A Just Energy Transition in South Africa

Socio-economic needs and the positive impacts of a future low-carbon economy

RES4AFRICA
RENEWABLE ENERGY SOLUTIONS FOR AFRICA
FOUNDATION

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In partnership with:

Abstract

South Africa is the largest electricity market in Africa, but its power generation is heavily dependent on coal. Additionally, the power sector suffers from frequent supply shortages and rising tariffs, and is influenced by lower energy intensity. At the same time, South Africa is progressively moving towards the large-scale deployment of renewables. The country's most recent guiding policy, the Integrated Resource Plan 2019 (IRP 2019), has set important targets for the addition of renewable generation capacity (22500 MW of solar and wind power) and the end-of-life decommissioning of a substantial amount of coal-fired generation capacity (about 11000 MW) by 2030.

Increasing the role of renewable resources to fill the gap left behind by decommissioned coal plants is associated with major socio-economic challenges, as the shift requires a restructuring not only of the power sector, but also of employment. Given that the coal sector is a major employer in South Africa, understanding the impact of the switch to low-carbon electricity on employment and the economy is crucial to ensuring a Just Transition for all those employed in the sector, as is aligning the transition with the power sector restructuring roadmap set out in the IRP 2019.

In order to facilitate the Just Transition, this study, developed by RES4Africa in partnership with CSIR and ERM, assesses the changes necessary in employment and workers' skills in line with the shift to renewables, as well as lessons learned from other countries transitioning away from coal. The first section of the study evaluates the number of jobs generated by renewables under the IRP 2019 deployment schedule and the skills which will be required as a consequence, providing a framework for the re-skilling of coal sector workers. The second section analyses the low-carbon transitions of five countries across three continents, identifying their successes and how they can inform South Africa's unique transition.

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List of Abbreviations

Part 1:

Name	Description
DNI	Direct National Irradiation
PV	Photovoltaic
DMRE	Department of Mineral Resources and Energy
DNI	Direct Normal Irradiation
DoE	Department of Energy
EIA	Environmental Impact Assessments
EPC	Engineering Procurement and Construction
EU	European Union
IEEE	Electrical and Electronics Engineers
IPPs	Independent Power Producers
IRP	Integrated Resource Plan
JEDI	Jobs and Economic Development Impact
kWh	kWh
MBA	Master's in Business Administration
MW	Megawatt
NDP	National Development Plan
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturers
PPA	Power Purchasing Agreement
REDZ	Renewable Energy Development Zones
REI4P	Renewable Energy Independent Power Producers Procurement Programme
RFQs	Requests for Quotations
SARETEC	South African Renewable Energy Technology Centre
TVET	Technical and Vocational Education and Training
UE	European Union
UIC	Utility Interconnection Engineers
US	United States
USA	United States of America

Part 2:

CCUS	Carbon capture, utilisation and storage
CHP	Combined heat and power
CO2	Carbon dioxide
Cosatu	Congress of South African Trade Unions
DMRE	Department of Mineral Resources and Energy
DoE	Department of Energy
ETUC	European Trade Union Confederation
EU	European Union
G20	Group of Twenty

GHG	Greenhouse Gas
GW	Gigawatt
HDI	Human Development Index
HELE	High Efficiency Low Emissions
IEA	International Energy Agency
ILO	International Labour Organisation
INDC	Intended Nationally Determined Contribution
IPPs	Independent Power Producers
IRP	Integrated Resource Plan
kWh	Kilowatt per hour
LED	Light-emitting diode
Mtoe	One million toe (tonne of oil equivalent)
MW	Megawatt
NDC	Nationally determined contribution
NDP	National Development Plan
OECD	Organisation for economic cooperation and development
POLES	Prospective outlook on long-term energy systems model
PV	Photovoltaic
R&D	Research and Development
RES4AFRICA	Renewable Energy Solutions for Africa
RKB	Ruhr Coal Vocational Training Society
SDG	Sustainable Development Goal
UE	European Union
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USSR	Union of Soviet Socialist Republics

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Part 1:

Part 2:

DEVELOPMENT OF A RE-SKILLING PLAN FOR SOUTH AFRICA IN SUPPORT OF A JUST ENERGY TRANSITION

Author: Stanley Semelane, Esther Mkhwebane, Dr Clinton Carter-Brown, Dr Brian North

in partnership with:

EXECUTIVE SUMMARY

This study presents a detailed analysis of a re-skilling framework for a just energy transition in South Africa. A re-skilling framework that unpacks opportunities in the solar PV and wind value chain was assessed. A just energy transition needs to ensure that there is training for new opportunities that will originate from solar PV and wind deployment. Developing a re-skilling plan framework will ensure that the renewable energy industry is serviced by the local workforce.

Moreover, prioritising employment opportunities in the energy transition will yield a long-term stimulated renewable energy deployment. This will further develop capacities for all skills required for the solar PV and wind sectors. The wind and solar Jobs Economic Development Impact (JEDI) analysis from 2019 Integrated Resource Plan (IRP) were quantified thus indicating job gains from the solar PV and wind sector. The workforce transfer from coal regions to sectors that might deploy solar and wind was conducted and it was found to be feasible. Job seekers generally travel to where job opportunities are, however, this approach is not desirable since it has the potential to create ghost towns. The development of a reskilling framework was found to be feasible with key enabling stakeholders. For South Africa to achieve a just energy transition, a just energy transition reskilling framework is recommended to enabling key stakeholders to start activating the reskilling framework.

1. INTRODUCTION

1.1 Background and justification

The international electricity sector is revolving towards a low carbon economy. This is resulting in a transition and new pathways for the energy system. The traditional electricity business models and value chains that are dependent on a vertically integrated utility power system are phasing out. Moreover, instead, rapidly changing technologies, modern infrastructure and declining production costs of renewable energies have increased the complexity of managing the supply side. This includes managing an energy mix from diverse energy sources of traditional and renewable generation, decentralised energy systems including Small Scale Embedded Generation. According to Climate Justice Alliance (2020), the energy transition is defined as: *"Just Transition is a vision-led, unifying and place-based set of principles, processes, and practices that build economic and political power to shift from an extractive economy to a regenerative economy. This means approaching production and consumption cycles holistically and waste-free. The transition itself must be just and equitable; redressing past harms and creating new relationships of power for the future through reparations. If the process of transition is not just, the outcome will never be. Just Transition describes both where we are going and how we get there."*

South Africa has committed to decarbonising the energy system to address climate change, and this has accelerated investments in the renewable energy sector. This study will build upon the success of the Renewable Energy Independent Power Producer Procurement Programme (REI4P) as well as the newly gazetted Integrated Resource Plan (IRP) of 2019. The National Development Plan (NDP) aims to ensure that a Just Transition towards a low carbon economy is achieved.

The impacts that could be derived from developing a skills framework in the energy transition space can play a role in stimulating job creation, new skill sets and diversify the economic activities in regions that are phasing out coal (i.e. Mpumalanga Province). Skill development in the renewable energy sector can contribute to mitigating probable job losses from the coal power stations as well as the mining economy that supplies feedstock into the coal sector.

The workforce that has generally worked in the coal value chain can benefit from a skills development framework linked to renewable energy technologies that will be deployed in South Africa between now and 2030. The IRP 2019 shown in Table 1 indicates that 11 017 MW of coal power will phase out between now and 2030. This shift calls for a transition in skills and services that will feed into the renewable energy value chain. Through a skills evaluation exercise, skills that could be easily transitioned into the renewable energy sector will be identified. This assignment will help inform the re-skilling framework needed to ensure that the adoption of renewables not only addresses climate change challenges but contributes to the broader economic development and job creation for South African citizens.

