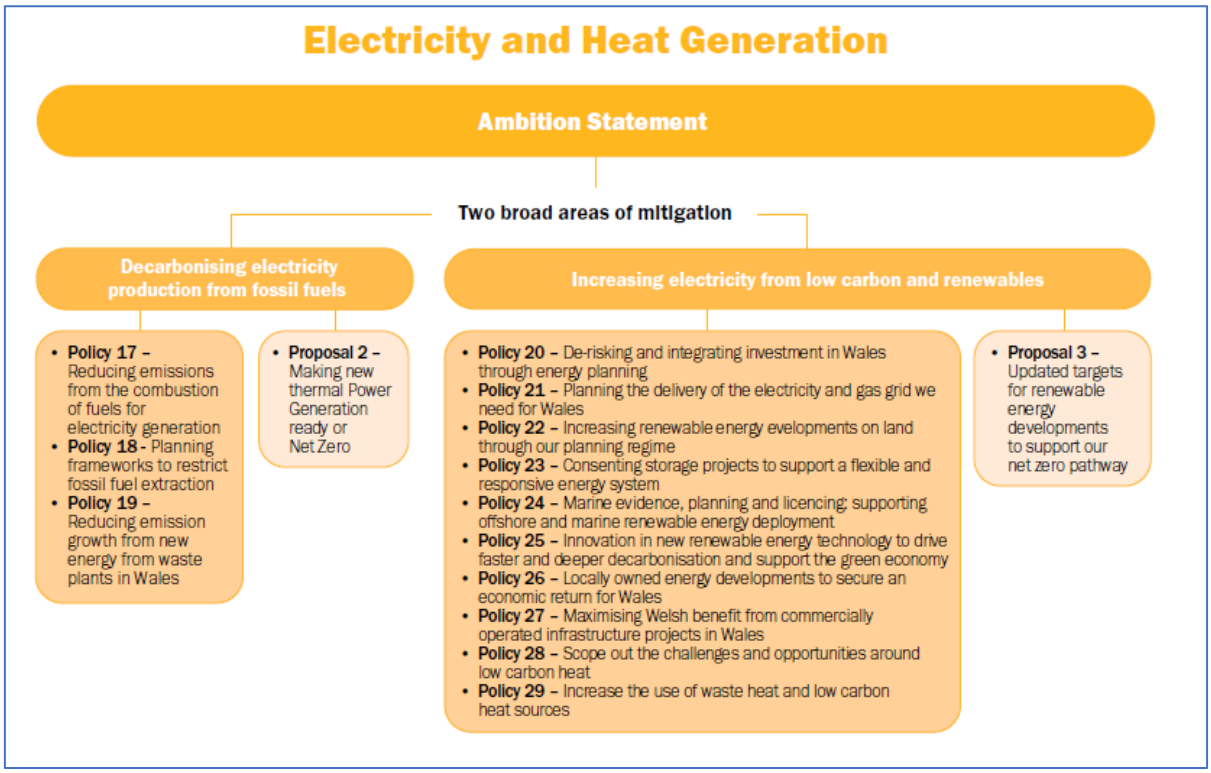
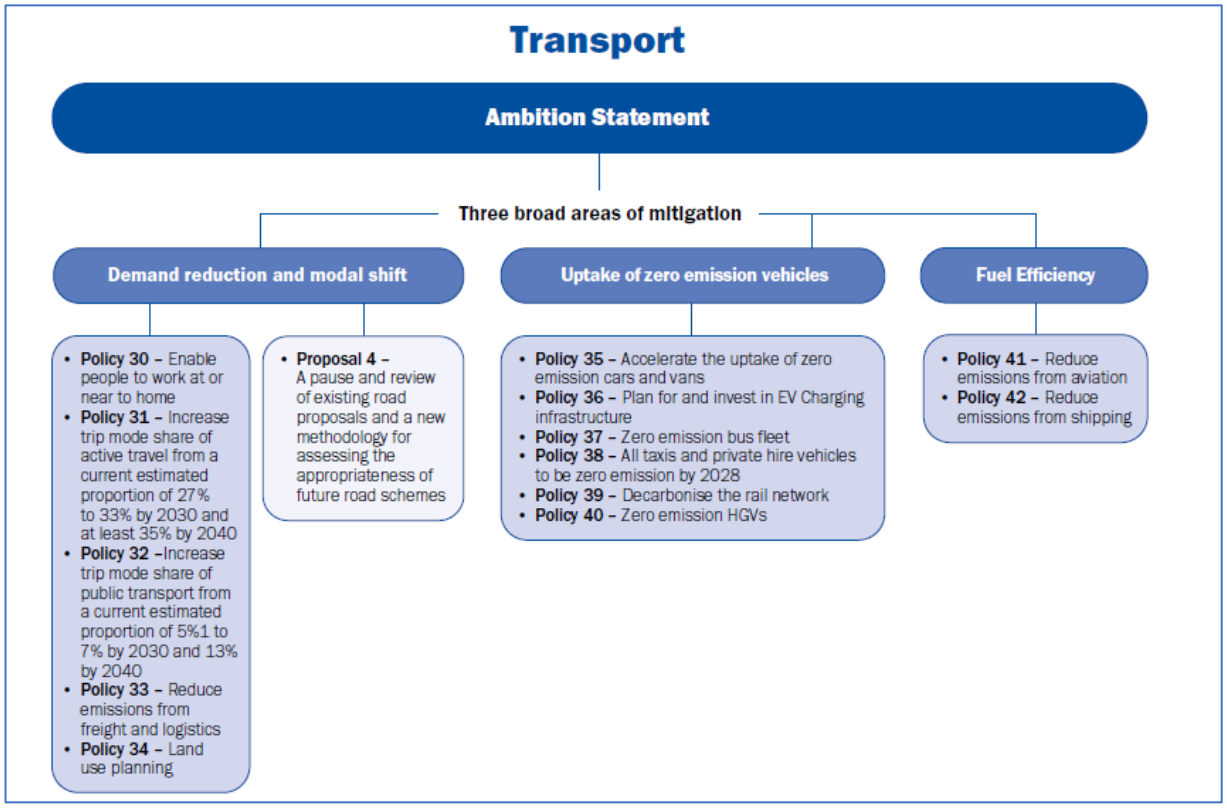


