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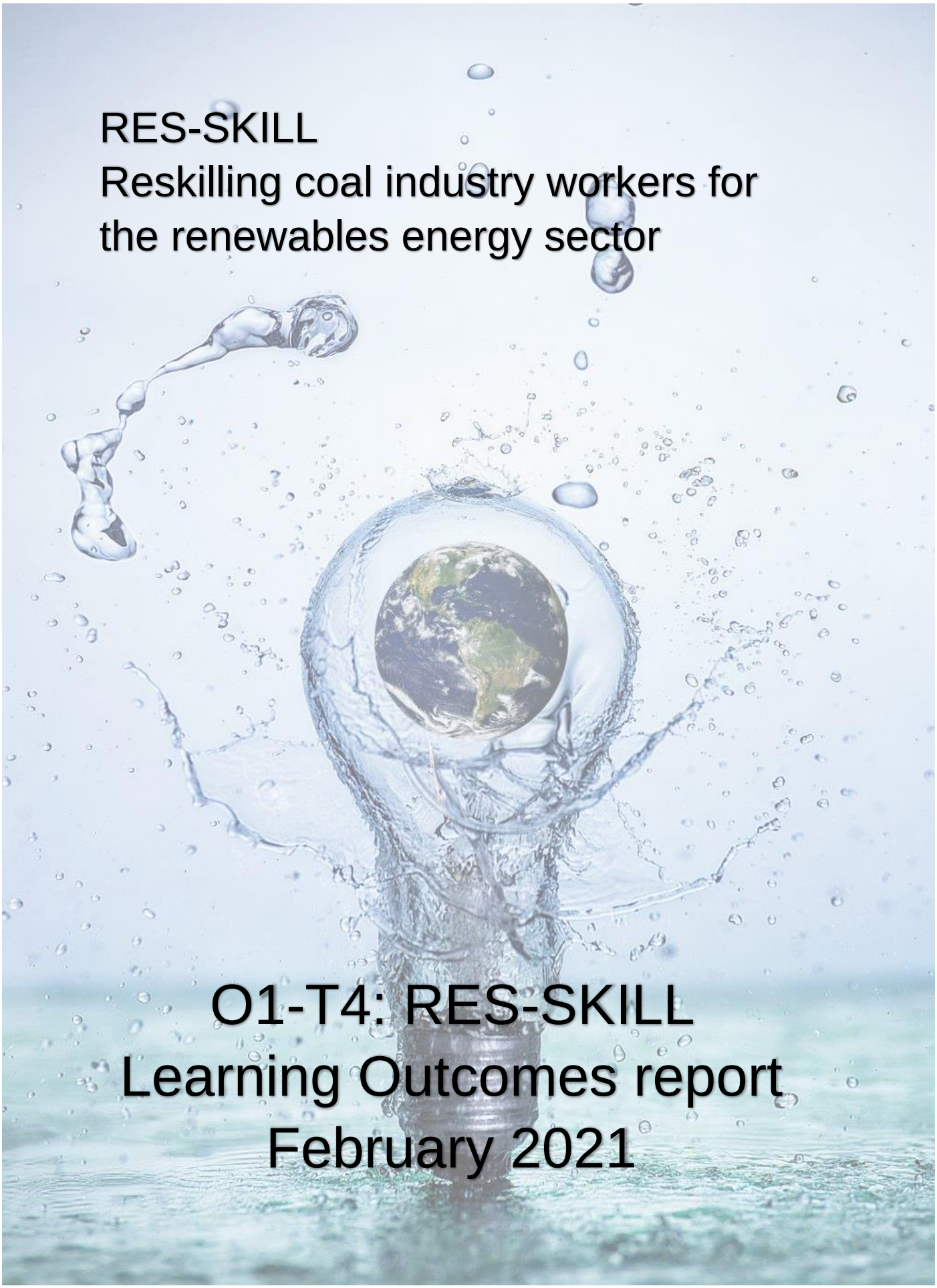
RES-SKILL

Reskilling coal industry workers for the renewables energy sector



O1-T4: RES-SKILL Learning Outcomes report

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Contents

Abbreviations

HVAC	Heating, ventilation, and air conditioning
RES	Renewable Energy Sources
VET	Vocational Educational Training
MW	Megawatt
GW	Gigawatt
OECD	Organisation for Economic Co-operation and Development
EU	European Union
PV	Photovoltaic
EQF	European Qualifications Framework
SCC	Sicherheits Certifikat Contraktoren (Safety, Health and Environment) also known as VCA in the Netherlands
ECVET	European Credit system for Vocational Education and Training
OHS	Occupational health and safety

RES-SKILL Partners

PROMEA	HELLENIC SOCIETY FOR THE PROMOTION OF RESEARCH AND DEVELOPMENT METHODOLOGIES ASTIKI ETAIRIA
BFI	Berufsförderungsinstitut Burgenland
LTT	LICEUL TEHNOLOGIC TICLENI
RENAC	RENEWABLES ACADEMY (RENAC) AG
MEERI	INSTYTUT GOSPODARKI SUROWCAMI MINERALNYMI I ENERGIA PAN
SZREDA	AGENTSIYA ZA REGIONALNO IKONOMICHESKO RAZVITIE

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1 Introduction

Coal-fired power plants produced almost 36.4% of global electricity 2019 (BP, 2020). The global operating coal generation capacity was 2,015 GW in 2019. There are currently 78 countries worldwide using coal power. For the 6 coal-intensive partner countries in the RES SKILL project (Greece, Germany, Austria, Romania, Bulgaria, Poland), the European Beyond Coal database (Reitz, 2021) observed the following coal power plant capacities:

Table 1: Coal capacity (in MW) in partner countries

	Coal capacity (in MW), as of 25 January 2021
Austria (AT)	246
Bulgaria (BG)	5.039
Germany (DE)	46.331
Greece (GR)	3.775
Poland (PL)	30.412
Romania (RO)	4.955

Coal (hard coal and lignite) is a carbon intensive energy source and a leading contributor to climate change. The burning of coal creates huge amounts of greenhouse gases and other toxic pollutants such as mercury, creating massive negative health impacts for populations living in the vicinity of coal power plants. Due to these negative climatic, environmental, social and economic impacts, the decline of hard coal and lignite on a global scale is inevitable in order to meet the international commitments of the Paris climate agreements from 2015, that aimed at limiting global warming well below 2° by end of this century against pre-industrial levels. To comply to the Paris Agreement, analysis shows that coal phase-out is needed by no later than 2030 in the OECD and EU-28, and by no later than 2050 in the rest of the world.

More and more countries thus consider to reduce the use of coal in their economies and the respective electricity mix. The accelerated withdrawal from lignite may have positive impacts and side effects such as:

- the shift away from lignite can significantly reduce CO_2 emissions,
- reduction of local air pollution levels and induced health issues,
- reduction of negative local environmental externalities such as water pollution,
- reduced need for costly coal and or electricity imports to a country and
- diminish expenditure for fossil fuel imports.

On the other side the transition away from coal creates issues that need to be carefully considered and addressed, such as:

- the need to maintain security of supply,
- smart replacement of coal power capacities with other sources of energy,
- the need to plan the closure of coal mines and its supporting infrastructure and
- the loss of jobs in regions sometimes heavily dependent on coal.

Coal jobs are expected to face a sharp decline in the coming years. The decarbonization of the EU-27 is expected to result in the loss of approximately 76.000 workers' jobs in coal mines

& plants until 2025 and up to 154.000 until 2030. Partnership countries (GR, DE, AT, RO, BG, PL) will be particularly affected, currently representing 81% of the total EU coal workforce (190k). Mitigating such negative social consequences requires a plan or a strategy. The just phase-out of hard coal and lignite mining successfully, requires a strategic alignment on national and regional level.

The expansion of renewable energy sources has created new markets and employment opportunities. EurObserv'ER (2020) - an EU funded market research project - has quantified renewable energy employment in the EU-28 at 1.51 million full time equivalent direct and indirect jobs in 2018 (EurObserv'ER, 2020). The surge of jobs in the Renewable Energy Sources (RES) sector is already happening and expected to continue and perhaps even more in the face of the announced European Green Deal, and the ambition to decarbonize the EU economies or the establishment of a hydrogen infrastructure and growing power demand by electric mobility. In other words, the renewable energy economy shows the potential to create more jobs than are projected to be lost in the European coal sector.

The skills and qualifications of coal miners or other jobs in the coal industry do not necessarily match the requirements of the RE sector. But put the other way round, some skills already present in the everyday work of coal industry employees, might fit quite well with some job profiles of emerging RE and new energy technologies, primarily in electrical engineering, mechanical tasks or beyond. It is the core ambition of this project to match the traditional coal skills with that of the emerging renewable energy world and identify potential gaps in re-skilling workers to enable them to participate in the structural change of the energy sector.

1.1 About this document

This document is a report of the analysis of the present coal workers skills against the skills available and required for blue collar jobs in the renewable energy sector particularly in the photovoltaic and wind industry. It brings out the complementarities and discrepancies between between coal workers and RES sector occupations through an analysis of present coal workers skillsets, the RES sector occupational requirement, and existing-related VET training offering. From the results of the analysis, this document reveals trends in skills supply and highlights imbalances in the labour market. To fill this gap, learning units with defined learning outcomes are recommended for former coal workers who want to be integrated into the RES sector.

1.2 The first output of RES-SKILL: Output 1 (O1)

The first output of the project "Reskilling coal industry workers for the renewables energy sector" comprises learning outcomes on RES sector skills, specifically addressed to coal workers. The output defines what learners (coal workers) should know, understand, and be able to do upon successful completion of the RES-SKILL course. The elaboration of the RES-SKILL learning outcomes is based on research on the current skillset of blue-collar occupations in the coal industry and the current and future training needs of the RES industry, as emerging from new environmental legislation (e.g., Renewable Energy Directive) and changing employers' expectations.

1.3 Objective

The primary objective of this output is to make available up-to-date, tailor-suited to occupational needs, RES learning outcomes for coal workers, appropriate for integration into RES sector VET provision. The formulation of evidence-based learning outcomes will support the development of a course curriculum with a structure of different modules, suitable to be embedded into existing VET provision for RES industry occupations in the 6 partnership countries (GR, DE, RO, AT, BG, PL). As such, VET providers and employers will be able to adopt and/or adapt the RES-SKILL modular programme either as a whole or partially, thus enriching their training provision for (former) coal workers that would need to reskill themselves through participation in continuous VET.

2 Data collection methodology

The research aimed to respond to the following questions:

1. Which are the current (technical and non-technical) skills of coal workers that have been acquired through formal, informal, and non-formal learning[1] (e.g., on-the-job training, experience)?
2. What are the current and future training needs of blue-collar workers and technicians in the RES industry, arising from the growing markets (e.g., of solar PV and wind) and the widespread diffusion of clean energy technologies?
3. What are the complementarities between coal workers' skills and RES industry occupations?
4. What are the knowledge and skills required by coal workers to increase their re-employability in the RES industry following the (permanent) shutdown of coal-driven activities?
5. How tailored to the specific needs of coal workers wishing to make the transition to RES sector jobs is the current supply of VET training offerings?

Data was collected using a combination of a survey and desk research.

2.1 Survey (assessing coal worker's current skills)

An assessment methodology designed by PROMEA and approved by all partners was used to collect data on the current skill set of coal workers as well as the skills that they will need to improve their employability in the RES sector in relevant job positions. A structured survey questionnaire (Annexes) was the main tool used to collect expert opinions. A web-based approach was employed for reasons of practicality and to facilitate the coding and analysis processes.

The survey questionnaire comprised mostly closed-ended questions as they are easier and quicker for respondents to answer and they offer better coding, analysis and comparison

[1] Formal education is linked with schools and training institutions; non-formal with community groups and other organisations; and informal covers what is left, e.g., interactions with friends, family and work colleagues.

possibilities. Open questions were included to obtain data on points that may have been omitted by the close-ended questions.

To ensure consistency and facilitate data analysis, the questionnaire was developed in English. Where feasible, and in cases where communication can only be established in national language(s), project partners translated both the questionnaire and responses (in case of additional comments, communication etc.). Each of the six partners shared the link with the identified target group so as to garner enough responses. The target group for the survey were:

- Employers in the coal & RES sector
- VET providers offering courses for coal workers & in the renewable energy sector
- Senior managers and employees from the renewable energy sector
- Heads of trainer departments and workplace trainers for renewable energy applications (e.g., wind and solar PV)
- Social partners, sector representatives and coal workers' representatives (e.g., members of professional associations)
- Field experts, academics, and researchers.