Table 1: Integrated Resource Plan 2019

Recommended Plan IRP 2019	Coal		Nuclear	Hydro	Storage	PV		Wind	CSP	Gas & Diesel	Other*
Current Base	37149		1860	2100	2912		1474	1980	300	3830	499
2019	2155	-2373						244	300		***
2020	1433	-557					114	300			
2021	1433	-1403					300	818			
2022	711	-844			513	400	1000	1600			
2023	750	-555					1000	1600			500
2024			1860					1600		1000	500
2025							1000	1600			500
2026		-1219						1600			500
2027	750	-847						1600		2000	500
2028		-475					1000	1600			500
2029		-1694			1575		1000	1600			500
2030		-1050		2500			1000	1600			500
TOTAL INSTALLED CAPACITY by 2030 (MW)	33364		1860	4600	5000	8288		17742	600	6380	
% Total Installed Capacity (% of MW)	43		2.36	5.84	6.35	10.52		22.53	0.76	8.1	
% Annual Energy Contribution (% of MWh)	58.8		4.5	8.4	1.2	6.3		17.8	0.6	1.3	

Grey	Installed Capacity
Yellow	Committed/ Already Contracted Capacity
Red	Capacity Decommissioned
Green	New Additional Capacity
Blue	Extension of Koeberg Plant life
Orange	Distributed Generation Capacity for own use

This report is in response to the request made by RES4Africa for the development of a Re-Skilling Plan in the South Africa energy transition. Due to the interest of the energy transition that is unfolding in South Africa, several stakeholders are conducting various studies to unpack new pathways that the transition provides. In order to coordinate various energy transition work-streams that are currently being developed by various stakeholders, there is a need to foster collaboration. As a result, the following stakeholders are identified as key for contributing towards the development of a Re-Skilling Plan for the South African coal regions that are confronted with the coal power station phase-out:

- Department of Energy,
- Eskom,
- IPP Office
- Mpumalanga Provincial Government
- Steve Tshwete Local Municipality

1.2 Research approach

To achieve the objective of this study (i.e. development of a re-skilling plan in support of just energy transition), a holistic view of skills currently operating in the coal value chain will be assessed. Possible linkages to various renewable energy employment opportunities will be assessed particularly for the solar PV and wind energy sector. This builds on an understanding of how energy contributes to the regional developmental agenda. Mapping of existing skills and those required in the energy transition will be conducted to contribute to a just energy transition, particularly in the Mpumalanga region that is a hub for the South African coal economy. The scope of work of the development of a Re-skilling Plan is a requirement that can contribute to the South African energy transition. To achieve a Re-skilling Plan that will have a meaningful role and impact, the following methodological approach is proposed:

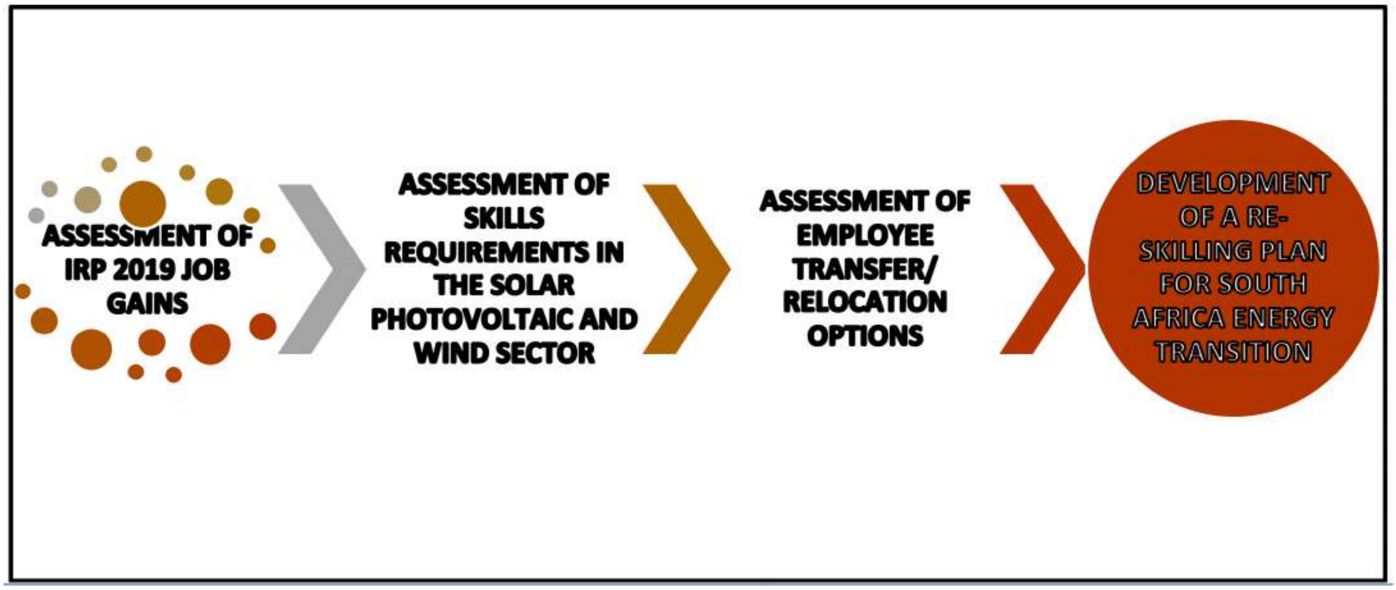

Figure 1: Graphic research approach

2. INTEGRATED RESOURCE PLAN AND JOB ANALYSIS

2.1 The South African energy landscape

The energy transition from fossil fuels to cleaner energy sources like solar, wind and biomass will gradually increase their share in the South African energy system. Over the years, dependence on fossil fuels has resulted in increasing greenhouse gas (GHG) emissions. This has prompted an increase in the adoption of cleaner energy sources like solar photovoltaic (PV), wind and biomass (Semelane et al., 2018). Nearly 88% of South African electricity is currently produced from coal. Consequently, it is no doubt that South Africa has a long way to go before its energy system can reflect a much higher percentage of renewables [3]. For almost two decades, the process of introducing more renewables in the South African energy system has been sluggish. The challenges that have confronted the South African power utility Eskom may have stimulated the call for increasing the share of renewable energies in the South African energy system [4]. While South Africa gradually increases the adoption of renewable energy in its energy system, the re-skilling framework in the context of a just energy transition is non-existent. Re-skilling of workers that are likely to service the energy transition is important for socio-economic development.

The adoption of renewables is likely to have socio-economic impacts on coal-dependent regions. As a result, it is important to understand job opportunities that will arise from the IRP. The REI4P Programme is recognised as one of the most successful private and public sector renewable energy development program in the world [4]. The South African coal phase-out needs to be prudently managed, thus creating an enabling environment for a just energy transition. Possibly, creating paths for alternative employment prospects in the coal phase-out regions.

The IRP released in 2019 shows a planned procurement of 6 000 MW large scale solar PV and 4000 MW of distributed rooftop PV from 2022 – 2030. On wind technology, 14 400 MW will be deployed between now and 2030. This excludes the 814 MW of solar PV and 1 362 MW of wind power plants that are currently under construction [5]. The energy transition in the 21st century is aimed towards a sustainable energy system that is characterised by universal access to energy services and security of supply from clean, efficient and low carbon energy resources [6]. Renewable energy cost has been progressively reduced since 2009. Wind and Solar PV technology have decreased cost by more than 65% and 80% respectively between 2010 and 2017 [7].