Figure 9.10: Decarbonisation pathway Wales – electricity and heat generation

Source: Welsh Government (2021b) Net Zero Wales Carbon Budget 2 (2021-25). Wales' commitment to tackling climate change. OGL. Digital ISBN 978-1-80391-158-8. https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-carbon-budget-2-2021-25.pdf



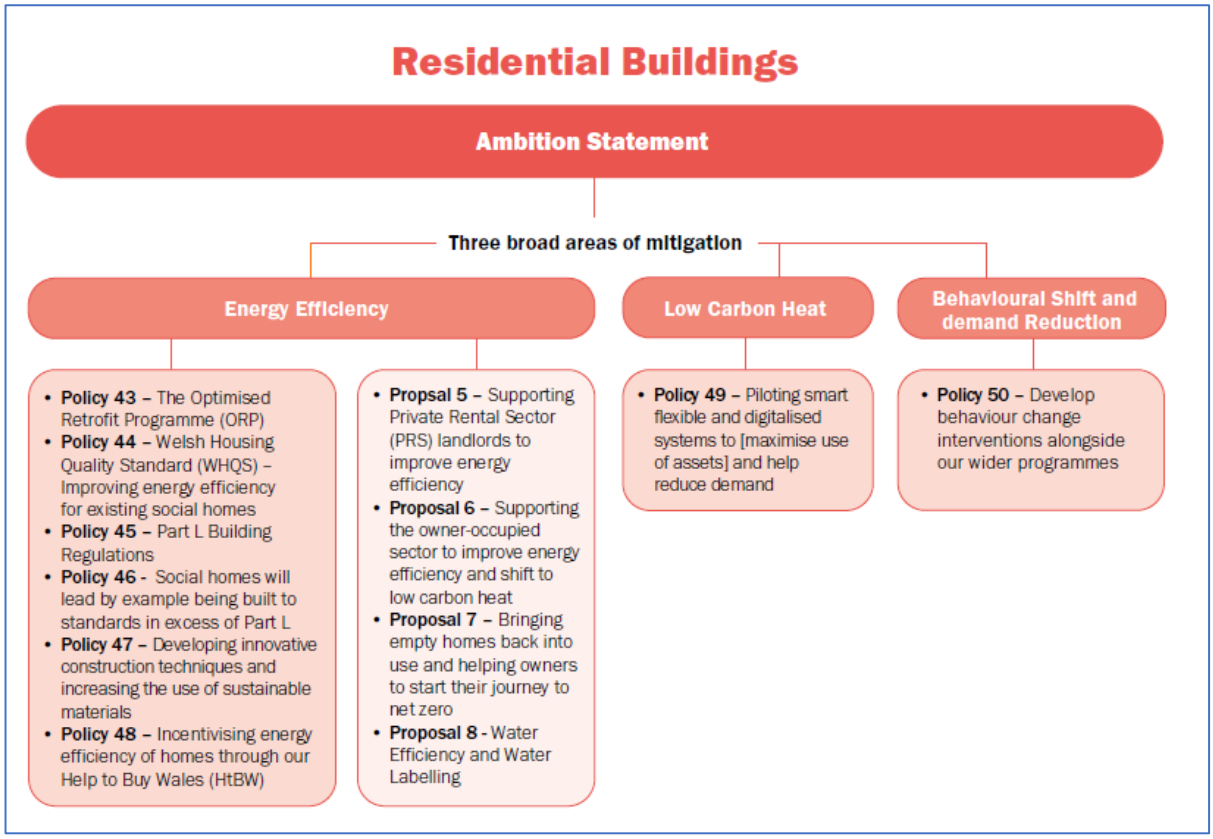


Figure 9.11: Decarbonisation pathway examples – transport and residential buildings

Source: Welsh Government (2021b) Net Zero Wales Carbon Budget 2 (2021-25). Wales' commitment to tackling climate change. OGL. Digital ISBN 978-1-80391-158-8. https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-carbon-budget-2-2021-25.pdf

Net Zero Wales also discusses skills, referring to the provision of a "competent green skills workforce for Wales", for example, with new build and retrofit skills for housing (with a focus on upskilling people already engaged in current housing retrofit activity, as well attracting new entrants into the green skills arena).