2.2 Desk research (assessing skill demand)

Desk research was carried out by each partner to collect information on the in-demand RES sector skills in relation and against the current coal worker's skill set (blue collar, low-skilled, technical jobs) and their supply in the partnership countries' VET education. The purpose was to supplement the evidence gathered through the survey and, additionally, identify trends in skill supply. It helped to define the level of skills needed by the RES labour market, compare it with the coal workers' existing skill set so as to determine the skills mismatches and complementarities. It focussed on:

1. RES sector workplace/skills requirements for blue collar / technical workers; data was collected from sources such as online/offline job vacancies, studies of skill authorities and awarding bodies.
2. RES-related (re)training programmes for low-skilled / technical / blue collar jobs; data was collected from sources such as vocational and online course directories, academic journals and publications, study guides, learning materials, college brochures.

A common approach was employed for documenting information gathered using a designed reporting forms (Annex 2).

3 Results of the questionnaire and the desktop research

All partners identified respective institutions and individuals and contacted them either by email, phone, or a combination of both. The online survey was accessible to these persons between 01.11.2020 and 15.01.2021. During this period, total of 150 responses were collected from persons active either in the coal or in the RES sector. The country breakdown of 150 respondents is in Table 2.

Table 2: Number of responses per country

Country	Questionnaire responses	VET offering	Relevant job offering
Greece	22	5	6
Austria	20	5	9
Romania	30	6	4
Germany	27	15	11
Bulgaria	15	5	6
Poland	30	5	5
Other *	6		
Total	**150**	**41**	**41**

*(UK, Zambia, Abu Dhabi, Mexico, Iran) and not known

70% of these persons have more than 8 years of professional experience in their indicated sector. These persons gave their assessment and opinion on the present coal workers knowledge level, technical skills, and non-technical/soft skills in different indicated areas.

Each partner equally identified at least 5 VET training offerings addressed to or including coal workers, and 5-10 job descriptions/vacancies on blue collar jobs in the RES industry. A total of 41 jobs advertisements for position in the RES sector and 41 VET training offered in all six partner countries was considered.

4 Result analysis and reporting

The first part of this result analysis points out the skills that present coal workers have that are similar to those of individuals in the blue-collar occupation of RES sector while the second part looks at the differences and what additional training coal workers might require to do jobs in the RES sector. The third part then looks into RES sector occupational needs both from the demand (job vacancies) and the supply end (VET trainings)

4.1 Complementarities between coal workers skills and RES sector blue collar occupation

4.1.1 Coal workers knowledge level

Coal workers are already trained or have gained experience in certain fields. The survey respondents indicated their opinion on the knowledge level of coal workers in the following work areas:

- **Mechanics** - machines and tools, including their design, uses, repair and maintenance.
- **Computers and Electronics** - circuit boards, processors, chips, electronic equipment. and computer hardware and software, including applications and basic programming.
- **Building and Construction** - materials, methods, and the tools involved in the construction or repair of various infrastructures.
- **Public Safety and Security** - relevant equipment, policies, procedures, and strategies for the protection of people, property, and institutions.

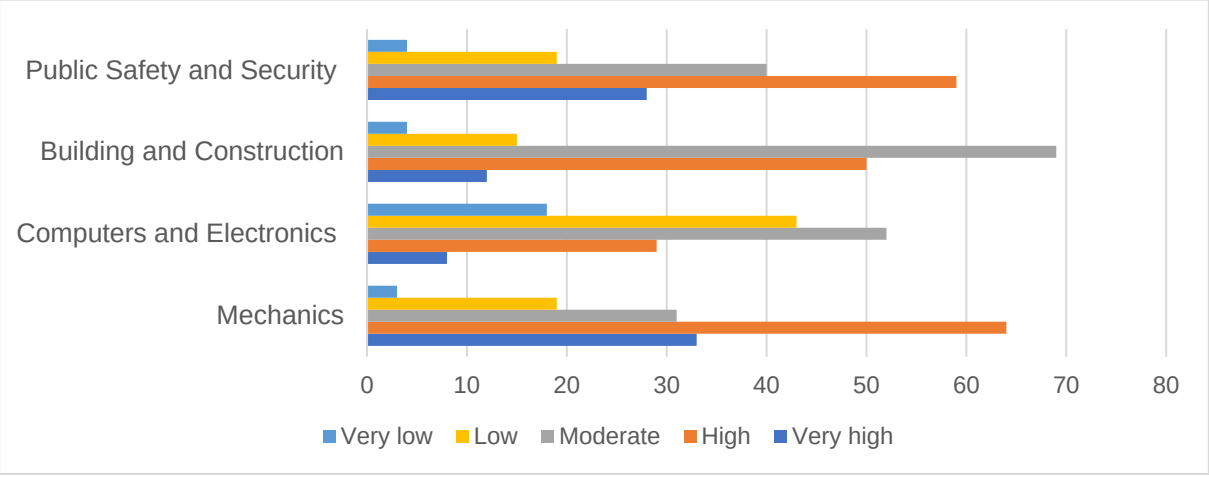

Figure 1: Coal workers knowledge level

Around two thirds of the survey respondents indicated that coal workers have a very high to high knowledge in mechanics as well as public safety and security. In contrast, coal workers are ranked high to moderately knowledgeable in building and construction and over 70% of respondents assume that computer and electronics knowledge are moderate, low or very low among the present coal workers suggesting that some additional skills in **computer and electronics** are wishful.

➔ **Conclusion**: Coal workers can provide the RES sector with some knowledge in mechanics, building and construction, and public safety and security.
➔ The identified training/re-skilling need for coal workers: computer and electronics.

4.1.2 Coal workers technical skills

The 150 respondents of the questionnaire indicated their estimation on the existing technical skills of coal workers according to the following aspects:

- **Operation and Control** - controlling operations of equipment and/or systems (e.g., drilling)
- **Operation Monitoring** - watching gauges, dials, or other indicators to make sure a machine is working properly
- **Quality Control Analysis** - conducting tests and inspections of products, services, or processes to evaluate quality or performance
- **Equipment Selection** - determining the kind of tools and equipment needed to do a job
- **Systems Evaluation** - identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system
- **Equipment Maintenance** - performing routine maintenance on equipment and determining when and what kind of maintenance is needed
- **Repairing** - repairing machines or systems using the needed tools

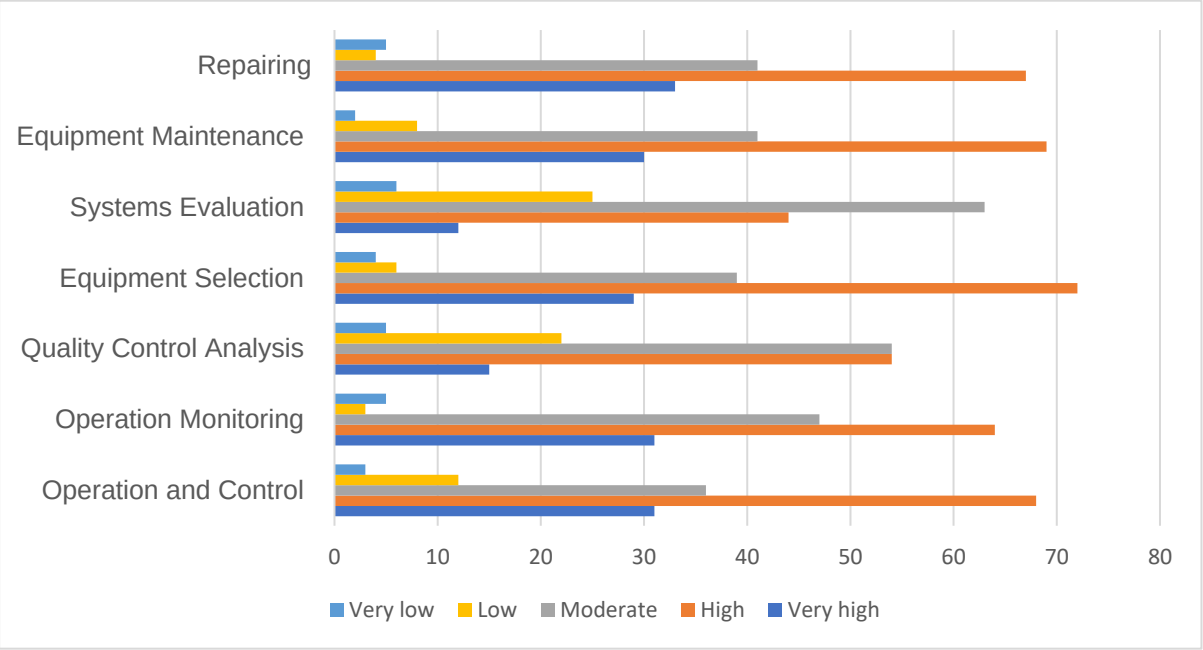

Figure 2: Technical skills of coal workers

More than 60% of these 150 survey participants believe that coal workers have high or very high technical skills in repairing, equipment selection /maintenance and operation monitoring / control. The questionnaire responses also bring out the fact that coal workers have moderate, low or very low skills in **system evaluation and quality control analysis** and as such need

further training respectively on identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system and conducting tests, inspections of products, services, or processes to evaluate quality or performance so as to be integrated in the RES sector.

- ➔ **Conclusion**: Coal workers can supply the RES sector with some technical skills in repairing, equipment maintenance, equipment selection, operation monitoring, operation and control.
- ➔ Identified training/re-skilling need for coal workers: system evaluation, quality control analysis,

4.1.3 Coal workers non-technical/soft skills

In addition to their technical skills sets, coal workers are expected to also possess a set of non-technical soft skills. Questionnaire respondents gave their opinion with regards to:

- **Practical thinking** - using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems
- **Troubleshooting** - determining causes of operating errors and deciding what to do about it
- **Spatial awareness** - being aware of others' reactions in relation to their environment and understanding why they react as they do
- **Coordination** - adjusting actions in relation to others' actions
- **Judgment and Decision Making** - considering the relative costs and benefits of potential actions to choose the most appropriate one
- **Instructing** - teaching others how to perform routine tasks
- **Dependability** - are reliable, responsible, and dependable, fulfilling obligations
- **Adaptability** - are open to change (positive or negative) and to considerable variety in the workplace
- **Persistence** - are persistent in the face of obstacles
- **Stress tolerance** - dealing calmly and effectively with high stress situations
- **Concern for others** - are sensitive to others' needs and wellbeing and are understanding and helpful on the job

The respondents' assessment summarised in Figure 3 indicates that coal workers presently possess very high or high dependable and persistent skills according to > 60% of respondents. These workers are also moderately good at instructing, troubleshooting or practical thinking. 20 to 30% of respondent indicated that coal workers do only have a relatively low level of skills relating to **adaptability and spatial awareness**.

- ➔ **Conclusion:** Coal workers cam work under stress conditions. They are highly dependable and have concern for other.
- ➔ Identified training/re-skilling need for coal workers: Need to increase spatial awareness and adaptability to new situations (rather psychological consulting than actual "training" measures).

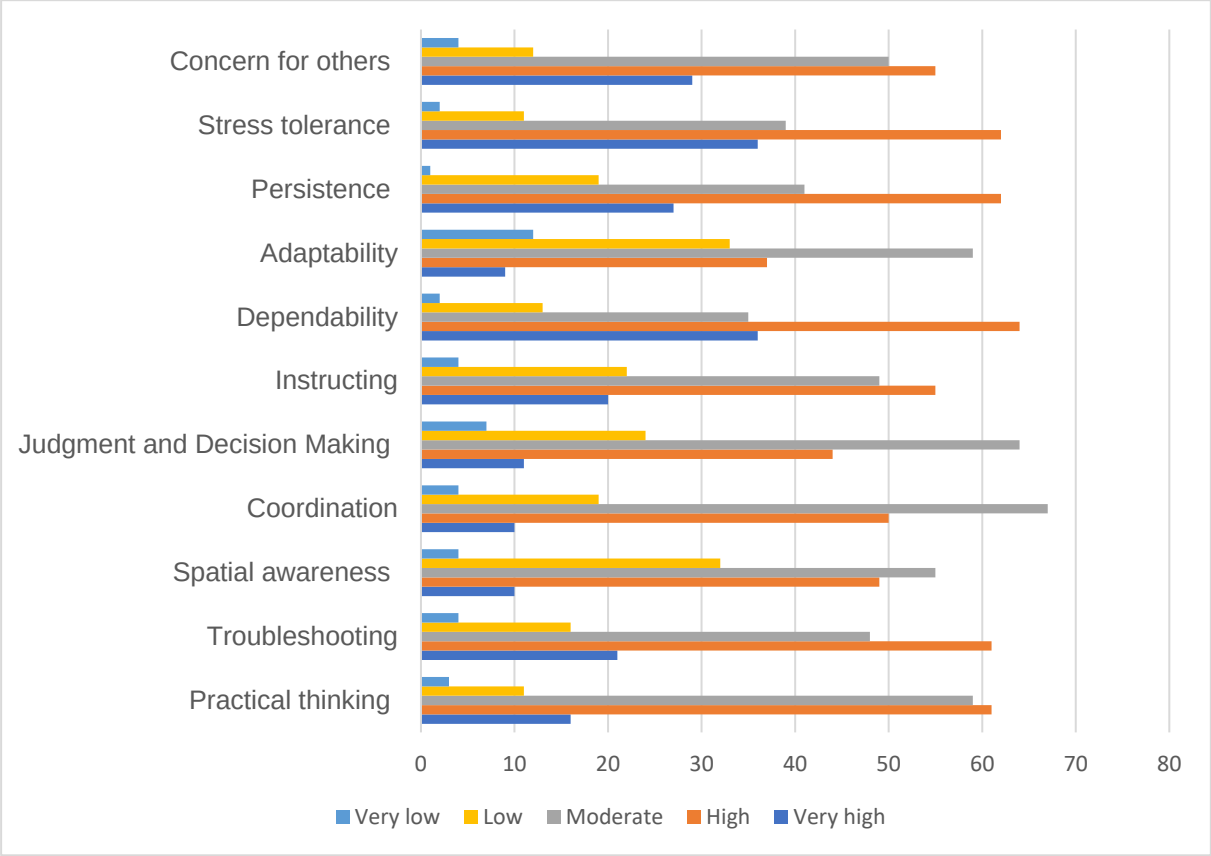

Figure 3: Non-technical skills of present coal workers

4.2 Discrepancies between coal workers skills and RES sector blue collar occupation

Whereas there are different set of skills required for coal and renewable energy industry workers, there are certain overlaps that might be identified in the respective job profiles. In the quest to identify these discrepancies, the 150 respondents gave their opinion on the knowledge, technical skills and non-technical skills possessed by the coals workers in which they might need additional training so as to carry out blue collar occupations in the RES sector.