2.2 Integrated Resource Plan (IRP) 2019 – Jobs Analysis

The Jobs and Economic Development Impacts (JEDI) model is utilised to analyse the economic impacts and jobs creation for Solar PV and wind technologies. The model forecasts the potential gross economic impacts of renewable energies, in this instance solar PV and wind power. The JEDI model is utilised to estimate employment, earnings, gross domestic product, and other economic impacts from the construction and operation of renewable energy projects and across the domestic supply chain. The model results include total economic impacts as well as impacts by industry, for example, construction, manufacturing and banking services. The JEDI model was employed to assess jobs and economic impact from the solar PV and wind as gazetted in the IRP 2019. Most jobs are created during the construction and maintenance value chain when solar power and wind plants are deployed (Llera et al., 2013; Sooriyaarachchi et al., 2015).

2.3 Local content assumptions

The local content assumption used to model the jobs that will be created by the wind and solar planned deployment are illustrated in Table 2. The assumptions used to quantify the wind and solar jobs and economic impact were adopted from the South African local content requirement.

Table 2: Local content assumptions

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
IRP MW Allocation		0	160	160	370	440	650	580	580	580	580	580
		LOCAL CONTENT POTENTIAL										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Equipment												
Module		24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%
Inverter		36%	36%	36%	36%	36%	36%	36%	36%	36%	36%	36%
Installation												
Construction and installation costs		90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Other												
Design and civil engineering		75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Other (public relations, legal, environmental studies)		80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Infrastructure - electricity and other		85%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Transportation - Country Specific		100%										
Operations and Maintenance												
Maintenance and repair services		90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Repair parts		30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Turbine (Generator, Gearbox, Nacelle)	75%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Blades	75%	0%	0%	0%	0%	0%	60%	60%	60%	60%	60%	60%
Tower	75%	0%	0%	0%	90%	90%	90%	90%	90%	90%	90%	90%
Equipment Shipping/Transportation	50%	0%	0%	0%	50%	50%	50%	50%	50%	50%	50%	50%
Construction												
Electrical Balance of Plant	25%	0%	0%	0%	60%	60%	60%	60%	60%	60%	60%	60%
Construction (Excluding Site Improvements)	90%	0%	0%	0%	90%	90%	90%	90%	90%	90%	90%	90%
Other												
Engineering and Other Professional Services	75%	0%	0%	0%	75%	75%	75%	75%	75%	75%	75%	75%
Site Improvement (i.e., Road Construction)	90%	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%
Operations and Maintenance (O&M)												
Plant Operations (staff, equipment such as trucks)	75%	0%	0%	0%	75%	75%	75%	75%	75%	75%	75%	75%
Replacement Parts	75%	0%	0%	0%	20%	20%	20%	20%	20%	20%	20%	35%
Civil Works (Access Road Maintenance, Etc.)	90%	0%	0%	0%	90%	90%	90%	90%	90%	90%	90%	90%

2.3.1 Wind industry jobs

The wind industry employs 1.15 million people in both onshore and offshore projects globally. Most wind and solar PV jobs are created in smaller countries. China accounts for about 44% of jobs created by the wind sector and South Africa job creation ranks last in the wind segment [7]. According to the Environmental and Energy Study Institute (2015), the wind power industry created 111,166 jobs in 2018. This is a 4% increase from 2017. About 33% of the created jobs were in the construction segment, while 24% were in the professional services and 24% in the manufacturing domain.

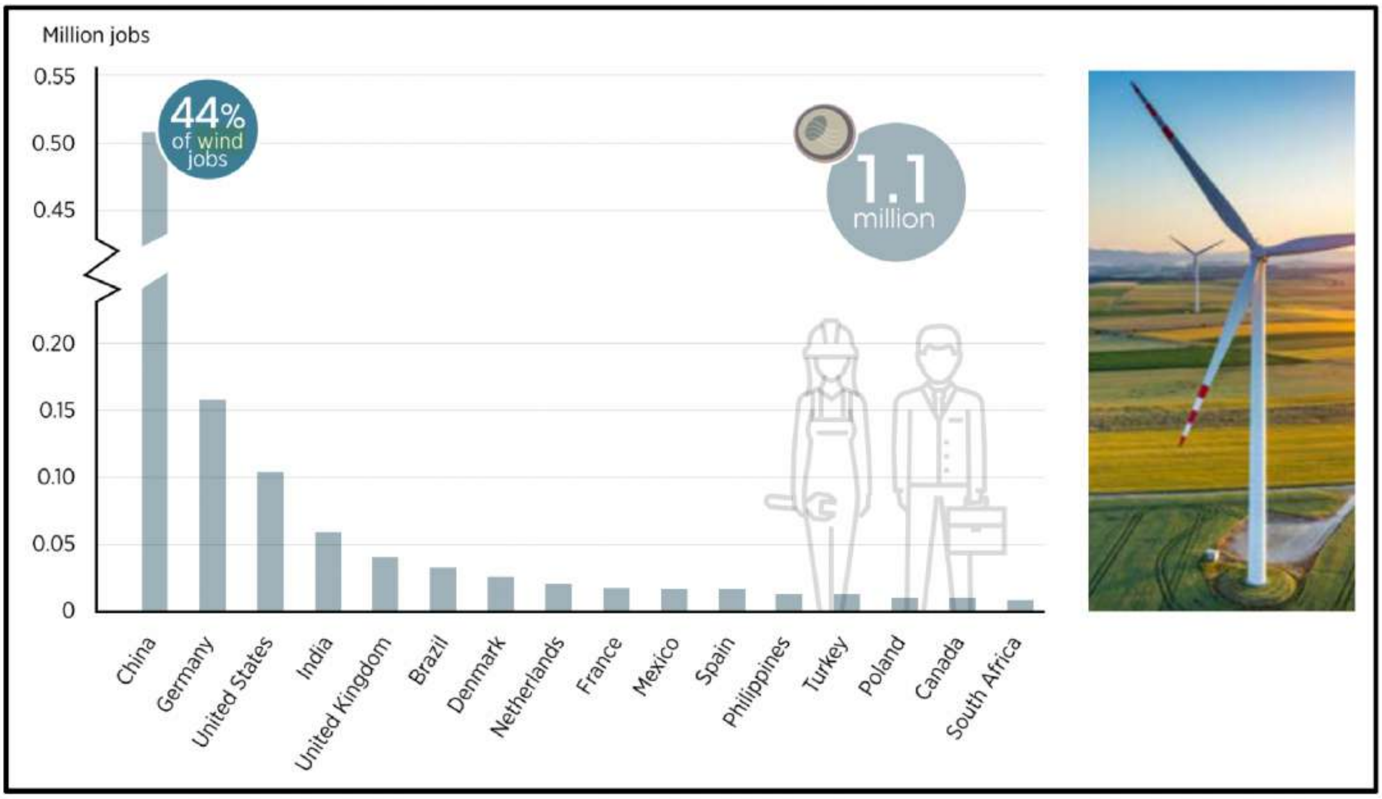

Figure 2: Global wind sector jobs [10]

2.3.2 South African wind sector job analysis

The JEDI analysis conducted for the planned wind deployment between 2020 and 2030 show job creation opportunities that will be created from the planned wind deployment. The wind sector is allocated 14 400 MW between 2020 and 2030. The jobs analysis conducted focused mainly on the IRP 2019. This is in the context of potential job losses that will happen in coal regions. Moreover, it is important to shows jobs that will be created due to the South African energy transition. This will also assist in finding ways that can further stimulate job creation from the South African energy transition.