In terms of the circular economy, and its links to the foundational economy, Welsh Government aims to maximise the economic benefits which transition presents to Welsh supply chains, in areas such as electric buses, low carbon homes and heat pumps**,** supporting businesses to develop future green skills and attain relevant accreditations. The plan mentions exploring ways to upskill local actors (e.g. builders' merchants) across Wales to offer energy efficiency advice. Skills for hydrogen development and research and development, addressing the skills gap for industrial fuel switching and the wider scale use of hydrogen as a fuel for industry are specifically mentioned as an element of the hydrogen pathway.

Collabourative approaches between industry and careers advisory services are proposed as means of addressing youth unemployment, to showcase new occupations and supporting children and young people with the needed skills. The need for active engagement of business and industry is also emphasised: "*Without active engagement from businesses (training apprentices, being vocal about the demand for new training where none exists, upskilling themselves and become advocates for decarbonisation) … objectives will not be achieved*" (Welsh Government 2021b).

9.2.2 New jobs to be created through the decarbonization process

The UK Government has set an ambition for two million green jobs in the UK by 2030 (Green Task Force 2021). The Energy Innovation Needs Assessment (EINA) identifies £27bn of GVA opportunity in 2050 from decarbonising the UK domestic market by 80% compared to 1990 emissions levels, supporting around 300,000 jobs. The EINA suggests that the UK could also capture export-related opportunities, potentially adding £26 billion to UK GVA and supporting approximately 200,000 jobs in 2050. Nuclear, road transport, and CCUS are identified as offering the largest job opportunities, along with offshore wind (BEIS 2019).

The Climate Change Committee (CCC) commissioned research that modelled economic opportunities emerging from accelerating the pace of emissions reduction to meet the UK's sixth carbon budget and net zero. The research found that this will result in an increase in UK GDP of around 2-3%, and about 300,000 additional jobs by 2050. These opportunities are linked to investment in green technology stimulating the use of spare capacity, reduced leakage from ongoing spending on imported oil and gas in favour of low carbon domestic investments, and dynamic innovation (CCC 2020).

According to the Green Jobs Taskforce report, the following employment growth linked to decarbonisation is foreseen at UK level:

- the UK's offshore wind sector could employ c.70,000 workers (40,000 direct jobs and 30,000 jobs in the supply chain) by 2026, compared to c.26,000 at present;
- there is an estimated need to recruit for 400,000 jobs in energy networks by 2050 (with 260,000 being new roles and 140,000 replacing those leaving the workforce);
- the UK domestic market for smart systems and flexibility solutions could support c.10,000 jobs by 2050;
- improving the building fabric energy efficiency of every building in the UK in need of retrofit will require 12,000 workers to be trained every year for about the next four years, followed by the need to increase annual recruitment by up to 30,000 workers between 2025-30;
- up to 78,000 new jobs in EVs, with 24,500 in battery manufacturing, 43,500 in the battery supply chain, and c.10,000 in EV manufacturing. Of the current 182,000 vehicle technicians, it is estimated that c.21,000 are already EV qualified, and c.50,000 workers in automotive manufacturing will need retraining or upskilling by 2025. An additional 7,500-10,000 workers will also be needed in battery cell manufacturing by 2030;
- by 2050 the heat network sector could create between 20,000-35,000 direct jobs. In 2019, there were c.900 heat pump installers in the UK; there may be a need for between 7,500-15,000 heat pump installers a year to be trained within the next seven years, resulting in around 60,000 workers needed for heat pump installation in domestic and non-domestic buildings;
- circular economy sectors such as repair, remanufacture and refill could create between 54,000 to 102,000 net jobs across all UK regions;
- sectors such as oil and gas will also undergo transformation, and workers will need to adapt and potentially transition to new sectors. Between 2014-2017, the UK oil and gas sector lost over 70,000 direct jobs as well as those in the supply chain. Another 80,000 workers are expected to leave the sector between 2018-35 due to natural attrition, without taking into account the impact of COVID-19. On the other hand, there could be a net increase of 40,000 direct jobs connected to the transition to a net zero North Sea energy industry.

Workers and skills in some of these sectors will be concentrated in specific regions (see Figure 9.12), with opportunities in Wales forecast in the tidal, automotive, CCUS and nuclear sectors.