4.2.1 Additional training needs on present knowledge

The focus on the type of knowledge discrepancies was on:

- **Mechanics** - machines and tools, including their designs, uses, repair, and maintenance
- **Computers and Electronics** - circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and basic programming
- **Physics** - physical principles, laws, their interrelationships, and applications to understanding material and atmospheric dynamics, and mechanical, electrical structures and processes
- **Building and Construction** - materials, methods, and the tools involved in the construction or repair of various infrastructures

- **Design** - design techniques, tools, and principals involved in production of precision technical plans, blueprints, drawings, and models
- **Education and Training** - principles and methods for teaching and instruction for individuals and groups, and the measurement of training effects
- **Mathematics** - arithmetic, algebra, geometry, calculus, and their applications
- **Public Safety and Security** - relevant equipment, policies, procedures, and strategies for the protection of people, property, and institutions

Figure 4: Additional Knowledge needs for coal workers

As indicated in Figure 4, the need for increased or extensive training was most pronounced in the computer and electronics section with over 70 % of respondents indicating that. Further training needs are required for design, education and training, and physics - all ranking beyond the 50% threshold.

➔ **Conclusion**: Identified training/re-skilling need for coal workers: Computer and electronics, so too do design skills need to be enhanced. This coincides well with the skill assessment above (4.1.1) which indicated that the coal workers have less knowledge in computer and electronics.

4.2.2 The need to acquire technical skills

The different technical skills required in the RES sector, on which the questions of additional training needs were based consisted of:

- **Operation and Control** - controlling operations of equipment and/or systems
- **Operation Monitoring** - watching gauges, dials, or other indicators to make sure a machine is working properly
- **Quality Control Analysis** - conducting tests and inspections of products, services, or processes to evaluate quality or performance

- **Equipment Selection** - determining the kind of tools and equipment needed to do a job
- **Systems Evaluation** - identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system
- **Systems Analysis** - determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes
- **Equipment Maintenance** - performing routine maintenance on equipment and determining when and what kind of maintenance is needed
- **Repairing** - repairing machines or systems using the needed tools

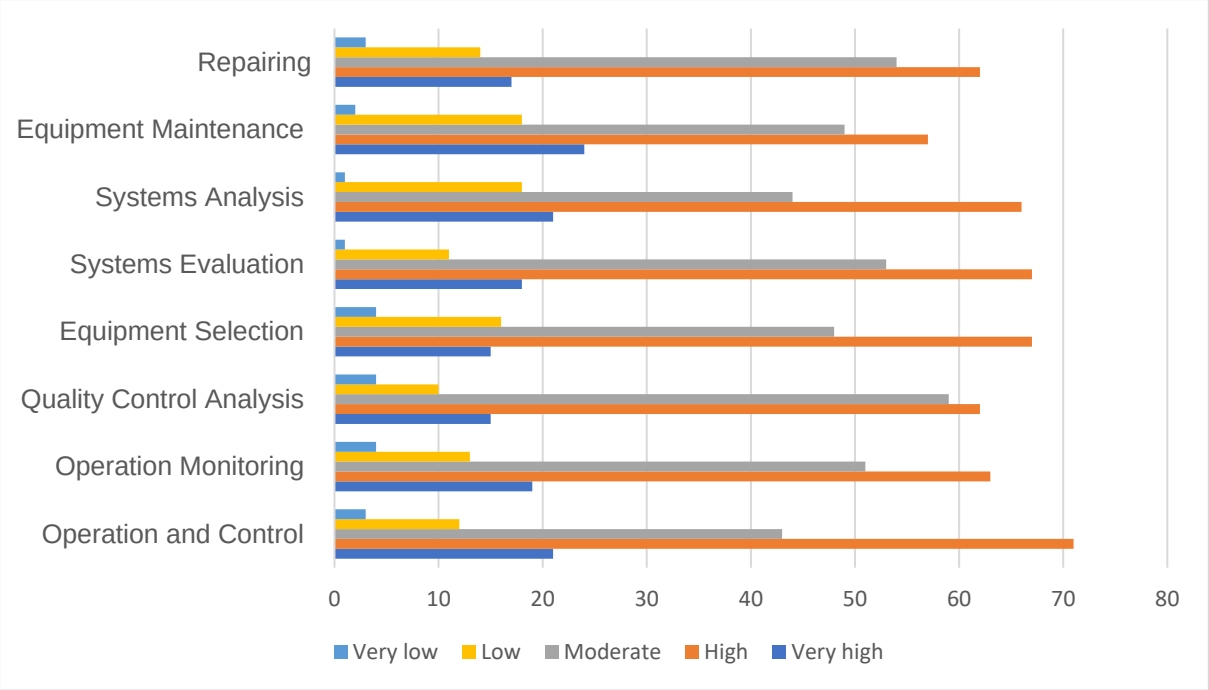

Figure 5: Additional technical training needs

More than 50% of the respondent (Figure 5) indicated that coal workers do have either a high or moderate level of training needs in all the above sectors given that the RES sector has a completely different technology. They do already have some of these basic skills but do need to acquire these special ones in order to increase the chances of switching to blue collar/technical jobs in the renewable energy sector.

➔ **Conclusion**: Identified training/re-skilling need for coal workers indicate that RE-skilling training measures must focus on technical skills in equipment maintenance, operation and control, system analysis and system evaluation and to a lesser extent on quality control analysis.

4.2.3 The need to acquire non-technical skills

The responses received from the 150 participants on the extent to which coal workers need to acquire non-technical skills, if they want to transition to blue collar/technical jobs in the renewable energy sector was according to the following areas:

- **Practical Thinking** - using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems
- **Troubleshooting** - determining causes of operating errors and deciding what to do about it
- **Spatial awareness** - being aware of others' reactions in relation to their environment and understanding why they react as they do
- **Coordination** - adjusting actions in relation to others' actions
- **Judgment and Decision Making** - considering the relative costs and benefits of potential actions to choose the most appropriate one
- **Instructing** - teaching others how to perform routine tasks
- **Dependability** - are reliable, responsible, and dependable, fulfilling obligations
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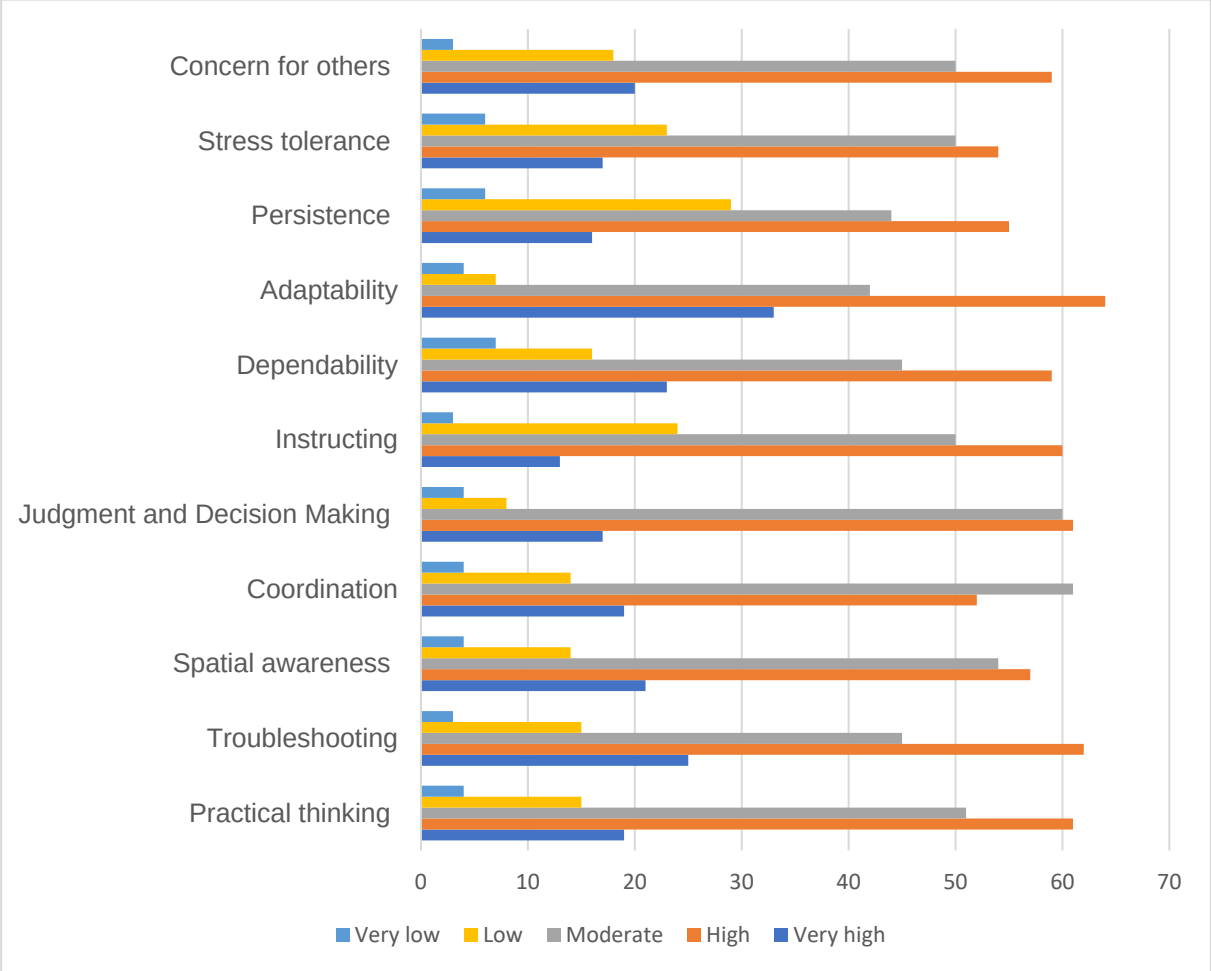

Figure 6: Additional training needs for non-technical skills

Whereas the technical skills mentioned above are rather straightforward, the soft skill development is a bit harder to grasp. For example, “using logic and reasoning to identify the strengths and weaknesses of alternative solutions” can be learned over a longer period of work but is also dependent on the natural endowment of individuals. However, according to the results seen in Figure 6, the three top most areas requiring very high to high trainings were **adaptability, troubleshooting and dependability**.

➔ **Conclusion**: Identified training/re-skilling non-technical skills for coal workers are exercises to determining causes of operating errors and deciding what to do about it to so as to increase troubleshooting capabilities. They also need to be reliable, responsible, and dependable, fulfilling obligations and open to change (positive or negative) and to considerable variety in the workplace.

4.3 RES sector occupational requirements (Skills demand)

To compliment information gained from the online survey, desk top research was used to assess what the RES sector presently requires in terms of knowledge, skills and competences. These was considered on two fronts – needs determined from job advertisements and supply determined from the available VET trainings in the RES sector.