The analysis for solar PV shows that 252 616 (direct, indirect and induced) jobs will be created during the in the construction phase. The wind sector will create 594 098 (direct, indirect and induced) jobs during the construction phase, see Figure 3.

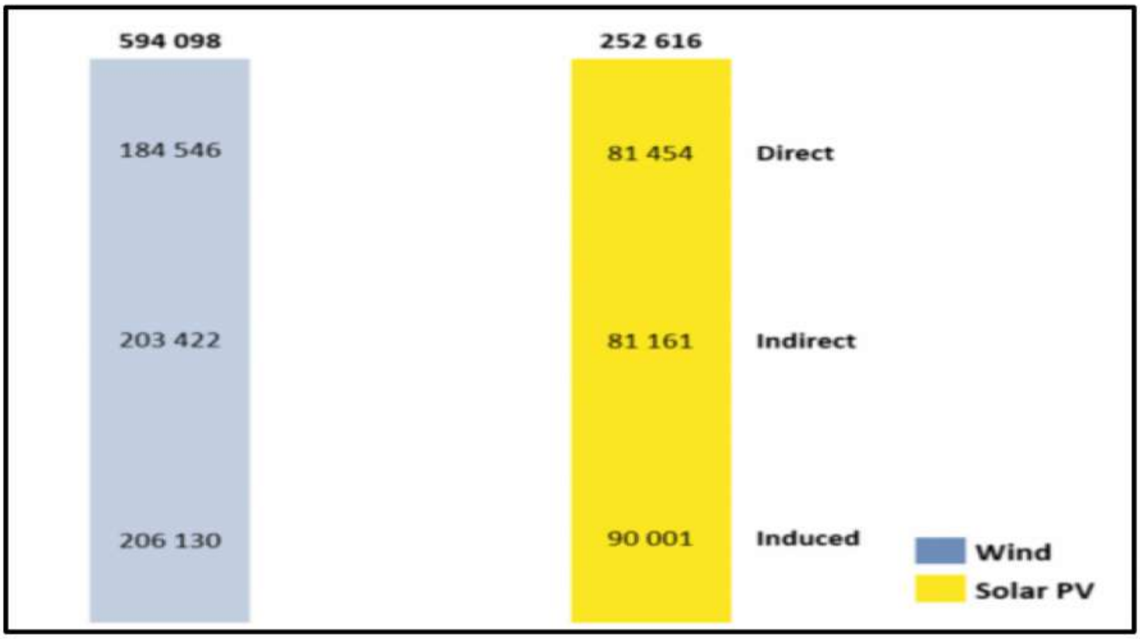

Figure 3: Combined wind and solar PV jobs analysis

Aggregated direct construction jobs for the wind sector between 2020 and 2030 are estimated to be 179 887. Additionally, the aggregated indirect construction jobs are forecasted to be 198 287 for the wind segment. This sums up to 378 174 (direct and indirect) jobs over 10 years. Figure 4 shows a significant number of jobs produced through indirect as well as induced jobs. Moreover, Figure 4 shows that the jobs created from direct, indirect and induced have a similar trend and a strong correlation, as a result, it is important to indicate the multiple job creation quotient of the renewable energy sector.

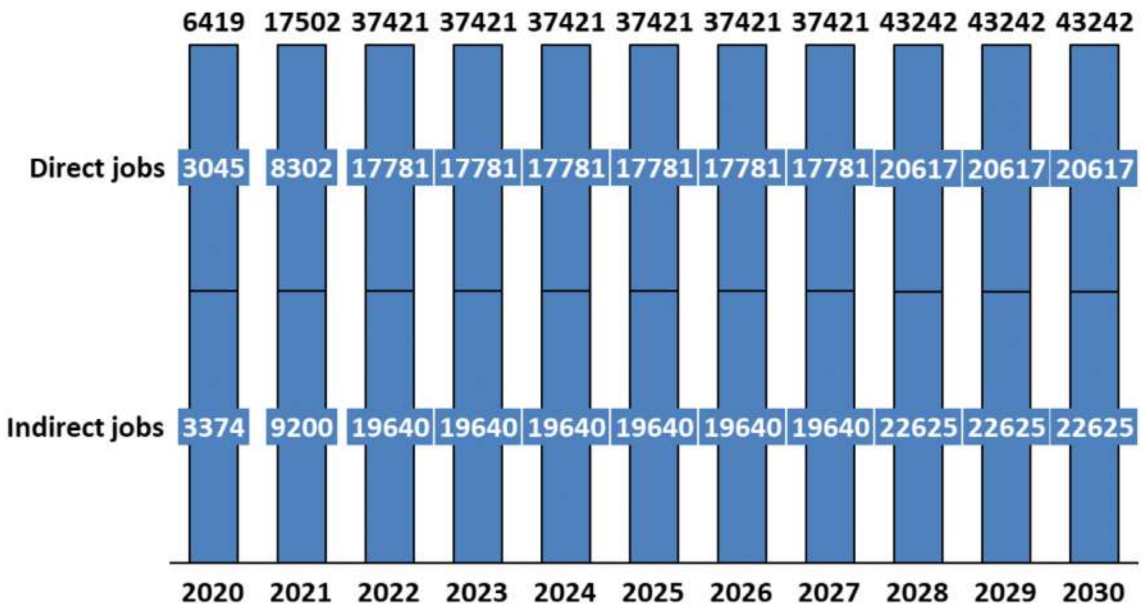

Figure 4: Wind sector aggregated construction jobs

Figure 5 shows wind sector jobs estimates until 2030. The analysis confirmed the limited number of jobs created during Operations and Maintenance (O&M). This calls for a strategic approach to the O&M segment to stimulate employment opportunities created. The total sum of job direct jobs that will be created by the wind sector is 4 659, while the indirect jobs are estimated to be 5 136. The induced jobs are projected to generate 5 582 jobs for the wind sector.