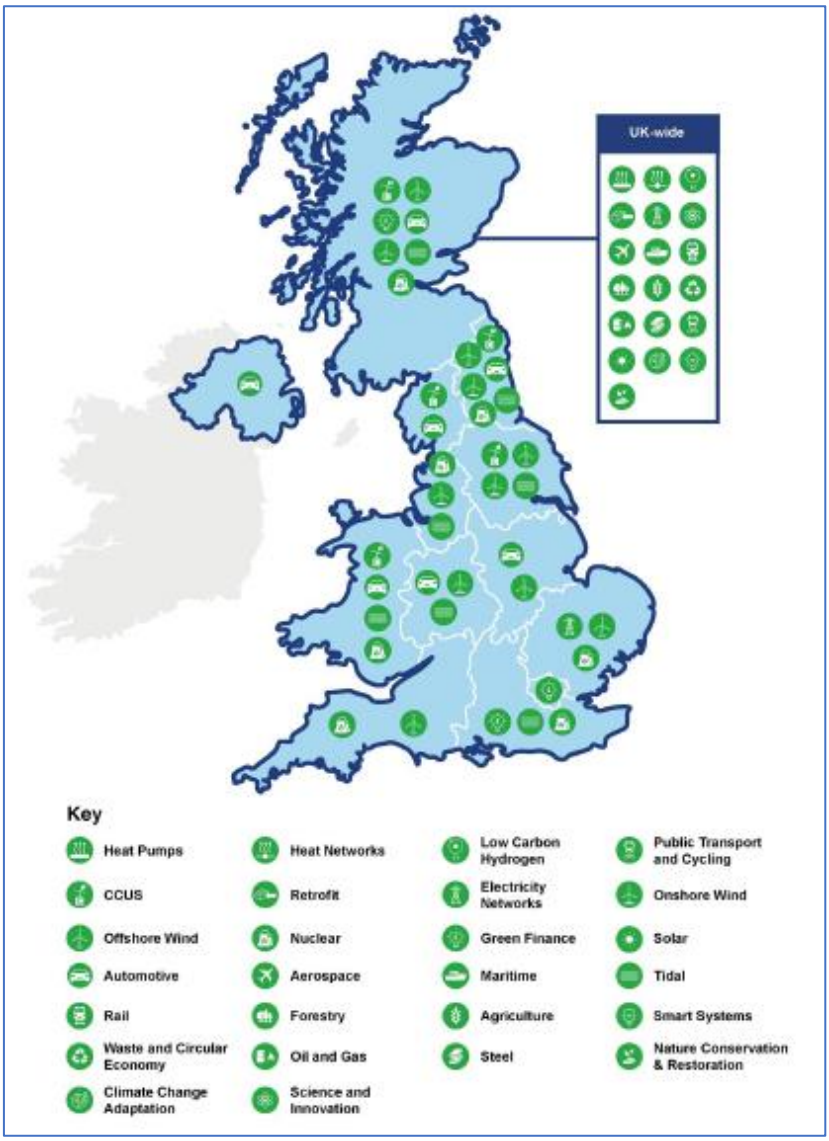


Figure 9.12: Potential regional employment opportunities and skills needs as UK sectors transition to net zero

Source: Green Jobs Taskforce (2021) Report to Government, Industry and the Skills Sector, https://www.gov.uk/government/publications/green-jobs-taskforce-report

Several recent Wales-level analyses forecast numbers of potential jobs in decarbonisation-related sectors, contingent on specific investment packages or measures being put in place. A 2021 report to the Future Generations Commissioner for Wales estimated that the level of new jobs created could be very significant in proportion to existing jobs numbers, with jobs more than doubling in some sub-sectors (Chapman & Kiberd 2021). These figures are based on a £6 billion green investment package proposed by Wales TUC which would create a total of 45,519 direct jobs across a range of sectors (see Table 9.7) (Transition Economics 2020). This work was considered to provide a reasonable indication of the investment and jobs in infrastructure required for a green recovery and decarbonisation in Wales (Chapman & Kiberd 2021).

A total of 60% of all jobs created would be in construction (approximately 27,300 jobs), with a further 14% in offsite manufacturing of housing, 7.5% in R&D, 7% in forestry and 6% in energy efficiency assessments. The remainder would be in engineering, environmental restoration and agronomic consulting (Chapman & Kiberd 2021).

Table 9.7: Wales TUC proposed green recovery investment package: jobs associated

Sector	Projects	Direct short-term job creation in Wales
Digital	Broadband upgrade	1,014
Manufacturing	R&D for decarbonising heavy industry – experimental technology (e.g. cement, petrochemicals, CCS demonstration, hydrogen)	3,426
Transport	Expand and upgrade rail network	5,870
	Build battery factories for EVs	3,960
	Electric car charging points rural	1,077
	Build cycle lanes and pedestrianisation	2,725
Buildings	Build social housing (using domestic offsite manufacture)	9,370
	Retrofit social housing	7,882
	Energy efficiency assessments	2,731
	Retrofit public buildings	572
Energy	Upgrade ports and shipyards for offshore wind supply chain	1,668
	Build manufacturing facilities for offshore (incl. floating) wind turbines	240
	District heating	1,051
Land	Reforestation schemes	2,895
	Environmental restoration (incl. flood defences)	709
	Support farmers to switch to organise agriculture	327
Total		45,519