4.3.1 RES sector needs identified from job advertisement

The RES sector needs were identified through 41 job advertisements collected from the renewable energy industry. 13 job types (Table 3) were identified from the 41 job advertisements according to the solar PV, wind and other RES sectors:

Table 3: Jobs identified and used in the study according to sector

Sector	Type of job
Solar / photovoltaics	• PV electrical engineer • PV electrician • PV fitter / installer • Project developer • PV operation and maintenance technician • Machinist road construction machinery (PV) • PV sales engineer
Wind	• Wind service technician
Others RE sector	• Technological engineer • Machine operator • Electric vehicles engineer • Installer HVAC system • Maintenance and repair electrician

Least qualification required for each position was European Qualification Framework (EQF)[2] 4 and must have completed compulsory education with some professional experience and a driver's license B. The following are the qualification identified through the desktop search:

- Completed secondary education or additional course - in the field of electrification
- Completed vocational training / apprenticeship or training (EQR 4)
    - as an electrician, electronics technician - energy and building technology, automation technology (trade),
    - in a technical / mechanical field,
    - as a mechatronics technician or a comparable qualification,
    - in electrical engineering or electrician with several years of experience,
    - as cutting machine operator with existing professional experience,
    - as an industrial mechanic or comparable SCC / VCA certificate desirable
- Second degree of professional qualification or higher
- Third degree of professional qualification

These required persons are to work on a full-time basis.

All 41 job advertisements considered in this study contained a description of what knowledge, skills and competences any applicant should have. As the 41 job advertisements were grouped into 13 RES types, so too were the demanded knowledge, skills and competences.

The results in Figure 7 indicated that, the knowledge least required for the execution of the 13 RES job types, is on education and training and public safety and security. Only one job type - project developer required persons to have this knowledge.

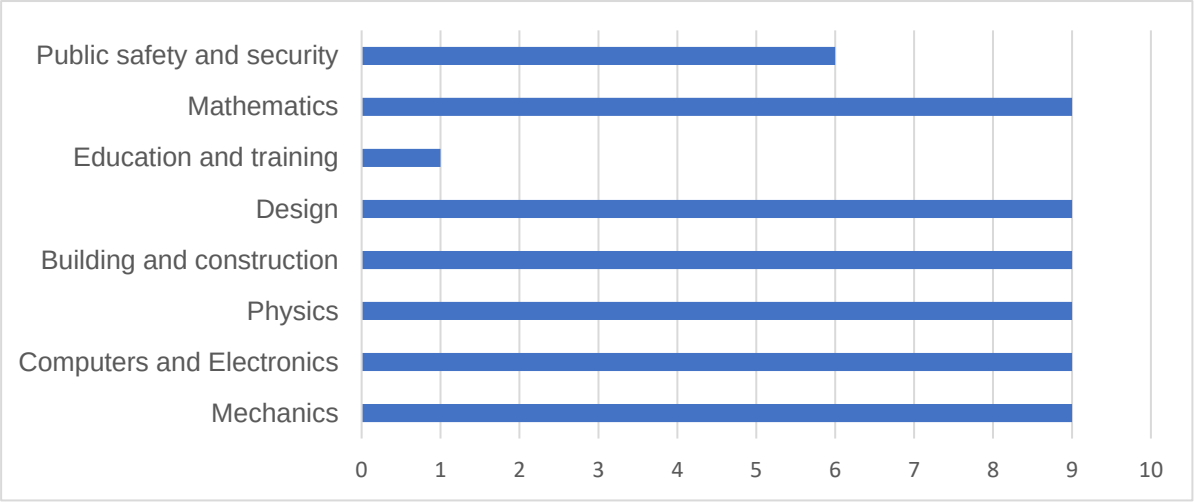

Figure 7: Knowledge required for RES jobs

[2] EQF is the common European reference framework, which connects countries' qualifications systems increasing the transparency of qualifications throughout Europe. It acts as a translation device to make national qualifications more readable and comparable across Europe, aiming to promote workers' and learners' mobility between countries and facilitate their lifelong learning.
EQF relates different countries' national qualifications systems and frameworks together around a common European reference – its eight reference levels based on "learning outcomes" (defined in terms of knowledge, skills and competences).

➔ **Conclusions**: RES demands knowledge in mechanics, computer and electronics, physics, building and construction, design, mathematics, public safety and security according to more that more than 50% of the job types identified.

For the technical-skills on demand in the RES sector all 13 job types demanded skills in:

- operation and control,
- operation monitoring,
- quality control analysis,
- equipment selection,
- systems evaluation,
- systems analysis,
- equipment maintenance,
- repairing

Therefore, there was no need for visualisation.

Within the job advertisement, the RES sector is in dire need for non-technical skills too (Figure 8). Of all categories considered within this study, the concern for others was the most needed skill sorted after. This was followed by coordination which entails the person being able to adjust actions in relation to others' actions. The least requires non-technical skills was on instructing others or teaching others how to perform routine tasks in which just 6 of the 13 job categories required that.

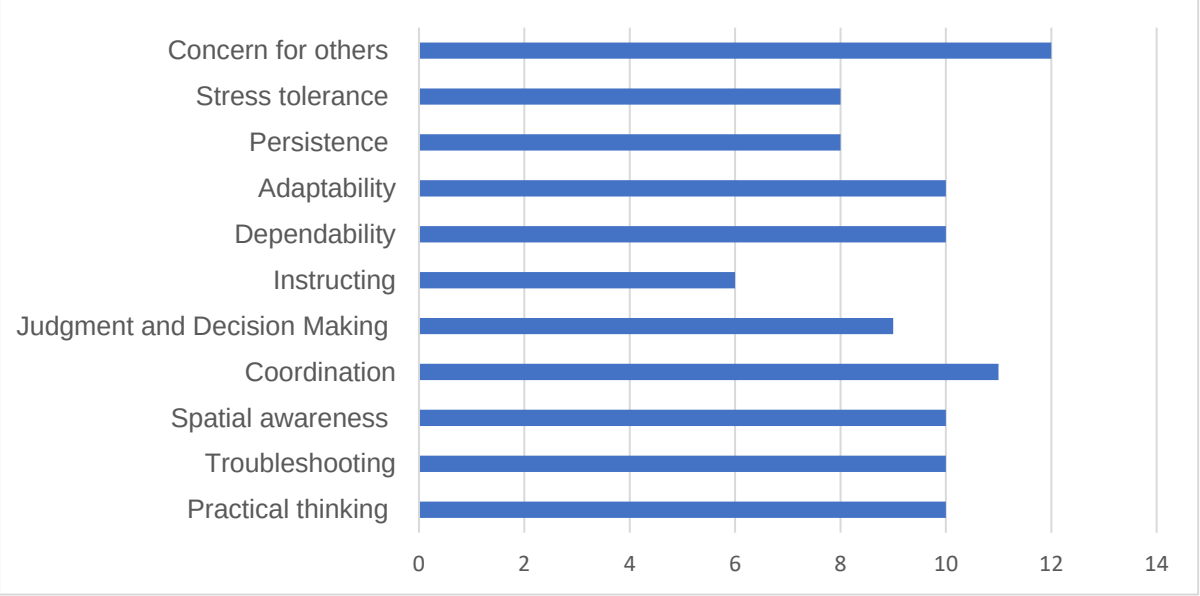

Figure 8: Non-technical skills required on the job

➔ **Conclusion**: For these skills which are usually not taught but gotten through life-long learning, all but instructing others is highly demand by the RES sector potential employers. Coordination skills is most important to hiring RE companies.

4.4 Existing RES related VET training offering (skill supply)

The skill supply to the RES sector is through VET with lots of experience on the job. Our desk study gathered information from 39 VET courses offered in all 6 partner countries. The results revealed that there are different types of training, ranging from short term training measures with a duration of a few days, right up to extensive training programmes of 3.5 years. Full-fledged educations enable trainees to carry out jobs as RES Installer, electrical engineer, PV system design, PV fitter / installer, solar thermal installer, PV electrician, electronic technician, network administrator or lab technician.

These persons are to come out with particular knowledge, technical skills as well as non-technical skills. The analysis of the input from these VET training offers indicates that after the training, the graduates have a lot of knowledge (Figure 9) in all cited aspects but for education and training.

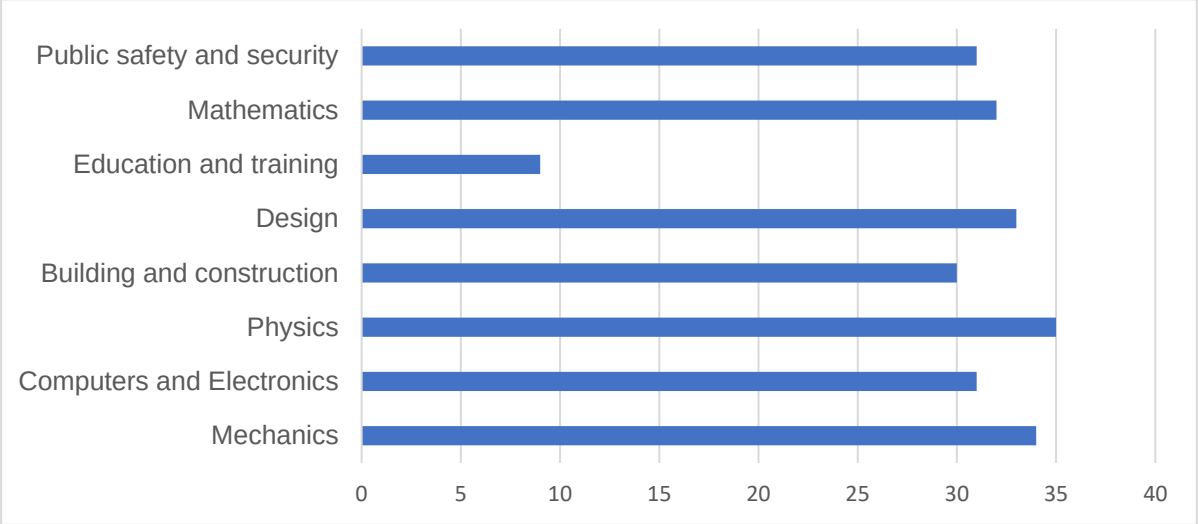

Figure 9: Knowledge covered within VET programmes

➔ **Conclusion**: RES vet training has little in their curriculum on education and training. They do not expect their graduates to be trainers in the field.

The programmes are designed in such a way that while impacting the participants with a lot of knowledge, they also acquire a lot of technical skills through practical training. Of the 39 courses considered within this study, the most technical skills (Figure 10) impacted on the graduates was on how to select equipment where they are to be able to determine the kind of tools and equipment needed to do a job. The was less focus on repairing.

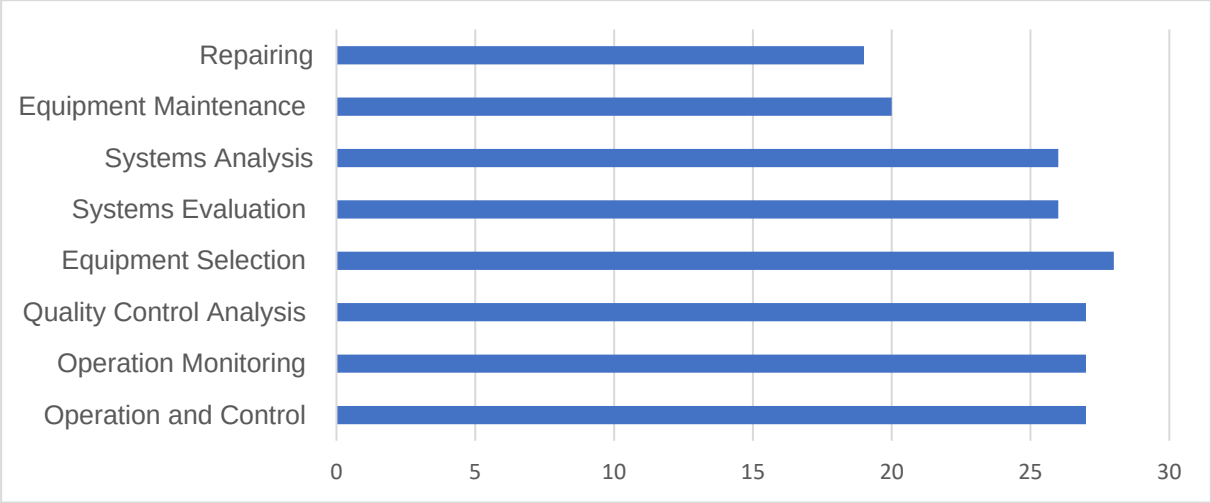

Figure 10: Technical skills supplied through VET trainings

➔ **Conclusion**: In all there is a moderate to high supply to the RES sector of persons with the above technical skills.

One thing which was glaring with nearly all the VET training offers analysed in this study, was the little or no presence of the citation of non-technical skills that the participants would acquire. Of course, it is understandable since most are acquired through life-long training on the job but some could still be impacted on the participants through the VET courses.

Less than 25% of the VET training offers (Figure 11) indicated the acquisition of non-technical skills through their trainings. With stress tolerant being absent from all.