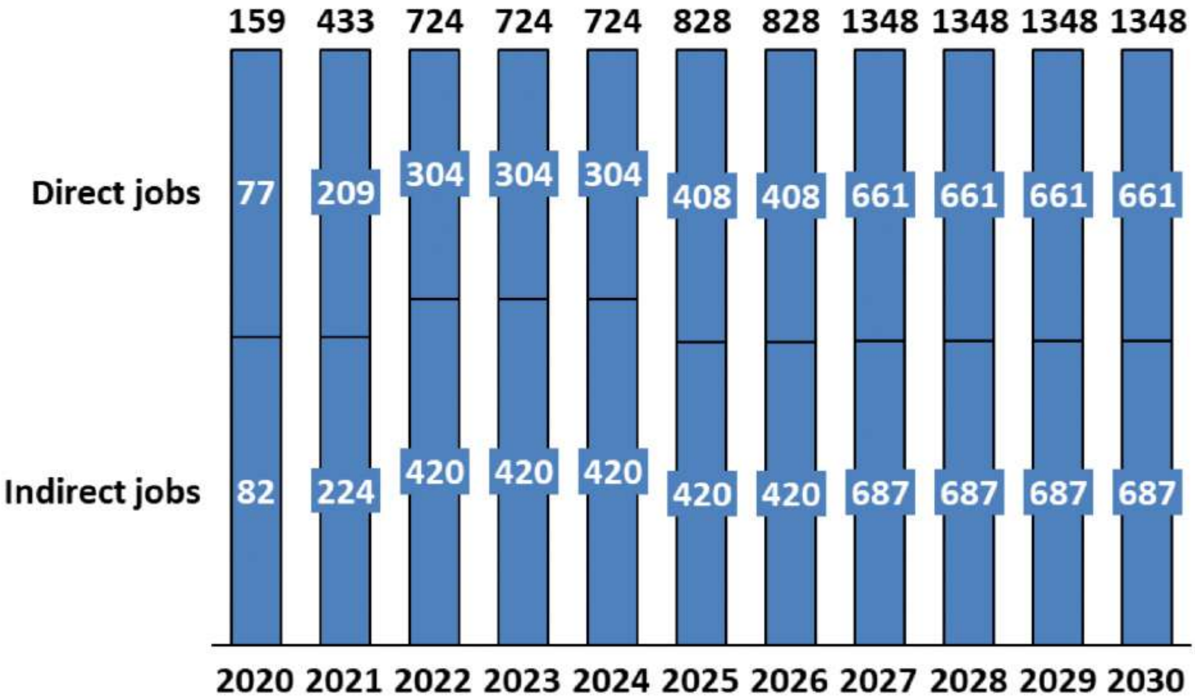

Figure 5: Wind sector aggregated operations and maintenance jobs

2.3.3 Solar PV jobs

Renewable energy employment globally has grown since 2012. In 2017, the strongest expansion took place in solar photovoltaic (PV). In reverse, jobs in wind energy have declined [7]. Globally, solar PV continues to create the highest employment opportunities in the renewable energy sector. The renewable energy employment reached 10.3 million jobs in 2017, a 5.3% increase compared with the previous years. The jobs created in 2018 increased by 7%, reaching 11 million jobs[10], [11]. In 2018, 3.6 million jobs were created by the solar PV sector, the wind sector created approximately 1.1 million jobs (see Figure 6). Many countries derive socio-economic benefits from renewable energy, but most of the employment benefits remain highly concentrated in countries like China, Brazil, the United States (US), India, Germany and Japan leading the pack. In 2017, China alone accounted for 43% of all renewable energy jobs. Its share is particularly high in solar heating and cooling (83%) and in the solar photovoltaic (PV) sector (66%). Figure 6 shows that solar PV industry was the largest employer with almost 3.4 million jobs, up by 9% from 2016. The growth transpired in China and India, while South Africa, the US, Japan and the European Union (EU) lost jobs.

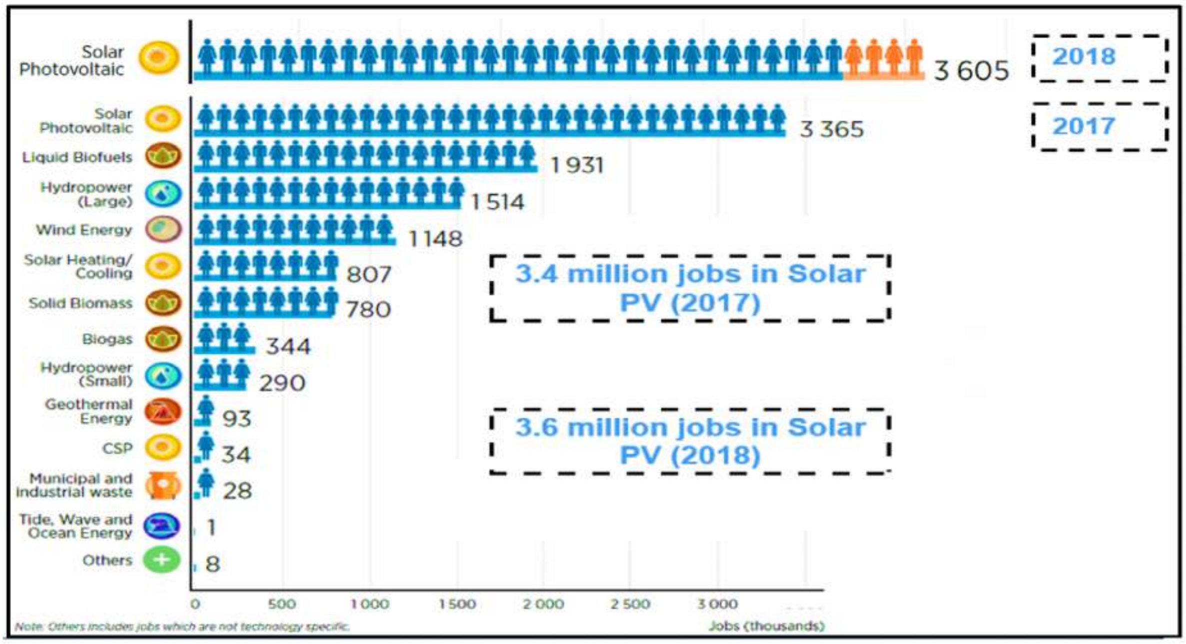

Figure 6: Employment by renewable energy technologies (IRENA, 2018; IRENA, 2019).

The falling costs of renewable energy technologies continue to drive the deployment of solar PV. Job creation challenges for renewable energy in the South African energy transition is that most of the components that are used are not produced domestically. Corporate strategies and industry alignments are important factors in the context of creating jobs and ensuring that some renewable energy component are produced locally While we know that a significant portion of the supply chain does not happen in South Africa, it is important for South Africa to define an energy transition pathway that will ensure that socio-economic impacts of coal phase-out are prudently managed. Aggregated direct construction jobs for solar PV sector are estimated to be 79 776 between 2020 and 2030. Additionally, the aggregated indirect construction jobs are forecasted to be 79 062 for the solar PV segment. This sums up to 158 838 (direct and indirect) jobs over 10 years. Figure 7 shows a significant number of jobs produced through indirect as well as induced jobs. Again, for the solar PV sector, a similar trend is observed between direct, indirect and induced jobs that are created thus highlighting a strong correlation.

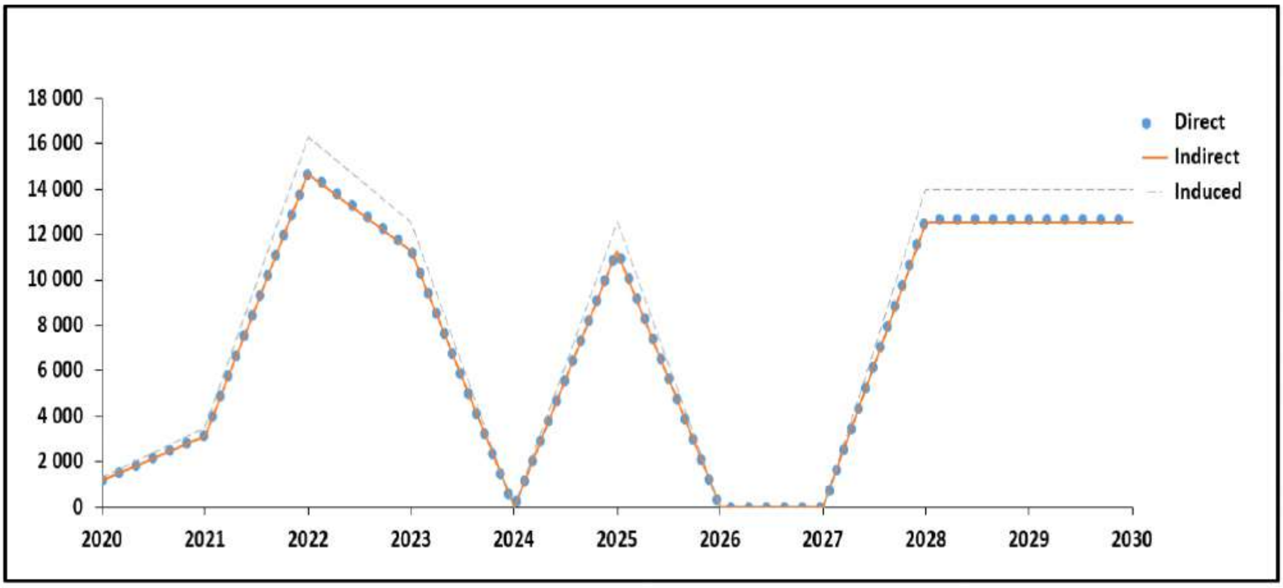

Figure 7: Wind sector aggregated construction jobs

2.3.4 South African solar PV sector job analysis

Figure 8 shows solar PV sector jobs estimates until 2030. The JEDI model analysis confirms the limited number of jobs created during Operations and Maintenance (O&M). This calls for a strategic approach to the O&M segment to stimulate employment opportunities created. The total sum of job direct jobs that will be created by the solar PV sector is 1 679, while the indirect jobs are estimated to be 2 098. The induced jobs are projected to be 1 916 jobs for the solar PV sector.