Source: Minio-Paluello M and Markova A (2020) Job creation in Wales from a Covid recovery infrastructure stimulus, Transition Economics, https://www.tuc.org.uk/sites/default/files/2020-08/ Wales%20TUC%20-%20Transition%20Economics%20-%20Job%20Creation%20Just%20Recovery.pdf

The Institute of Welsh Affairs[16] vision for a Wales with 100% renewable electricity by 2035 includes job creation forecasts of c.20,150 jobs annually across Wales during a 15-year investment period:

- 9,500 annual FTE jobs related to energy efficiency measures;
- 1,800 annual full-time equivalent (FTE) jobs in solar PV;
- 2,000 annual FTE jobs in onshore wind;
- 1,300 annual FTE jobs in offshore wind;
- 5,200 annual FTE jobs in the tidal range, tidal stream, wave and floating wind sectors;
- 50 annual FTE jobs in in-stream hydropower;
- 300 annual FTE jobs in fuelled technologies (biomass, anaerobic digestion, energy recovery);

Looking specifically at retrofit, an estimated 26,500 new jobs could be created by a retrofit programme for housing in Wales (Brown et al 2021).

[16] https://www.iwa.wales/wp-content/media/2019/03/IWA_Energy_WP6_Digital-2.pdf

9.2.3 Reskilling / retraining needs of the local workforce

As noted in previous TRACER report D3.4 on the social challenges and re-skilling needs of the workforce in TRACER target regions, further reductions to already low levels of coal employment in Wales are anticipated. Nevertheless, the old coal-mining areas of the South Wales Valleys (and to a lesser extent North Wales) continue to be marked by the legacy of coal and related industries, with below-average income and wage levels, a prevalence of lower skilled and more precarious employment, and poorer quality of life (e.g. on health indicators).

A range of socio-economic, political and technological changes whose specific impacts are not yet clear will shape the future of the workforce structure in Wales up to 2030/2050.[17] These include demographic shifts and population ageing, as well as the impact of emerging technologies (including AI and digitalisation) on working patterns and practices, as well as the long-term impacts of both Covid-19 and Brexit. The end of access to EU Cohesion policy funding poses a risk that public investment for structurally weaker areas, such as the Welsh Valleys, will diminish over time, leading to poorer quality infrastructure, training, and support for business investment and innovation.

The anticipated skills needs for transition-related growth sectors have been outlined at UK level (Green Jobs Taskforce 2021). For example, continued development of the offshore wind sector is expected to require a broad range of skills, including asset management, project management, engineering and technical skills (e.g. mechanical, electrical and control and instrumentation, blade and turbine technicians), science (e.g. marine biology, geophysics, hydrography, oceanography), advanced first aid and rescue, and offshore-specific skills (e.g. confined spaces, working at heights). For housing retrofit, a current critical shortage of retrofit designers and co-ordinators is highlighted, together with the issue that education and training mostly being focused on new-build using traditional on-site techniques, with not enough emphasis being placed on low carbon systems (see **Table 9.8**).

Table 9.8: Skills requirements/reskilling needed in green transition (UK wide, extract from longer table)

Sector	**Skills requirements/reskilling needed**
Offshore wind	Manufacturing (L2-6), electrical engineering (L3), welders (L3-4), engineering (L4-5), project managers (L4), product development managers (L5), offshore technicians and seamen
Onshore wind	Welders (L3-4), engineers (degree level) and construction workers (L1-3)
Solar	Electricians (L4), roofers (L2) and engineers (degree level)
Tidal	Manufacturing (L2-6), electrical engineering (L3), welders (L3-4), engineering (L4-5), project managers (L4), product development managers (L5), offshore technicians and seamen
Nuclear power	An updated forecast of skill requirements expected 2021 from the Nuclear Skills Strategy Group.
Electricity networks	Grid infrastructure operatives (L3-8), civil and mechanical engineers (L3-7), data analytics (L3-7), modellers and programmers (L4-8), cyber security (L4-8), environmental scientists (L3-7), overhead lines people & general grid electric system installers (L2-7), integration of electric vehicle charging / microgeneration / domestic storage / demand side response, smart metering (L3-8)

[17] Fawcett J and Gunson R (2019); Universities Wales (2019); Welsh Government (2015); Welsh Government (2018); Welsh Government (2019c); Welsh Government (2019d).