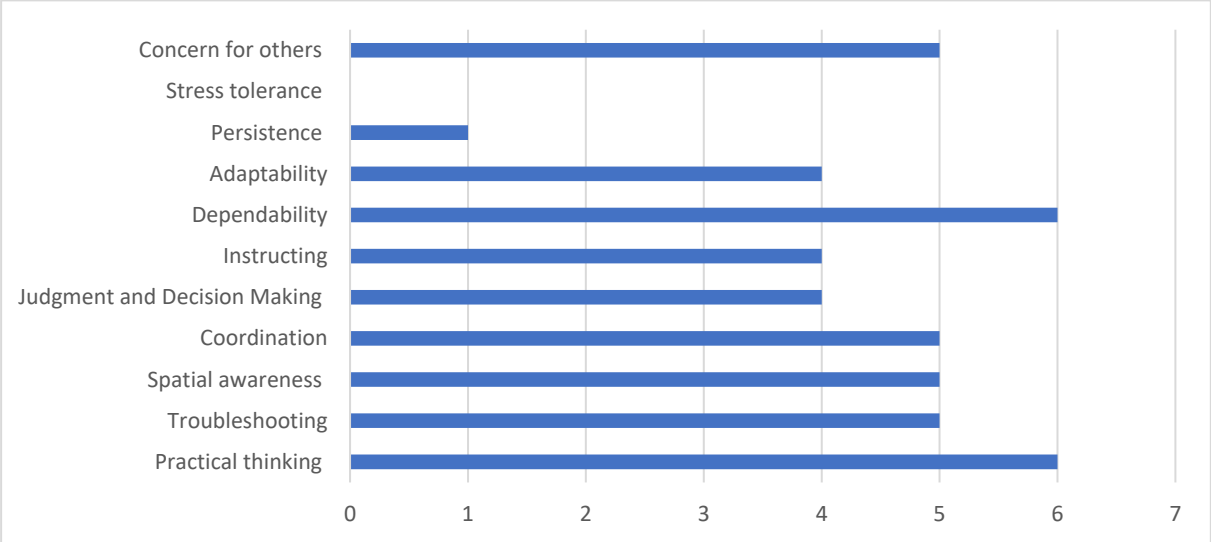

Figure 11 Non-technical skills supplied through VET trainings

➔ **Conclusion**: Though non-technical skills are seldom part of the VET trainings given their ambiguity on how to train persons on this, however, some such as trouble shooting, coordination, instructing can still be included more in the training curriculum.

5 The mismatch between demand and supply

From the above data and analysis of both the RES and the coal sector, skills are demanded and can be supplied. The skills demand is reflected on an overview of the skills needed in the RES labour market while the supply is reflected on a complete skill set that summarizes which skills coal workers already have and which they can gain from the current VET offerings. The sources for skill demand and supply are therefore as follows.

Demand	Supply
• Job vacancies identified in the desk research • Results indicating what additional training needs of coal workers (4.2)	• VET offerings identified in the desk research • The online survey results indicating the present skill set of coal workers (4.1)

The demand and supply of knowledge, technical and non-technical skills are compared to each other to see the mismatch. This equally support us to identify where there is a need for training. In the graphs below the following should be considered:

1= Very low demand or supply

2= Low demand or supply

3= Moderate demand or supply

4 = high demand or supply

5 = Very high demand or supply

5.1 Demand and supply of Knowledge

According to Figure 12,

- There is a high to very high demand for knowledge in all but for education and training.

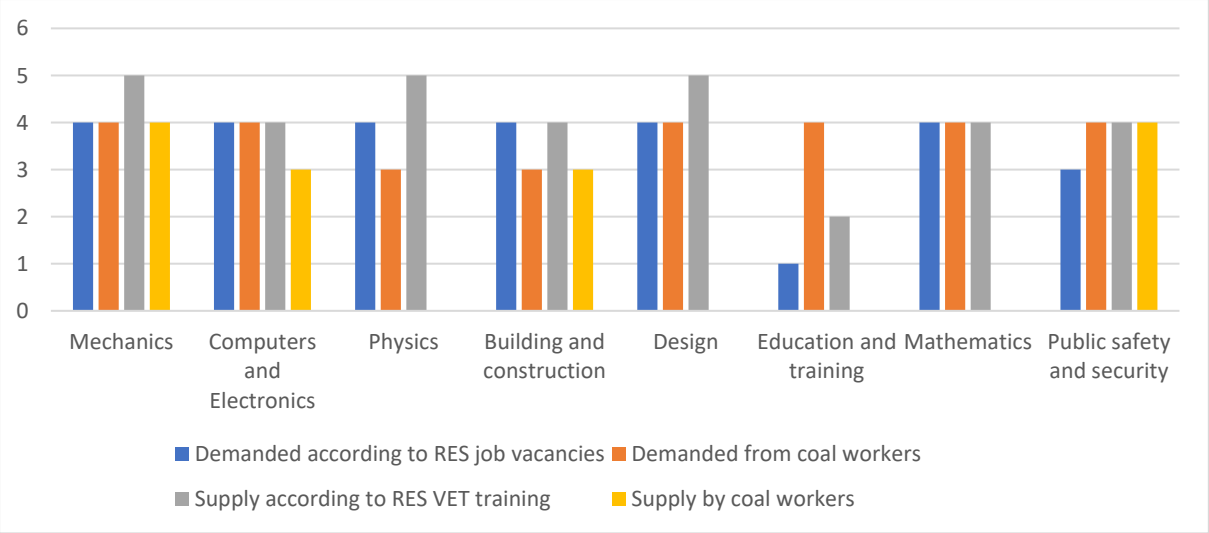

Figure 12: Comparison of demand and supply of knowledge

- The supply of the type of knowledge from the RES VET trainings is either more than or matches what is demanded on the job in the RES sector.
- There is equally a high to very high demand to train and re-train the coal workers too fit into the RES sector.
- Persons from the coal sector come with some knowledge in mechanics and public safety and security equal to the demand in the RES sector
- Coal sector workers can supply moderate to no knowledge on computer and electronics, physics, building and construction, design and mathematics as such need trainings on these themes.

5.2 Demand and supply of technical skills

Figure 13 looks at the mismatch in technical skills.

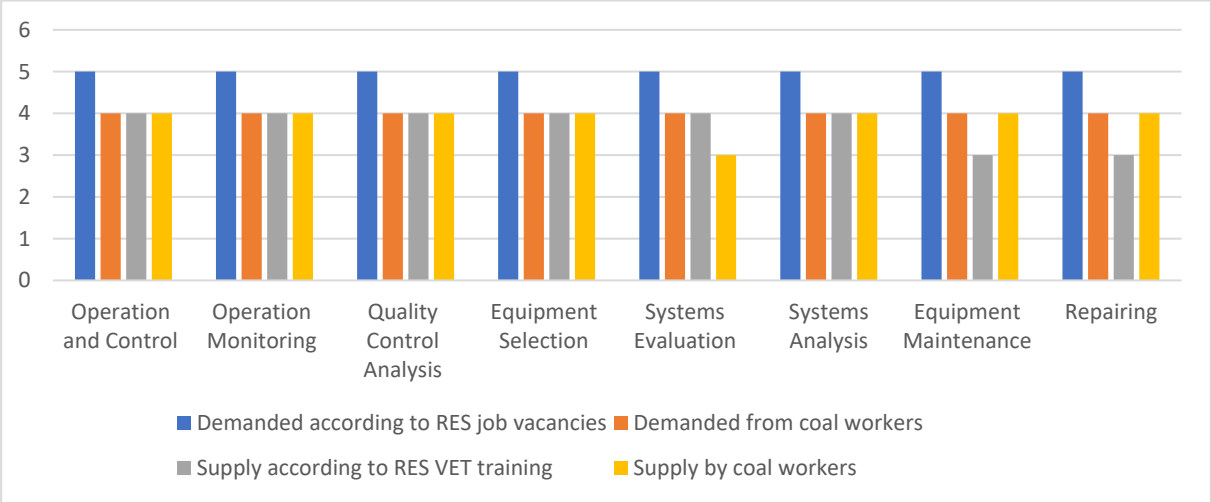

Figure 13: Comparison of demand and supply of technical skills

- Demand of the technical skills according to RES job vacancies is high as compared to the supply of these skills by the VET
- Though coal workers can supply these technical skills, they still need to have a high demand for RE technology specific trainings to fit into the RES sector.
- Skill supply from coal workers is moderate when it comes to system evaluation

5.3 Demand and supply of non-technical skills

On the other hand, a comparison of the non-technical skills can be seen in Figure 14.

- There is a high to very high demand for non-technical skills in the RES sector.
- RES VET cannot supply the sector with these skills as it stands at very low.
- The coal workers do have moderate to high level of non-technical skills which they can supply to the RES sector.
- The coal workers however highly need upskilling in all especially in the coordination where the mismatch is greatest.

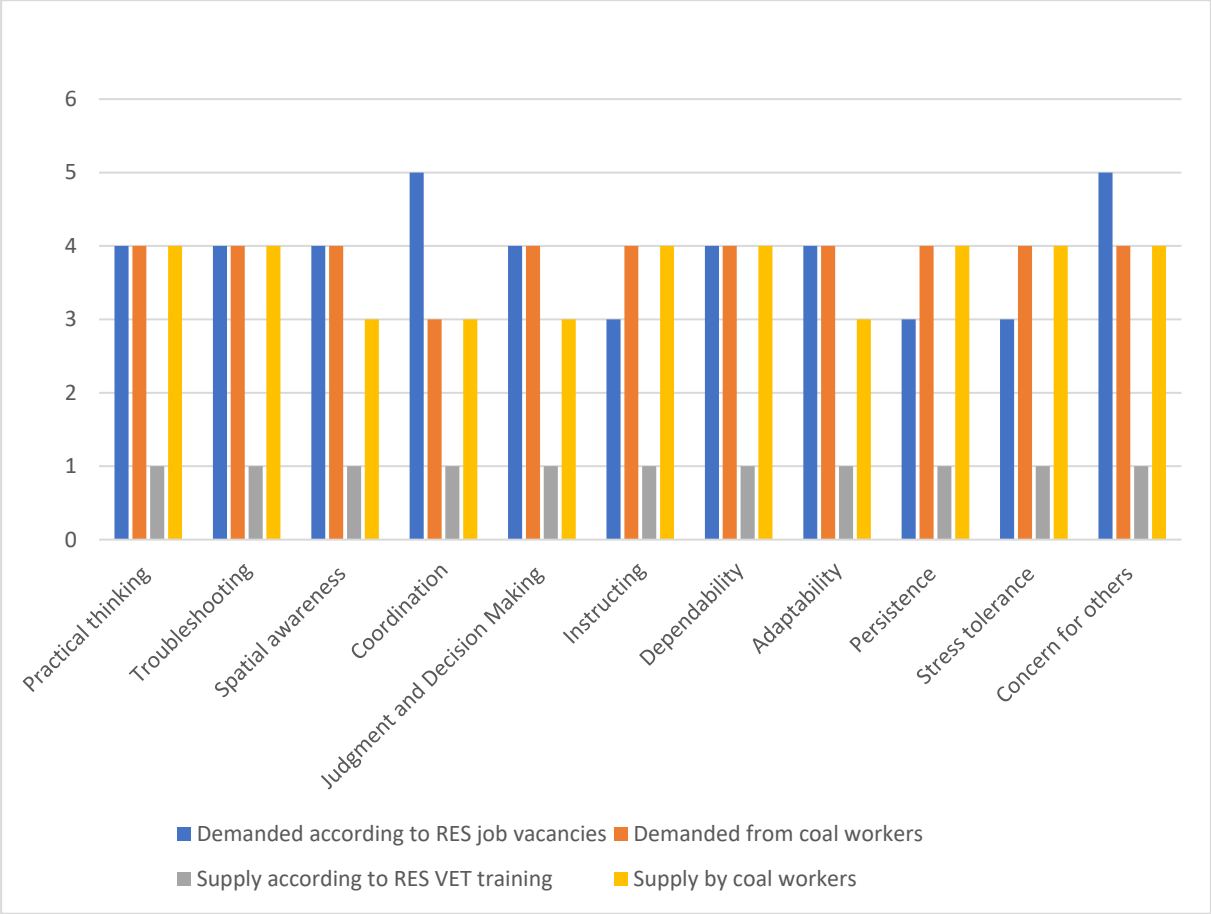

Figure 14: Comparison of demand and supply of non-technical skills

➔ **Conclusion**

- Coal workers need to acquire knowledge on the PV solar and wind technologies
- They need technology specific technical skills to these technologies
- Non-technical up-skilling is needed particularly for the most identified areas of troubleshooting, coordination and team building or concern for others.

6 Learning outcomes based on the European Qualifications Framework

From the analysis, it has been identified that for coal workers to gain employment in the RES sector, they would need knowledge, technical skills as well as non-technical up-skilling in RES particularly PV solar and wind technologies. These skills can be acquired from taking part in the right training that will provide them with theoretical and hands on practical knowledge.