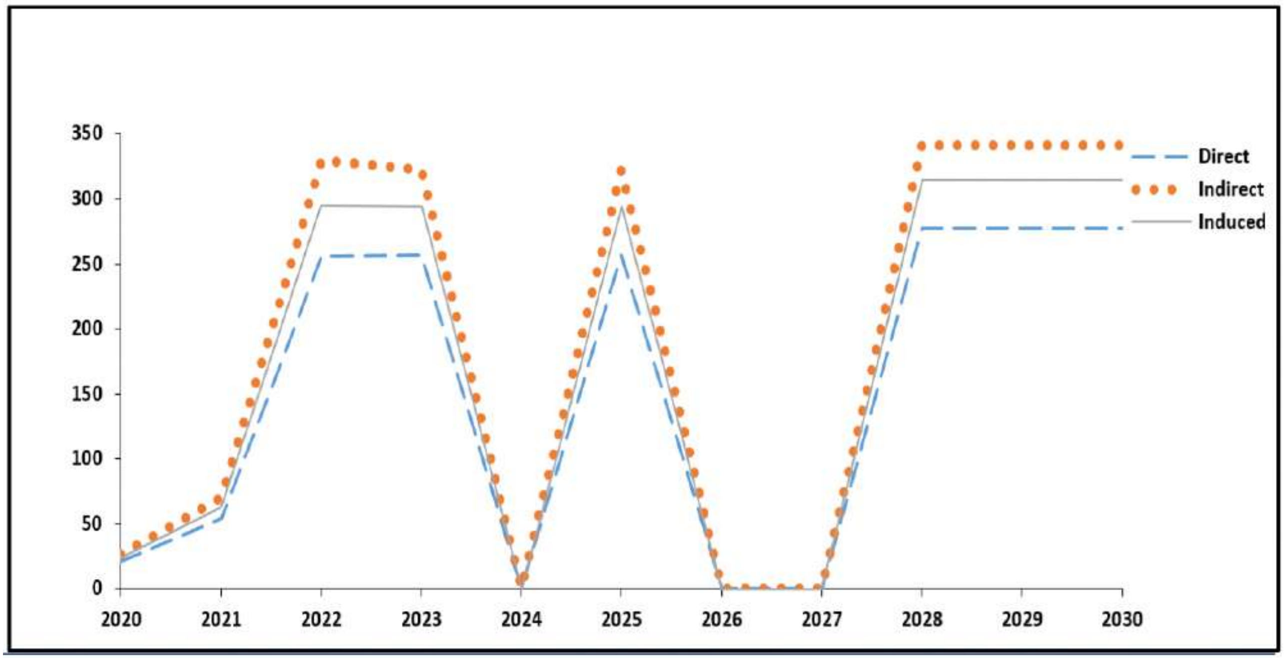

Figure 8: Solar PV sector aggregated operations and maintenance jobs

3. ASSESSMENT OF SKILLS REQUIREMENT IN THE SOLAR PHOTOVOLTAIC (PV) AND WIND SECTOR

3.1 Solar PV technology skills assessment

The determination of the skills for Solar PV is guided by the different value chain stages that present various opportunities in the solar PV value chain. Figure 9indicates the stages in the value chain.

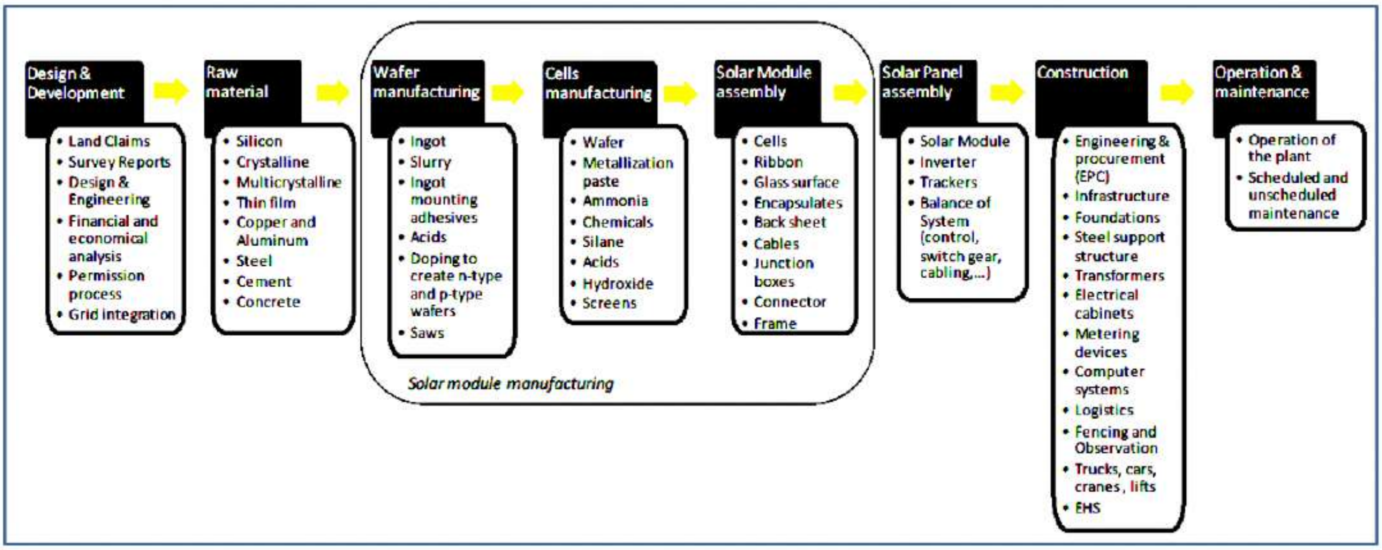

Figure 9: Solar PV value chain (Source: SADC Energy Foresight Study)

These activities in the value chain are dependent on the availability of resources in the country such as infrastructure, the know-how and the market. Below is a summary of the different value chain stage, with the identification of the required skills in each one.

3.1.1 Design and development

The initiation stage of the project comprises of conceptualization of the idea, verification of viability of the idea, which leads to granting of the permission for the establishment, particularly for the land use. Studies such as the Environmental Impact Assessment (EIA) is done, to ensure there are no negative impacts on society, the environment. This phase consists of designing of the project, selection and sizing the equipment and development of the plant layouts. The formal submission is done, through the project developers, to the Department of Mineral Resources and Energy for approval. Therefore, the critical skills required at this stage include project developers, design engineers, environmental assessors and others.