Smart systems	Skill development will be needed in smart systems specific supply chains (e.g. energy storage, smart product design), plus in existing more mature supply chains (energy assessors, housing retrofit, network infrastructure). Electricians (L4), electrical engineering (L3), data analytics (L3-7), modellers and programmers (L4-8), electronic engineering (L3-8), control engineering (L3-8), cyber security (L4-8), integration of electric vehicle charging / microgeneration / domestic storage / demand side response, smart metering (L3-8)
New home build and retrofit	Currently, there is a critical shortage of retrofit designers and co-ordinators. Within domestic buildings, skilled workers needed include energy efficiency installers and assessors (L2-4), retrofit co-ordinators (L5). For larger non-domestic buildings, higher level qualifications for design and sign-off, e.g. architects, chartered passive house designers, chartered surveyors, and building management systems installations qualifications (BEMS Level 3 NVQ)
Heat networks	Specialist skills required for three stages of a heat network project. (1) Design: project management, design engineering and supporting professions (legal, financial, commercial). (2) Build: project management, construction and commissioning. (3) Operations & Maintenance: engineering, operator, and technician skills
Waste/circular economy	Sorting and reprocessing (L1-3), repair and manufacturing (L3-6), circular economy business planning/development (masters level – engineers, material scientists, managers) plus lifelong learning building on existing business skills
Automotive sector	Skills needed will include: charge point installers, operators, smart charging services, engineering, manufacturing, purchasing, material planning and logistics, vehicle scrappage and recycling, vehicle recovery operations, emergency services personnel, quality assurance and operations quality involved with batteries

Source: Green Jobs Taskforce (2021) Report to Government, Industry and the Skills Sector, https://www.gov.uk/government/publications/green-jobs-taskforce-report Note: 'L' refers to qualification levels, these are explained here: https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels

Within Wales, recent work on skills shortages (linked to Wales TUC's proposed green recovery investment package) has found that the majority of the skills shortages identified are in areas relating to construction, heating, and electrical installation (see **Figure 9.13**) (Chapman & Kiberd 2021). However, specific reskilling needs will depend on both UK and Welsh Government investment priorities and decarbonisation pathways, and many key issues have not yet been decided.[18]

The current Welsh Government Programme for Government (Welsh Government 2021a) outlines a range of objectives related to employment and skills which are relevant to the skills needs of energy transition, including:

- promoting parity of esteem between vocational and academic routes in Welsh education;
- reviewing adult education to increase the numbers of adults learning in Wales;
- reforming qualifications and expand the range of 'made in Wales' vocational qualifications;
- exploring how to strengthen professional learning communities; and
- strengthening the Regional Skills Partnerships.

Commitments include guaranteeing all young people under 25 the offer of work, education, training, or self- employment; creating 125,000 all-age apprenticeships; and delivering quality jobs, training and innovation by decarbonising more homes through retrofit, using local supply

[18] https://committees.parliament.uk/committee/517/industry-and-regulators-committee/news/161468/uk-will-miss-net-zero-target-without-urgent-action-warns-lords-committee/

chains. Welsh Government's second Carbon Budget Delivery Plan (Welsh Government 2021b) recognises that this is a pivotal moment to develop green skills for the jobs of the future:

"The need to re-position skills within the net zero agenda must take place alongside other structural challenges impacting on the labour market including digitalisation, automation and the long-term response to Covid. These disruptive forces complicate public policy responses, but they also offer a window in which we can improve the skills of people in declining or vulnerable sectors of employment. The transition to net zero and the structural challenges offer us an opportunity to actively tackle inequalities."