Based on the evidence collected and analysed and following the instructions of the methodology report, learning outcomes have been defined for such future courses. These learning outcomes are mainly addressed to VET providers and RES sector employers that offer training opportunities.

This section of the report defines and presents the RES-SKILL learning outcomes, setting the foundations for an up-to-date course on RES-relevant skills for coal workers according to the European Qualification Framework (EQF).

This approach shifts the emphasis from input (type and duration of learning experience) to actual learning i.e., to what a person is able to do upon the completion of a learning process. By shifting the focus to learning outcomes, EQF manages to:

- Match the needs of the labour market with education and training offerings;
- Facilitate the transfer and use of qualifications across different countries and education and training systems;
- Enable the validation of non-formal and informal education;
- Transfer units of learning outcome, based on a credit system European Credit system for Vocational Education and Training (ECVET).

The development of national qualifications frameworks with descriptors based on learning outcomes is a step towards making qualifications and levels of learning explicit for all users. According to the EQF, "*learning outcome*" is defined as a statement of what a learner knows, understands and is able to do upon the completion of a learning process. They are described as follows:

- **Knowledge:** The outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices related to a field of work or study. According to the EQF, knowledge is described as theoretical and/or factual.
- **Skill:** The ability to apply knowledge and use know-how to accomplish tasks and resolve problems. According to the EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical skills (involving manual dexterity and the use of methods, material tools and instruments).
- **Competence:** The proven ability to use knowledge, skills and attitudes, in work in study situations and in professional and personal development. According to the EQF, competence is described in terms of responsibility and autonomy.

The following learning outcomes have been defined based on the evidence collected and analysed:

Table 4: Principal learning outcome developed from the evidence of the needs of the coal workers collected and analysed

Evidence shows that coal workers need:	**Principal learning outcome**	
	Solar Photovoltaic	**Wind energy**
to acquire knowledge on the PV solar and wind technologies	• Be able to describe using basic scientific knowledge how PV systems and their component's function. • Be able to appraise PV system design and assess the destined site.	• Be able to describe the most common wind energy systems, name its components and discuss its control systems. • Be able to describe the potential, resources and costs of wind energy.
technology specific technical skills to these technologies	• Be able to install civil and mechanical components of the solar photovoltaic systems. • Be able to install civil and mechanical components of the solar photovoltaic systems. • Be able to test and commission electrical components of photovoltaic systems.	• Be able to install mechanical and electric components of an onshore wind plants. • Be able to explain the electro-technical components and functions of a wind turbine and be able conduct maintenance operations in a professional manner.
Non-technical up-skilling particularly for the most identified areas of trouble shooting, coordination and team building or concern for others.	• Be able to follow and apply health and safety rules and regulations while working on PV systems • Be able to analyse a PV system, maintaining and troubleshoot it. • Be able to maintain and troubleshoot the installation of civil and mechanical components of the solar photovoltaic systems. • Be able to analyse a PV system and carrying out service and repair work.	• Be able to carry out basic mechanical operation and maintenance of wind turbines in excess of 1mw. • Be able to carry out basic electrical operation and maintenance of wind turbines in excess of 1mw. • Be able to carry out basic hydraulic operation and maintenance of wind turbines in excess of 1mw. • Be able to apply regulation and laws related to health, security and environment and risks when working on a wind turbine • Be able to apply systematic trouble shooting- and repair techniques in a safely manner.

To each principal learning outcome, is a corresponding learning unit with a title that is clear, comprehensible and reflects its content. To ensure compatibility with EQF standards, the RES-SKILL learning outcomes are described "holistically" in the context of a coherent description as a matrix, subdivided into individual elements of knowledge, skills and competence. This description mode is clearly structured as regards the subsequent assessment of learning outcomes and enables the comparison with the respective national curricula.

Below are the learning units for PV and wind technologies derived from the principal learning outcomes which came as a result of the data analysis.

6.1 Learning Outcome for Photovoltaics

Learning unit	**6.1.1 Occupational health and safety practice**		
Overall learning outcomes	Be able to follow and apply health and safety rules and regulations while working on PV systems.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- mechanical and electrical features necessary for the long life of the PV system under a wide range of operating conditions - dos and Don'ts of material handling and storage - do's and don'ts of DC wiring and installation of other electrical components - installation work on a PV power system in accordance with relevant standards and regulations - Occupational health and safety (OHS) standards and associated risks when working on that particular site - electrical work safety and health	- set up and maintain safe work procedure - apply appropriate workplace codes and standards concerning PV system, installation and operation - identify, select and use required tools and equipment safely and properly - identify safety hazards and mitigate them - apply safe and accepted practice for personnel and property protection	- follow organization rule-based decision-making process - take decision with systematic course of actions and/or response - use of electrical measuring devices and hand tools - plan and organize work to meet deadlines - manage relationships with customers with intent on satisfying its requirements for service delivery - choose best methods to complete assigned tasks - critically evaluate information obtained from customers, supervisor and co-workers to perform day to day activities

Learning unit	6.1.2 Understanding Solar Energy and PV Systems Basics		
Overall learning outcomes	Be able to describe using basic scientific knowledge of how PV systems and their component's function.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- definition of the terms: energy and power, cell, module, string, array, mono-crystalline, poly-crystalline, amorphous silicon - basics of Electricity - understanding Solar Energy concept - PV Systems Basics - Occupational health and safety (OHS) standards and associated risks when working on that particular site	- identify series, parallel and series/parallel circuits - calculate energy loads using Ohm's and Power Laws - define proper orientation and inclination of solar array - interpret the technical specifications and output characteristics of photovoltaic modules and components - properly use electric measuring instruments - read and understand manuals, health and safety instructions, memos, other company documents. - fill up documentation applicable to one's role - identify the various colour codes as per standard electrical, mechanical and civil nomenclature"	- follow organization rule-based decision-making process - take decision with systematic course of actions and/or response - work constructively and collaboratively with others - recognize problems and search for solutions. - choose best methods to complete assigned tasks - approach relevant authority when required - apply domain knowledge, observations and data to select course of action to perform tasks related to solar photovoltaic systems - Ask questions for better understanding

Learning unit	6.1.3 Understanding PV System Design and site survey		
Overall learning outcomes	Be able to appraise PV system design and assess the destined site		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- definition of the terms: energy and power, cell, module, string, array, mono-crystalline, poly-crystalline, amorphous silicon - basic concepts of trigonometry and coordinate geometry - irradiation and irradiance. - effect on array output of current and voltage based on connections, orientation and shading - power and energy received from solar radiation in a given area - efficiency, cost, specifications, functioning and operating principle of different types of available pv electrical components - mechanical and electrical features necessary for pv system - occupational health and safety (ohs) standards and associated risks when working on that particular site	- utilize drawings, schematics, instructions and recommended procedure in installing equipment - assemble equipment as specified by design - verify and confirm suitability of equipment and load - verify and confirm site conditions - identify and assess any site-specific safety hazards associated with the - installation of the system - determine, using field measurements and sun path diagram and shades	- communicate with supervisor - follow organization rule-based decision-making process - take decision with systematic course of actions and/or response - planning and organization of work to meet deadlines - manage relationships with customers with intent on satisfying their requirements for service delivery - recognise problems and search for solutions - choose best methods to complete assigned tasks - approach relevant authority when required - ask questions for better understanding

Learning unit	6.1.4 Installation of civil and mechanical components of PV system		
Overall learning outcomes	Be able to install civil and mechanical components of the Solar Photovoltaic systems.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- effect on array output based on connections of modules, tilt angle, orientation and shading - efficiency, cost, typical specifications, functioning and operating principle of different types of commercially available pv electrical components - mechanical and electrical features necessary for the long life of the pv system - material handling and storage - installation work on a pv power system in accordance with relevant standards and regulations - occupational health and safety (ohs) standards and associated risks when working on that particular site	- identify type of footing required - construct equipment foundation - install mounting system - install photovoltaic modules - install battery bank stand and inverter stand - determine the type of mounting structure required depending on the type of roof - determine the type of footing and fixtures required depending on the type of roof - determine whether any shading will occur and estimate its effect on the system. - determine the cabling route and estimate the length of cable required	- communicate with supervisor - follow organization rule-based decision-making process - take decision with systematic course of actions and/or response - planning and organization of work to meet deadlines - work constructively and collaboratively with others - follow code of conduct - manage relationships with customers with intent on satisfying their requirements for service delivery - recognize problems and search for solutions. - approach relevant authority when required - apply domain knowledge, observations and data to select course of action to perform tasks related to solar photovoltaic systems - ask questions for better understanding

Learning unit	**6.1.5 Installation of electrical PV Components**		
Overall learning outcomes	Be able to instal civil and mechanical components of the Solar Photovoltaic systems.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware Of:	**Skills** Able to:	**Competences** Able to:
	- effect on array output based on connections of modules, tilt angle, orientation and shading - efficiency, cost, typical specifications, functioning and operating principle of different types of available pv modules and electrical components - mechanical and electrical features necessary for the long life of the pv system - material handling and storage - effect of blocking and bypass diodes - dc wiring and installation of other electrical components - connection of the solar power plant - installation work on a pv power system in accordance with relevant standards and regulations - occupational health and safety (ohs) standards and associated risks when working on that particular site.	- prepare for solar installation - install electrical components - install cables, connectors and protective devices - get the grounding systems installed - install battery bank (as required) - determine whether any shading will occur and estimate its effect on the system. - determine the cabling route and estimate the length of cable required - determine where the array junction box (if required) and inverter will be located. - measure solar irradiance with a pyranometer. - determine, using field measurements and sun path diagram, the times and dates when a pv array will be shaded by obstacles - observe how current and voltage of a module varies with load	- communicate with supervisor - follow organization rule-based decision-making process. - take decision with systematic course of actions and/or response. - planning and organization of work to meet deadlines. - work constructively and collaboratively with others - manage relationships with customers - recognize problems and search for solutions - choose best methods to complete assigned tasks - approach relevant authority when required - apply domain knowledge, observations and data to select course of action to perform tasks related to solar photovoltaic systems - ask questions for better understanding

Learning unit	**6.1.6 Completing System Installation, Testing and Commissioning**		
Overall learning outcomes	Be able to testing and commission electrical components of Photovoltaic Systems.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- tools & tackles required for inspection and commissioning of the plant - connection of the solar power plant - installation work on a pv power system in accordance with relevant standards and regulations - testing and commissioning activities and its interpretation - visual inspection, continuity of wiring, earthing, polarity check, insulation and voltage drop - measurement of losses in a pv system at different points and interpretation of the results - typical faults, their causes and resolution for all system components - occupational health and safety (ohs) standards and associated risks when working on that particular site	- visually inspect entire installation, identifying and resolving any deficiencies in workmanship - activate system and verify overall system functionality and performance; compare them with expectations - preparation of the inspection report and take appropriate action - verify labelling of solar pv system. - initiate start-up procedures as per manufacturer instructions and record energy meter reading at start-up - commission the system - explain to end-user safety issues associated with operation and maintenance of system - complete system documentation and transfer system documentation package to end-user/operator	- follow organization rule-based decision-making process - take decision with systematic course of actions and/or response - planning and organization of work to meet deadlines - work constructively and collaboratively with others - manage relationships with customers with intent on satisfying its. requirements for service delivery - recognize problems and search for solutions. - choose best methods to complete assigned tasks - approach relevant authority when required - apply domain knowledge, observations and data to select course of action to perform tasks related to solar photovoltaic systems - ask questions for better understanding

Learning unit	6.1.7 Electrical maintenance and Troubleshooting on PV systems		
Learning Overall learning outcomes	Be able to analyse a PV system, maintaining and troubleshoot it.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- solar energy and power generation - basics of electrical concepts, measurement equipment and functioning - usage and handling and maintenance procedure of equipment and systems - complete know-how on manufacturer's warranty policy - procedure for identification and rectification of various faults - various types of tools, measuring equipment and procedures involved in maintenance and troubleshooting of electrical components of the solar pv power plant - relevant occupational health and safety standards and waste management procedures - importance of wearing protective clothing and other safety gear while carrying out maintenance activities.	- identify maintenance needs on system and component level - perform diagnostic procedures and recommend corrective actions - verify the connections, cables and junction boxes as per the design/ working drawings - check the integrity and working condition of all connections, fuses and circuit breakers within junction boxes/combiner boxes - troubleshoot the identified faults and escalate the issue to superiors if faults cannot be identified or rectified - maintain and troubleshoot earthing and lightening protection systems, modules, inverter and monitoring system - following quality and safety procedures - read and interpret the maintenance schedule	- follow organization rule-based decision-making process. - planning and organization of work to meet deadlines. - work constructively and collaboratively with others - manage relationships with customers with intent on satisfying its. requirements for service delivery - recognize problems and search for solutions - approach relevant authority when required - use reasoning skills to identify and resolve basic problems - use intuition to detect any potential problems which could arise during operations - use acquired knowledge of the process for identifying and handling issues