3.1.2 Raw material production

This stage of the value chain focusing on the production of the raw material which will be used in the production of the equipment that will be required for the solar panels. This comprises of a variety of suppliers that are not only supplying the solar PV industry but other sectors as well. This includes companies like ArcelorMittal that supplies steel, PPC that supplies cement etc.

Therefore, less focus will be given to this stage, with regards to the skills that exist, as it is much broader than the solar PV industry.

3.1.3 Solar module manufacturing

The panel comprises of components (such as wafers, cells) that are manufactured individually, and subsequently assembled. Top producers of these components are located in countries such as China, Germany, Taiwan, the United States of America (USA) and others. The assembling of these components has created job opportunities in South Africa, where relevant skillset is utilized.

3.1.4 Solar panel assembly

Various components sourced from different suppliers are assembled in South Africa, by companies such as ART Solar. This field has created a market for solar specialists and professionals. The skillset required for panel assemblers are trade workers who build units for electrical or mechanical equipment (Study.com 2019).

3.1.5 Construction

The construction of a solar PV plant sees many jobs created through this value chain stage. Various activities are performed by companies that provide Engineering Procurement and Construction (EPC). Activities include final equipment design, selection and procurement of equipment and components, and construction of the plant. A variety of skillset is used from engineers, designers, procurements specialists, technicians and more.

3.1.6 Operation and maintenance

This stage of the value chain presents some job opportunities for the locals, where many suppliers play the role of operation and also maintenance of the equipment. Skillset found at this stage is dominated by the technicians and electricians that performs monitoring of the system (which can be remote and less frequent) and providing maintenance services.

3.2 Summary of career disciplines required in solar PV

The summary of the skillset required is discussed below, paying attention to the critical career disciplines as aligned with the activities in the value chain that has been identified to apply to South Africa. These are divided into System Design, Project Development and Installation, Operation and Maintenance, with the relevant information on various career disciplines sourced from Solar Energy International (Solar Energy International 2018).
The summary of the skills required for the different solar PV value chain, is described in Figure 10.

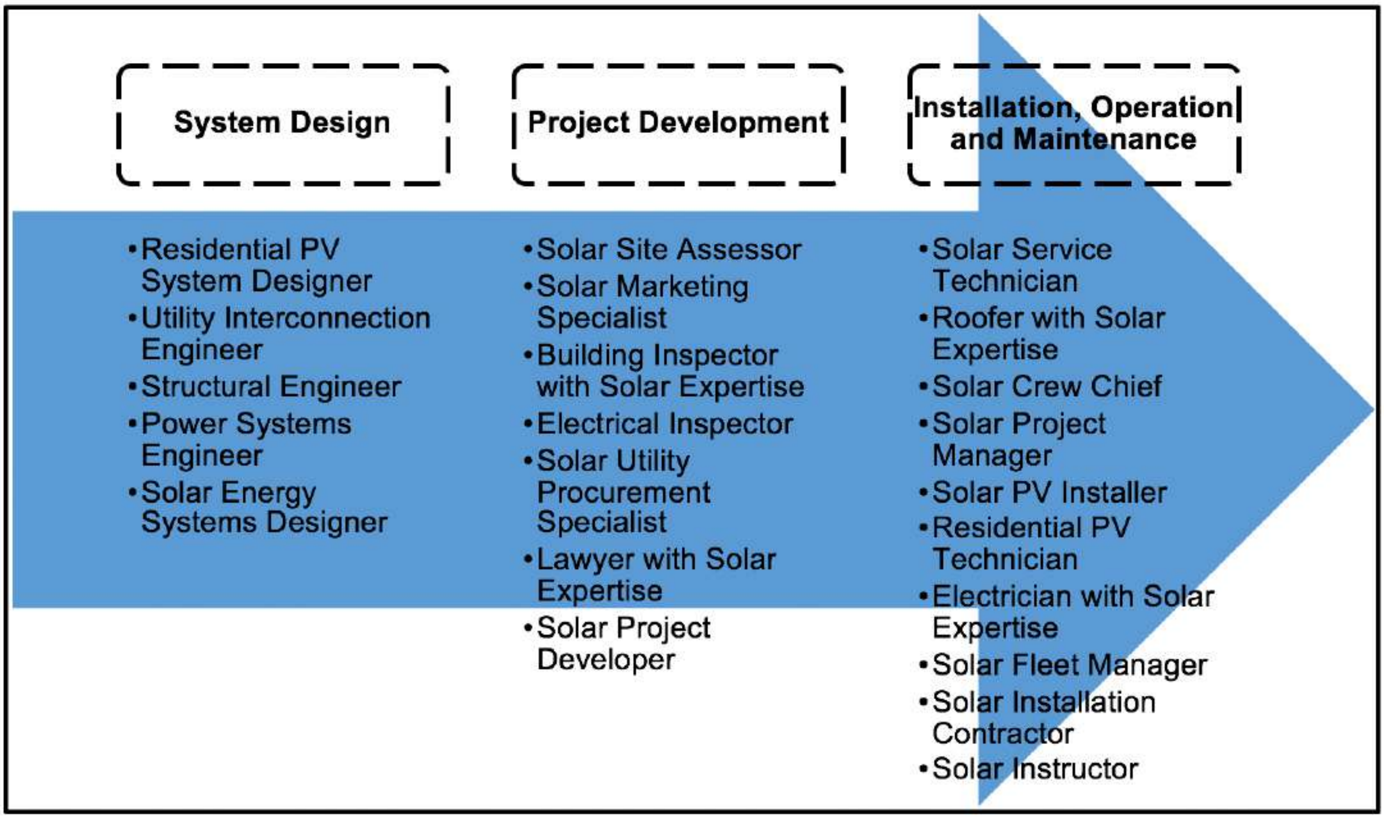

Figure 10: Skills requirement in the Solar PV industry

3.2.1 System design

The skills requirements that the System Design phase involves a wide range of skillset that achieves the objectives of this phase, and it includes different career disciplines with different activities to perform, with different skills and qualifications. Below are some of the identified role players in this phase.

- **The Residential Designer is** a designer of solar PV systems for residential customers. They participate during site assessments and installations. After the designer has been determined the client's needs and site characteristics, they finalize all the necessary calculations to size the solar energy system. The Residential Designer selects the components and establishes all of the project's electrical and mechanical specifications. They provide the plans for construction as well as the permit.
  - The skills requirements for Residential PV System Designer include proficiency in drafting, using AutoCAD software and knowledge of construction techniques. They must be familiar with codes and standards that govern PV installations. They are further required to have critical thinking and problem-solving skills, and the ability to pay attention to details. They must possess effective communication skills with both technical and non-technical individuals.

- **Utility Interconnection Engineer** manages the interconnection of the electric grid and power generation equipment. Some of the functions include design, evaluation, and problem solving (material or technical). The Utility Interconnection Engineers (UIC) are responsible for different functions in various stages of the project from initial site selection to power generation. They perform resource planning and oversee the quality of the design. They manage the application for interconnection as well as the agreement process. They further conduct the technical evaluation and due diligence for utility interconnection. The engineers manage equipment specifications, concept design drawings, power flow analysis, site evaluations, interconnection budgets, single line and three-line diagrams.

- Utility Interconnection Engineers are required to have technology design and computer skills and to have the knowledge of the medium and high voltage design, and also able to pay attention to detail. They are further expected to manage people and projects, to have skills such as decision-making and problem solving. Mathematics skills are another skill they are expected to have. The required professional qualification is a Bachelor's Degree in Engineering.