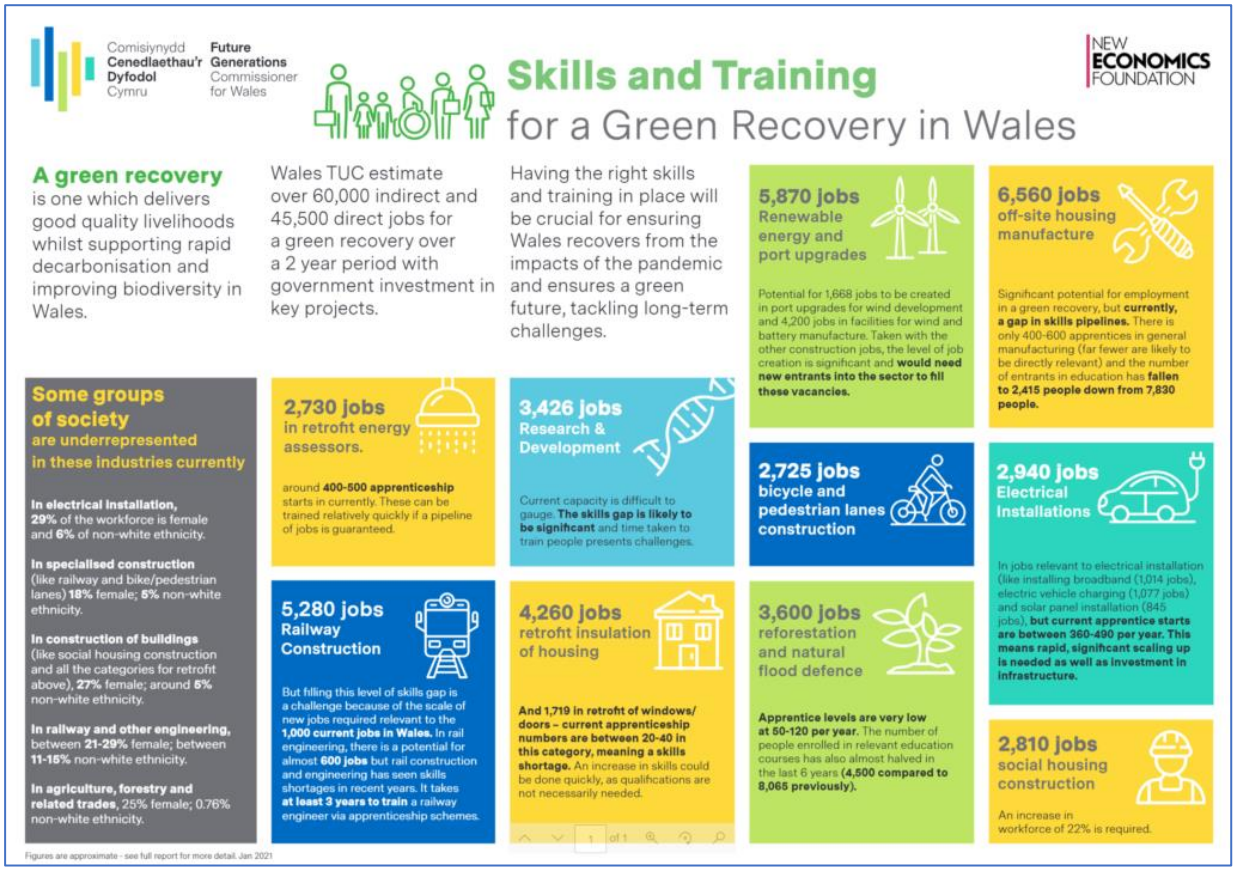


Figure 9.13: Skills and training for a green recovery in Wales

Source: Chapman A and Kiberd E (2021) Skills Through Crisis. Upskilling and (Re)Training for a Green Recovery in Wales, New Economics Foundation and Future Generations Commissioner for Wales

Consequently, work is currently underway to develop a *Net Zero Wales Skills Action Plan* by Spring 2022 (Welsh Government 2021b). Welsh Government is working with stakeholders to:

- Build on labour market intelligence from the Regional Skills Partnerships, including in relation to job quality, asking them to highlight skills gaps and shortages and work with the further and higher education sectors in Wales to help inform supply and meet the needs of employers;
- Define and achieve acceptance of industry requirements. The Skills Action Plan will build on existing work to map the skills base and understand demand for key sectors;
- Develop National Occupational Standards (NOS) responding to the low-carbon agenda (see ***Box 1***);
- Review qualifications for future skills needs (see ***Box 2*** on the ongoing work on the Credit and Qualifications Framework for Wales);
- Develop government incentives or legislation/regulation to stimulate skills demand.

Box 1: National Occupational Standards (NOS) in Wales responding to the low-carbon agenda

National Occupational Standards (NOS) are reviewed and developed in consultation with a representative sample of employers from across the whole of the UK. In Wales, Regional Skills Partnerships reports are used to identify occupational trends, helping the NOS system to respond quickly during periods of economic adjustment. Green recovery and the net zero agenda are already being given priority by NOS developers, although there is no single generic NOS suite that relates to low/zero carbon. However, it may be possible to identify and map NOS which, on a cross-sectoral basis, relate to low or zero carbon, sustainability and the green agenda. Relevant products which have recently been commissioned/reviewed or which are in development include:

- Environmental Technology (Zero Carbon) NOS for the Building Services sector (e.g. Air Source Heat Pumps, Biomass/Bio Fuels (Gas/Liquid), Fuel Cell Technology, Grey Water Recycling, Micro Wind Energy, Rainwater Harvesting)
- Vehicle Recycling
- Construction Site Management and Supervision (links to energy efficiency retrofit and assessing/evaluating the sustainability and environmental impact of construction developments)
- Sustainable Food Production
- Green Deal Energy Assessment and Advice.

Source: Welsh Government

Welsh Government has also recently awarded £2 million to six further education colleges in Wales to deliver part-time and flexible courses training courses for jobs in the green economy (Levels 2-5), designed to match skills gaps identified in priority sectors.

At regional level, the new *regional energy strategies* in Wales along with the new *regional economic frameworks* (currently in draft form) should play a key role (alongside the Regional Skills Partnerships Regional Skills and Employment Plans) in creating route maps and identifying regional priorities for reskilling, upskilling and new skills development. Skills and employment related to energy transition and decarbonisation have been given high priority in the emerging strategies e.g. related to offshore wind and marine energy in North Wales.

Box 2: Credit and Qualifications Framework for Wales (CQFW) Green Recovery and Transition to Net Zero

The CQFW framework offers parity of esteem for qualifications and helps learners to see progression routes, particularly where they are following non-traditional pathways. Wales maintains a policy position on retaining common UK-wide underpinning standards to aid alignment to other UK qualifications frameworks and to facilitate transferability/portability of learning across borders.