Learning unit	6.1.8 Civil maintenance and Troubleshooting on PV systems		
Overall learning outcomes	Be able to maintain and troubleshoot the installation of civil and mechanical components of the Solar Photovoltaic systems.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of: - basics of solar pv power plant - types civil foundations - interpretation of working drawings - maintenance & operational requirements, handling procedures and warranties of different types of civil and mechanical components - faults that can occur in civil/mechanical components and their corrective measures - tools, equipment and procedures involved in maintenance and troubleshooting - importance of cleaning the solar modules, types of cleaning equipment, their usage procedures - relevant occupational health and safety standards and waste management procedures - handling procedure of solar modules	**Skills** Able to: - carry out civil / mechanical works related to module mounting structure - clean solar modules periodically - maintain all other civil works within the plant including internal roads, boundary wall, drainage system, grass /bushes /trees etc. - follow quality and safety procedures - fill up documentation applicable to one's role -	**Competences** Able to: - communicate with supervisor - follow organization rule-based decision-making process - take decision with systematic course of actions and/or response - planning and organization of work to meet deadlines - work constructively and collaboratively with others - manage relationships with customers - recognize problems and search for solutions - choose best methods to complete assigned tasks - approach relevant authority when required. - apply domain knowledge, observations and data to select course of action to perform tasks related to solar photovoltaic systems - ask questions for better understanding

Learning unit	6.1.9 Service and repairs		
Overall learning outcomes	Be able to analyse a PV system and carrying out service and repair work.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- solar energy and pv systems - mechanical and electrical features necessary for the long life of the pv - material handling and storage - effect of blocking and bypass diodes - basic functioning and operation of other electrical components - connection of the solar power plant - installation work on a pv power system in accordance with relevant standards and regulations - measurement of losses in a pv system at different points and interpretation of the results - typical faults, their causes and resolution for all system components - occupational health and safety (ohs) standards and associated risks when working on that particular site.	- prepare for troubleshooting activities - verify customer complaints - verify/validate diagnosis results - repair and replace faulty pv components and its accessories - test pv system - monitor pv system operation and check status - preparing monitoring equipment and recording of operation data according to the regulation that apply. - implement monitoring and recording of off-grid data in accordance with standards. - create an off-grid monitoring report in accordance with standards.	- debrief customer - communicate with supervisor - follow organization rule-based decision-making process. - planning and organization of work to meet deadlines. - work constructively and collaboratively with others - manage relationships with customers - recognize problems and search for solutions - approach relevant authority when required - apply domain knowledge, observations and data to select course of action to perform tasks - ask questions for better understanding - use reasoning skills to identify and resolve basic problems - use intuition to detect any potential problems which could arise during operations

6.2 Learning Outcome for Wind Technology

Learning unit	**6.2.1 Wind Energy Systems**		
Overall learning outcomes	Be able to describe the most common wind energy systems, name its components and discuss its control systems. Be able to describe the potential, resources and costs of wind energy.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- basics of wind energy systems - wind characteristics, resources and site parameters - the basic aerodynamic laws and wind turbines - wind turbine design and turbine control - wind energy system economics	- estimate the power output - estimate costs related to wind energy systems	- discuss the basics of wind energy systems (electrical systems, mech. + hydraulic systems, safety apparatus, rotor blades)

Learning unit	**6.2.2 Wind Technology Mechanical**		
Overall learning outcomes	Be able to carry out basic mechanical operation and maintenance of wind turbines in excess of 1mw.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- basic mechanical laws and functions of wind energy plant. - construction and function of the mechanical components of a wind turbine - corrosive conditions and methods of reducing effects. - mechanical safety	- carry out mechanical work - assemble mechanical components of a wind turbine - dis-assemble and re-assemble, test and re-commission mechanical components of a wind turbine, safely using appropriate tools and equipment. - identify faults and assess the wear of the mechanical system. - evaluate risks and hazards and efficiently plan the repairs. - to recognise and identify the wear and corrosion of mechanical equipment and suggest appropriate actions to reduce the effect. - use, control and correctly dispose of waste materials following current regulations	- safely use specialist tools and equipment used in the maintenance of wind energy plants - undertake safe working practice and accident prevention measures in installation work - work independently and on his/her own responsibility without supervision - adopt plan repair schedules and assess functional disruption.

Learning unit	**6.2.3 Wind Technology Electronical**		
Overall learning outcomes	Be able to carry out basic electrical operation and maintenance of wind turbines in excess of 1mw.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	- Competences Able to:
	- general basics of electric and electronic physics, law and framework conditions - the functions of electrical and electronic wind turbine components - Electrical safety - functions of electric and electronic components and their integration into wind turbine operational functions.	- use safety equipment in a specified manner - conduct systematic fault-finding, functional diagnostics and repair work including documentation of work completed in accordance with prescribed standards. - use of tools and carry out measurement procedures and electrical work instructions. - read, understand and apply electrical (plant) documentation	- carry out first aid and conduct rescue operations in the event of accidents with the plant electrics - recognise risk situations and implement safety precautions in line with country-specific H&S regulations.

Learning unit	**6.2.4 Wind Technology Hydraulics**		
Overall learning outcomes	Be able to carry out basic hydraulic operation and maintenance of wind turbines in excess of 1mw.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- basics of hydraulic in wind energy - the construction and function of hydraulic components fitted to a wind turbine. - units of pressure and tools for pressure measurement. - hydraulic safety and how to safely perform reliable testing and measurement procedures on hydraulic components. - the need for systematic maintenance, testing and inspection of hydraulic systems.	- safely perform reliable testing and measuring procedures on hydraulic plant. - to service hydraulic elements of wind turbine systems. - describe, with the aid of suitable diagrams, the construction and operation of a given electro-pneumatic device and a given electro-hydraulic device - identify electro, pneumatic and hydraulic components shown as symbols in given circuit diagrams and reference materials following standards - carry out maintenance, inspection, testing and fault finding on fluid power systems. - describe aspects of health and safety legislation and regulations and safety precautions that apply when working with fluid power equipment and systems	- read, interpret and apply the information shown on hydraulic plans. - correctly dispose of seal material and hydraulic oils. - undertake safe working practices - explain the procedures used when fault finding in electro-pneumatic and electro hydraulic systems. -

Learning unit	6.2.5 Wind turbine onshore installation		
Overall learning outcomes	Be able to install mechanical and electric components of an onshore wind plants.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- wind technology - wind turbine structure and electromechanical functioning - essential mechanics, electrics hydraulics for wind turbines - installation phases - component installation and assembling (tower, nacelle, rotor and blades) - communication structures - procedures, regulations and documentation - existing law and regulations concerning safety and the role of local health and safety regulations	- install a wind turbine (tower, nacelle, hub and blades and assembling of components inside the turbine) - fulfil installation assignments - to use onshore communication systems and are familiar with the key vocal instructions in professional terminology and the sign language.	- take necessary safety (precautionary) measures and to act responsible in emergency situations, also at heights. - discuss methods to clarify scopes of an assignment in the team and with the work scheduler - work in a team

Learning unit	**6.2.6 Electrical Maintenance of wind turbine**		
Overall learning outcomes	Be able to explain the electro-technical components and functions of a wind turbine and be able conduct maintenance operations in a professional manner.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- wind turbine electrical and electronic processes. - the functions of electric and electronic components and their integration into wind turbine operational functions. - risks in the maintenance of electro-technical wind turbine components and functions and conduct maintenance operations in a professional manner. - compliance with health and safety regulations and teamwork in carrying out self-supervised maintenance operations. - necessary measurement and testing devices and tools.	- implement safety precautions in line with country-specific health and safety regulations. - use safety equipment and tools in a specified manner - conduct systematic fault-finding, functional diagnostics and repair work - conduct documentation of work completed in accordance with prescribed standards. - assess functional performance of electrical components and carry out necessary adjustments and repair work.	- recognise risk situations - read, understand and apply electrical plant documentation - handle available/prescribed communication tools and procedures. - provide first aid and conduct rescue operations in the event of accidents with the plant electrics - is aware of his responsibility in conducting operations but also recognises situations demanding consultation with superiors. - delegate assignments in a responsible manner.

Learning unit	**6.2.7 Health, Safety and Environment (HSE) in the wind energy industry**		
Overall learning outcomes	Be able to apply regulation and laws related to Health, Security and Environment and risks when working on a wind turbine		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- local regulation and laws (waste disposal and transport, etc.) - the importance/requirement of a clean work and an orderly workplace (for own safety, safety of others, company image) - of job-specific environmental conditions - the regulatory aspects for health & safety - the risks related to working on a wind turbine and get a basic knowledge of prevention measures - waste disposal procedures and regulations	- read meteorological data and weather forecasts / reports - adapt their actions according to the weather symptoms	- deal calmly and effectively with high stress situations - inspect work place during and after the end of a practical lesson. - act responsibly in emergency situations - dispose of waste according to defined procedures and regulations. - detect and assess possible risk situations due to environmental conditions.

Learning unit	**6.2.8 Wind turbine Trouble shooting and repair**		
Overall learning outcomes	Be able to apply systematic trouble shooting- and repair techniques in a safely manner.		
Learning outcomes correspond to EQF Level 4	**Knowledge** Knows/Aware of:	**Skills** Able to:	**Competences** Able to:
	- systematic fault-finding techniques. - authorized repair techniques. - wind turbine component and their function. - sensors and their function. - communication on wind turbine construction sites. - personal protective equipment, its functions and maintenance. - possible sources of risk or danger and possible environmental influence factors on site, knowledge of weather conditions and symptoms. - existing law and regulations.	- use a systematic trouble shooting strategy to find the root cause of a problem simulated in: ○ a hydraulic system ○ a cooling system ○ a generator ○ an electrical system - risk-assess work assignments and inspection of personal safety equipment - lock-out and tag-out an electrical- and hydraulic circuit - select technically appropriate and authorized repair technique	- assess work environment - communicate on site - keep the organised - planning and execution of the job assignments - work in team of at least two - to communicate repercussions of identified damage

7 Guidelines and examples on how to prepare corresponding learning materials.

Learning outcomes is a kind of common reference for teaching, learning and assessment. While an appropriate teaching and learning strategy enable learners to achieve the defined learning outcomes, an appropriate assessment method is used to check if the learning outcomes have been achieved (European Commission, 2011).

The strategy of aligning learning outcomes statements with teaching and learning is the right process of applying learning outcomes. Learning outcome statements should assist teachers in identifying and combining teaching methods. Teachers with their own discretion should look at how general or specific learning outcomes are and apply appropriate and flexible teaching methods to reach these defined outcomes. There should however be absolute collaboration among the teachers of different outcomes within a teaching course or module so as to create a meaningfully linked learning pathway.

Aligning learning outcomes to teaching and learning is about connecting the abstract idea of a learning outcome to what teachers actually do to help students learn, and the things that students do to learn (Cedefop, 2017). To safeguard this connection, teachers should do the following:

i. Define what they expect students to learn and able to do
ii. Identify and choose the appropriate teaching methods to support the student attend the defined outcomes
iii. Design suitable curriculum encompassing all that is needed to have the student reach these outcomes
iv. Select the right assessment tasks and criteria will enable students demonstrate that they have achieved the outcomes
v. Set a grading and qualification system to evaluate how well the students match the learning outcomes.

According to Biggs (2003) quoted in Cedefop (2017), the teacher's job is to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes. The key is that all components in the teaching and learning system – the curriculum and its intended learning outcomes, the teaching methods used, the resources to support learning, and the assessment tasks and criteria for evaluating learning – are aligned to each other and support achieving the intended learning outcomes.

The alignment between learning outcomes, teaching, learning and assessment helps to make the overall learning experience more coherent, transparent and meaningful for learners (European Commission, 2011). This alignment can only be effective with appropriate and well-prepared learning material and resources to create this link.

According to CEDEFOP, teaching materials, such as textbooks, are a key tool for introducing and reinforcing national core curricula and unified national standards and assessment. They continue to be the predominant learning resource in most European countries, despite the advent of instructional technology and substantial resources devoted to the provision of computers in schools (Cedefop, 2010).

Educational programmes should be adequately and equitably resourced, with books, other learning materials, open educational resources and technology that are non-discriminatory, learning conducive, learner friendly, context specific, cost effective and available to all learners (Education 2030, 2016).

The following are some examples of teaching material that should guide the process of learning so as to achieve the defined outcome (UNESCO, 2021).