The recognition of prior learning and experience (RPL/RPEL) to ensure that the content of continuous professional development (CPD) remains robust and to avoid duplication in training programmes is of particular importance to the skills of people in declining or vulnerable sectors of employment, as some of these skills might transition into net zero related or other emerging roles. Through adopting RPL measures, individuals can be helped to recognise their existing competencies to ensure they do not have to duplicate training to move to a new job. Research is currently underway looking at examples of where the existing skills of people in declining or vulnerable sectors of employment in Wales have been recognised through RPL processes, and how some of these skills might transition into net zero roles. A key message from recent RSP reports has been that employers may move away from lengthy and costly regulated learning programmes, meaning that individuals should be encouraged to build up “bite-size” elements of qualifications through unitised accredited learning (UAL).

Source: Welsh Government

The stakeholder consultation carried out under TRACER WP 5 identified areas of need and opportunity related to the impact of energy transition on skills and the labour market in Wales (see **Table 20**.9). These sit alongside Wales’ recognised strengths, including ongoing high level research on renewable energy technologies and decarbonisation, a well-regarded academic

and research sector with strong international links, and existing collabouration with industry on decarbonisation. The Regional Innovation Scoreboard 2021 (European Commission 2021) also highlighted Wales' strong performance in tertiary education, lifelong learning and digital skills.

Table 20.9: Vision for R&I in the energy transition in Wales based on TRACER stakeholder consultation (extract)

	Areas of Need	Areas of Opportunity
Labour market, skills and community support	• Public ownership of energy transition; • Promote local infrastructure and wealth creation; • Access to education and training and skills development; • Creating good quality jobs; • Effective communication of transition benefits for energy literacy; • Identify locational dynamics (e.g. job & residence location); • Address deprivation, especially in former coal mining areas.	• Digitalisation; • Large scale initiatives; • Connecting training providers with businesses and policymakers; • Create and/or promote "centres of excellence" in energy; • Community energy projects; • Co-creation of internationally recognised skills, qualifications and progression frameworks for energy and environmental work.

Source: Michie, R., den Hoed, W. & Fonseca, L. (2021) Report setting out a vision and future-oriented priorities in Wales. Deliverable 5.3. Smart Strategies for the transition in coal intensive regions. TRACER Project, No: 836819.

Key priorities identified in the TRACER stakeholder consultation included the need for:

- a clearer path to help planning for the future, including for jobs and skills;
- high quality jobs and fair work practices;
- synergies between action in innovation policy, education and skills and energy policy;[19]
- prioritisation of connectivity to create employment in areas where well paid jobs are less readily available; and
- provision of training for more deprived communities, especially those previously reliant on the coal industry

Alongside Welsh Government's work on the net zero skills agenda, other actors in Wales are currently prioritising green skills issues in parallel, including:

- the Green Industries Wales Hybrid Green Skills Council, which was launched in October 2021 with a focus on connecting organisations and individuals to highlight existing green skills-based projects, ventures and schemes across Wales identifying collective challenges and opportunities and exploring areas for knowledge share and collaboration;[20] and
- representatives of the renewable energy industry sector, who are launching a network on skills development to support a Net Zero Wales.[21]

[19] For example, it would be important to link work on net zero skills to developments such as the Wales Infrastructure Investment Plan, the Digital Strategy for Wales, the new Wales innovation strategy, and proposals such as Unnos, a Welsh national construction company, and Ynni Cymru, a publicly-owned energy company for Wales.
[20] https://www.nptcgroup.ac.uk/2021/10/08/why-addressing-the-need-for-green-skills-in-wales-is-imperative/; https://businessnewswales.com/green-skills-council-the-first-step-for-green-action/
[21] https://tocyn.cymru/en/event/a5242887-94b4-4feb-8463-990be657ee08

Following on from the TRACER WP 4 meeting in December 2021, stakeholders in Wales have been meeting regularly to further discuss the skills issues raised, recognising both the potential to pursue future funding opportunities, and also identifying a sense of urgency and need for immediate joint action on common issues.

Swansea University is currently developing the SWITCH-On Skills project, which builds on their 'triangle of training' to develop a demand-led multi-level training academy to support transition to net zero in the industrial, transport, buildings, homes and communities sectors in Wales (see Figure 9.14). SWITCH-On Skills will work in partnership with HE/FE and industry to provide the skills required for low carbon living, skills pipelines, upskilling and retraining. This may provide another forum for discussing and promoting the green skills agenda (including reskilling and upskilling) within Wales.

Figure 9.14: Swansea University's SWITCH-On Skills project

Source: Swansea University SWITCH-On Skills project

It is clear that there is motivation within Wales to address the skills needs of energy transition, including reskilling and upskilling needs. However, to do this at the pace needed is extremely challenging, especially as some major decisions have yet to be taken at UK and Wales levels about the decarbonisation and energy transition pathways. At the same time, Wales and the UK are dealing with important contextual changes such as Covid and Brexit, where the long-term impact on relevant factors such as population, migration, employment and economic activity are not yet clear.

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