- **Textbooks** are the most visible aspects of a curriculum and are often considered the main script that shapes the teaching and learning processes (UNESCO, 2017). Quality textbook development and provision involves four main steps: development (based on curricular frameworks); procurement systems (state or private sector, approved textbooks list); distribution and access (arrival in schools, issuance to students); and storage and conservation.
- **Teachers' guides** support teachers in their teaching practices. Effective teachers' guides should: contain explicit communication of conceptual goals with links to proposed activities, provide knowledge and support to help understand and implement teaching plans, reinforce pedagogical content knowledge, give guidance on the practice and understanding of relevant pedagogical activities, present alternatives and freedom of choice, and engage teachers in ongoing reflection.
- **Supplementary materials** include books, newspapers, informational pamphlets, and other materials printed in mother tongue and instructional languages reflecting local customs and concerns.
- **Multimedia and digital resources** are a growing source of knowledge for teachers and learners.

Implementing learning outcomes therefore depends establishing a bridge between the learning outcomes statements and the learning and teaching process. This requires that learning outcomes statements for different purposes (qualifications standards, programme profiles and curricula) be related to each other and do not operate as isolated and separated elements (Cedefop, 2017).

8 Conclusion

The analysis of the present coal workers skills from Germany, Austria, Greece, Bulgaria, Poland and Romania against the skills available and required for so called blue collar jobs in the renewable energy sector in these countries shows that there are some areas in which the coal workers and those in the RES sector have matching skills, and other aspects where there is a mismatch (gaps).

It identifies the skills of the coal sector which can be used in the RES sector, in particular in of the photovoltaic and wind industry, to be knowledge in mechanics, building, construction, and public safety and security. These persons equally possess technical skills in repairing, equipment maintenance, equipment selection, operation monitoring, operation and control which can be of use to the RES sector.

Meanwhile, it is very visible from the study that coal workers however still need some RES sector specific knowledge, technical and non-technical skills to be able to work in the sector in due time. Additional knowledge is particularly needed in troubleshooting, coordination and team building or concern for others.

A look at the trends in RES sector skills supply by existing VET highlighted an imbalance in the labour market which can be filled by coal workers should they be re-skilled through the right training programme addressing their needs.

Therefore, to fill this knowledge gap of coal workers, appropriate learning units with defined learning outcomes have been defined forming the base for training of these coal workers who want to join the RES sector in the future. Based on our study, for coal workers to be able to be fully integrated in the RES sector, they need to be trained (depending on which sector) in:

- Learning units for Photovoltaics
  - Occupational health and safety practice
  - Understanding Solar Energy and PV Systems Basics
  - Understanding PV System Design and site survey
  - Installation of civil and mechanical components of PV system
  - Installation of electrical PV Components
  - Completing System Installation, Testing and Commissioning
  - Electrical maintenance and Troubleshooting on PV systems
  - Civil maintenance and Troubleshooting on PV systems
  - Service and repairs
- Learning units for Wind Technology
  - Wind Energy Systems
  - Wind Technology Mechanical
  - Wind Technology Electronical
  - Wind Technology Hydraulics
  - Wind turbine onshore installation
  - Electrical Maintenance of wind turbine
  - Health, Safety and Environment (HSE) in the wind energy industry
  - Wind turbine Trouble shooting and repair

To each learning unit is a defined learning outcome. These learning outcomes on RES sector skills, specifically addressed to coal workers are the first output of the project “Reskilling coal industry workers for the renewables energy sector”.

By presenting the learning outcomes in the form of what RES-SKILL learners should know understand and be able to do upon the completion, reskilling of the coal workers will drastically improve the supply of quality work force for RES industry.

With the pre-existing knowledge of coal workers, the length of time to get them prepared for employment in the RES sector will be shorter. This will go a long way to help fill the gap in the RES industry in a short time and support these coal workers gain employment after closure of coal plants and mines.

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Annexes

Annex 1: Survey questionnaire

The survey questionnaire will be completed online in the following link: *The URL will be provided here after the questionnaire has been reviewed from partners and has been finalised*.

This is an editable form of the survey questionnaire, provided for feedback/fine-tuning purposes.

RES-SKILL - Reskilling coal industry workers for the renewables energy sector

What is the purpose of the survey?

Given the EU's ambition to transform its energy system and become carbon neutral by 2050, coal jobs are expected to face a sharp decline in the following years. However, renewable energy economy shows the potential to create more jobs than currently exist in the coal sector.

The purpose of this survey is to determine the set of skills, knowledge, and competences required by coal workers to transition to similar-profile renewable (RES) sector jobs. Your input will aid to the development of a freely available online retraining course that will cater specifically to the transition of coal workers to the renewable sector.

Who should participate?

- Employers in the coal & RES sector
- VET providers offering courses for coal workers & in the renewable energy sector
- Senior managers and employees from the renewable energy sector
- Heads of trainer departments and workplace trainers for renewable energy applications (e.g., wind and solar PV)
- Social partners, sector representatives and coal workers' representatives (e.g., members of professional associations)
- Field experts, academics, and researchers.

How long does it take?

Less than 15 minutes!

Thank you very much in advance for your participation and valuable contribution!

All respondents (that also provide their email) will enjoy early access to RES-SKILL learning course.

A. RESPONDENT PROFILE
A1. Name:
A2. Organisational affiliation (if applicable):
A3. Position / organisational affiliation (please choose one of the following): - Site director / manager in the coal or renewable industry - Team leader (e.g., power plant, mines, wind fields) - Head of in-house training department in coal or renewable industry - Workplace trainer / mentor in coal or renewable industry - Senior / experienced coal worker in coal or renewable industry - Employer in coal or renewable industry - Contractor in coal or renewable industry - Recently transitioned from coal to RES sector industry as (please specify position below) - VET provider offering / course designers / instructors on re-orientation opportunities for coal workers - VET provider offering / course designers / instructors on courses for employment in the RES sector (e.g., for technicians) - Development agency with a mandate to assist in coal phase-out - Coal workers' association representative / board member - Researcher monitoring employment trends and skills - Field expert / academic in the mining or renewable energy sector - Other (please specify):
A4. Years of professional experience (please choose one of the following): - No experience / < 1 year - 1-3 years - 4-7 years - >8 years
A5. Country:
A6. Email (optional):
B. ASSESSMENT OF COAL WORKERS' CURRENT KNOWLEDGE AND SKILLS
B1. In your experience, to what extent are coal workers already knowledgeable in the following areas? (please rate from 'very low' to 'very high')

Mechanics - Knowledge of machines and tools, including their designs, uses, repair, and maintenance	Choose an item.

Computers and Electronics - Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and basic programming	Choose an item.
Building and Construction - Knowledge of materials, methods, and the tools involved in the construction or repair of various infrastructures	Choose an item.
Public Safety and Security - Knowledge of relevant equipment, policies, procedures, and strategies for the protection of people, property, and institutions	Choose an item.
B2. In your experience, to what extent do coal workers already have the following technical skills? (please rate from 'very low' to 'very high')	
Operation and Control - Controlling operations of equipment and/or systems (e.g., drilling)	Choose an item.
Operation Monitoring - Watching gauges, dials, or other indicators to make sure a machine is working properly	Choose an item.
Quality Control Analysis - Conducting tests and inspections of products, services, or processes to evaluate quality or performance	Choose an item.
Equipment Selection - Determining the kind of tools and equipment needed to do a job	Choose an item.
Systems Evaluation - Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system	Choose an item.
Systems Analysis - Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes	Choose an item.
Equipment Maintenance - Performing routine maintenance on equipment and determining when and what kind of maintenance is needed	Choose an item.
Repairing - Repairing machines or systems using the needed tools	Choose an item.
B3. In your experience, to what extent do coal workers already have the following non-technical/soft skills? (please rate from 'very low' to 'very high')	
Practical thinking - Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems	Choose an item.
Troubleshooting - Determining causes of operating errors and deciding what to do about it.	Choose an item.
Spatial awareness - Being aware of others' reactions in relation to their environment and understanding why they react as they do	Choose an item.
Coordination - Adjusting actions in relation to others' actions	Choose an item.
Judgment and Decision Making - Considering the relative costs and benefits of potential actions to choose the most appropriate one	Choose an item.
Instructing - Teaching others how to perform routine tasks	Choose an item.
Dependability - Are reliable, responsible, and dependable, fulfilling obligations	Choose an item.
Adaptability - Are open to change (positive or negative) and to considerable variety in the workplace	Choose an item.
Persistence - Are persistent in the face of obstacles	Choose an item.
Stress tolerance - Dealing calmly and effectively with high stress situations	Choose an item.
Concern for others - Are sensitive to others' needs and wellbeing and are understanding and helpful on the job	Choose an item.

B4. In your experience, what additional knowledge and skills (technical and soft), other than those discussed above, do coal workers have?	
C. ASSESSING THE COMPLEMENTARITY AND MISMATCHES OF COAL WORKERS TO RES SECTOR BLUE COLLAR AND TECHNICAL OCCUPATIONS	
C1. In your experience, to what extend do coal workers need additional training in the following knowledge areas, if they want to transition to blue collar/technical jobs in the renewable energy sector? (please rate from 'not at all' to 'extensive training')	
Mechanics - Knowledge of machines and tools, including their designs, uses, repair, and maintenance	Choose an item.
Computers and Electronics - Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and basic programming	Choose an item.
Physics - Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding material and atmospheric dynamics, and mechanical, electrical structures and processes.	Choose an item.
Building and Construction - Knowledge of materials, methods, and the tools involved in the construction or repair of various infrastructures.	Choose an item.
Design - Knowledge of design techniques, tools, and principals involved in production of precision technical plans, blueprints, drawings, and models.	Choose an item.
Education and Training - Knowledge of principles and methods for teaching and instruction for individuals and groups, and the measurement of training effects	Choose an item.
Mathematics - Knowledge of arithmetic, algebra, geometry, calculus, and their applications	Choose an item.
Public Safety and Security - Knowledge of relevant equipment, policies, procedures, and strategies for the protection of people, property, and institutions	Choose an item.
C2. In your experience, to what extend do coal workers need to acquire the following technical skills, if they want to transition to blue collar/technical jobs in the renewable energy sector? (please rate from 'not at all' to 'extensive training')	
Operation and Control - Controlling operations of equipment and/or systems	Choose an item.
Operation Monitoring - Watching gauges, dials, or other indicators to make sure a machine is working properly	Choose an item.
Quality Control Analysis - Conducting tests and inspections of products, services, or processes to evaluate quality or performance	Choose an item.
Equipment Selection - Determining the kind of tools and equipment needed to do a job	Choose an item.
Systems Evaluation - Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system	Choose an item.
Systems Analysis - Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes	Choose an item.
Equipment Maintenance - Performing routine maintenance on equipment and determining when and what kind of maintenance is needed	Choose an item.
Repairing - Repairing machines or systems using the needed tools	Choose an item.

C3. In your experience, to what extend do coal workers need to acquire the following non-technical skills, if they want to transition to blue collar/technical jobs in the renewable energy sector? (please rate from 'not at all' to 'extensive training')	
Practical Thinking - Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems	Choose an item.
Troubleshooting - Determining causes of operating errors and deciding what to do about it.	Choose an item.
Spatial awareness - Being aware of others' reactions in relation to their environment and understanding why they react as they do	Choose an item.
Coordination - Adjusting actions in relation to others' actions	Choose an item.
Judgment and Decision Making - Considering the relative costs and benefits of potential actions to choose the most appropriate one	Choose an item.
Instructing - Teaching others how to perform routine tasks	Choose an item.
Dependability - Are reliable, responsible, and dependable, fulfilling obligations	Choose an item.
Adaptability - Are open to change (positive or negative) and to considerable variety in the workplace	Choose an item.
Persistence - Are persistent in the face of obstacles	Choose an item.
Stress Tolerance - Dealing calmly and effectively with high stress situations	Choose an item.
Concern for others - Are sensitive to others' needs and wellbeing and are understanding and helpful on the job	Choose an item.

C4. In your experience, what additional knowledge and skills (technical and non-technical), other than those discussed above, do coal workers need to have if they want to transition to renewable energy blue collar & technical occupations?

Would you like to receive more information about RES-SKILL project and its results? This will allow you to have early access to training materials and toolkit!

- Yes
- No

Annex 2: Desk research reporting form

Data collection forms for presenting information gathered via desk research. Please make as many copies of the tables as needed.

Desk research form for VET offerings	
VET offering title:	
Qualification Level	
Training Provider	
Country	
Type of course	☐ Standalone apprenticeship course ☐ Vocational course with integrated apprenticeship period
Duration	
Scope of course	[e.g., to obtain a diploma / up-skilling / retraining]
Target audience information	[Description of participants, e.g., age of participants, I-VET or C-VET, relevant professional groups]
Core Modules & Topics addressed	
Knowledge/skills/competences (to be) obtained upon the completion of training	
Source	(link)

Desk research form for job listings	
Job title	
Location & country	
Description	
Type	[e.g., full-time, part-time, freelance]
Qualification Level	[if mentioned]
Employer	
Knowledge required	- …
Technical skills required	- …
Non-technical / soft skills required	- …
Source	(link)