- **Civil/Structural Engineers** in the solar PV industry perform various tasks which includes conducting structural analyses of the utility-scale PV projects and for residential/ commercial projects. They do evaluations of the structural loads on solar array support structures and buildings. They prepare foundation designs for solar arrays and related equipment. They make preparations of the calculations and drawings for approvals. The Civil/Structural Engineers assists Project Managers by resolving technical issues relating to structural loading. Also, they conduct inspections and do troubleshooting in the field and interface with civil works subcontractors and authorities designated for the building.

- The Civil/Structural Engineers have Mathematical and Science skills. They can conduct operations analysis and perform technology design. They have advanced computer skills and the ability to manage personnel resources. Additional skills include the ability to do systems analysis, quality control analysis, and monitoring of the operations. Also to programming skills. The ideal qualification is a Bachelor's Degree in Civil Engineering.

- **Power Systems Engineers** have the expertise in power generation field, transmission, and distribution. For the integration of renewable technologies such as the (solar PV system) into the grid, they provide research, development and analysis that is required. Their responsibilities may include implementation of commercial and utility-scale solar power projects. They evaluate the efficiency and safety of the existing solar power systems and collaborate with manufacturing engineers to test new equipment. The engineers prepare and study technical drawings, specifications of electrical systems, and topographical maps for installation. The Power Systems Engineers do calculations and establishes manufacturing, construction, and installation specifications. Their responsibilities include monitoring of the installation, maintenance, support, documentation, and testing activities to ensure compliance with specifications.

- They are required to have critical thinking skills, design skills, mathematics and engineering skills. They have proficiency in specialized computer programs and electronics. They are expected to have decision-making and problem solving skills; also the ability to perform quality control analysis. A Postgraduate Degree in Computer Science, Software Engineering are some of the qualifications expected for the Power Systems Engineers.

- **Solar Energy Systems Engineer** performs site-specific engineering analysis of commercial, industrial, or utility-scale solar projects. They design large photovoltaic or solar thermal systems. The Solar Energy Systems Engineers makes recommendations on the engineering and manufacturing changes that will achieve solar design objectives. They develop the requirements for specifications and integration that allows solar power safely, that will flow into the national power grid effectively and efficiently. For solar power systems, they create electrical three-line diagrams using computer-aided design software and run computer simulations of solar PV generation for optimization of the system performance. They provide support and technical direction to field teams during installation, start-up, testing, and system commissioning, and monitoring the performance.

- The Solar Energy Systems Designer must have system design skills. Also, background in mathematics and science. They must be proficient in advanced computer design software, and be able to manage people and projects. Equipment selection, sizing and configuration are some of the technical skills they are expected to have. Bachelor's Degree in Science or Engineering with a significant amount of experience in the solar industry are encouraged for this role in the solar PV industry.

3.2.2 Project development

- **Solar Site Assessors** conduct site evaluation in-person or remotely for residential and commercial solar projects to determine how much energy can be harvested at a given location. This is followed by written and verbal system recommendations to potential customers. They create and share detailed site drawings, reports and analysis. They generate leads, schedule assessments, and meet with customers; assess and document electrical systems and roof conditions. They monitor the patterns of weather and also perform shade analysis. They may determine the size and layout of solar panels, the type, calculation of potential savings and costs, also writing of recommendations in a formal report for the customer is another expectation. The Solar Assessors might facilitate customer financing and rebate. Furthermore, in a large firm, they communicate site details to the company's solar designers and installation teams.
  - The Solar Assessors are required to have experience with programs such as Solmetric SunEye, SolarPathfinder and related. They must be proficient in the use of Microsoft Office. Also, they must possess electrical, thermal and roofing knowledge. Assessors must have strong customer service skills, and be able to pay attention to detail. They must have the ability to explain solar economics. They are required to be self-starters, energetic and be comfortable in a fast-paced environment. They must have the ability to lift and manoeuver the folding ladder. The expected qualification is a grade 12 certificate and having industry-specific training.

- **Solar Marketing Specialists** drive the solar business expansion. They analyse the promotional potential of a solar company and create advertising tools as well as the outreach programs. They evaluate the consumer market needs. They acquire knowledge of trends and consumer demands relevant to the marketing of solar energy goods and services. They gather data and use it to create marketing campaigns for solar energy markets. They develop branding initiatives for solar energy products. Solar Marketing Specialists research to gather customer opinions and marketing strategies that are related to solar energy technologies. They develop communications materials (including presentations, advertisements etc.).
  - A Bachelor's Degree in Business or Marketing is preferred, with specific industry training.

- **Building Inspectors with Solar Expertise** in the solar industry, do inspections of the solar-related structures to determine structural compliance with the relevant specifications, building codes and other relevant regulations. They inspect quality and safety during and post-construction of the solar energy systems, buildings, foundations, the wiring, plumbing, the electrical circuits and other solar power-related structure. They approve and sign plans that meet required specifications, site layouts and specifications as well for compliance with legal requirements and safety regulations. They further monitor the installation to ensure compliance with regulations.

- The Building Inspector is required to have skills either as a general electrician, carpenter and/or plumber. Have a thorough knowledge of building safe and construction practice. They must know standards on solar installation and the related codes and have basic skills in mathematics. Specific solar training is critical for quality inspections.

• **The Electrical Inspectors** conduct inspections to confirm safety, functionality and conformance to the codes of the electrical systems and equipment. They inspect the solar PV system wiring and check whether the electrical system can handle the load that will be placed on it. They confirm that the PV system can work properly with the electrical system and that it is compliant.

- The Electrical Inspectors are required to have advanced electrical theory and practice, a thorough understanding of the Institute of Electrical and Electronics Engineers (IEEE) standards. They must know the electrical code. They need to have skills in problem solving, decision making and have good judgement and an ability to pay attention to detail. Basic mathematics knowledge is preferred. Electrical construction training is advantageous.

• **The Solar Utility Procurement Specialist** develops contracts for solar energy delivery. They negotiate favourable terms, hey build strategic relationships with new and existing solar producers. They prepare the Requests for Quotations (RFQs) and purchase orders; they further verify the accuracy of requisition orders and specifications. They check if there's sufficient stock to meet the needs. The Solar Utility Procurement Specialist maintains and reviews purchasing and pricing reports and tracks the status of requisitions, contracts, and orders. They analyse energy portfolios to support procurement recommendations by the utility's renewable energy procurement leadership. They conduct research that is related to regulation and economic issues.

- The Procurement Specialist has qualifications such as Bachelor's Degree either in Finance, Accounting, Business Administration, or related field, with a strong background in mathematics and writing skills. They are required to have skills such as interpersonal skills and advanced skills in mathematics and finance, and have the ability to establish and maintain strong professional relationships. They are to have research and negotiation skills, as well as written and verbal communication skills. They must be proficient in specialized software, and know solar market trends. The ability to pay attention to detail is another skill required.

• **Legal Practitioners with Solar Expertise** represent clients in regulatory proceedings. They draft contracts and legal documents. They assist clients with project development (including issues such as land use and control) and financing and further advise clients on regulatory compliance matters. They assist with contracting and negotiation of complex transactional documents, tax guidance, and project financing.

- Qualifications for the legal practitioners could be three years or a four-year degree from law school, where solar expertise may be gained through certification in energy law or through experience. They need to have critical thinking and problem solving skills. They are also expected to have advanced judgment, decision making, and negotiation and persuasion skills. Knowledge of solar industry, energy and environmental fields is required. Knowledge of contract and regulatory policy is also required.

- **The Solar Project Developer** produces the most effective solar energy solutions for their clients by combining the best technologies and sites. They provide a critical connection between engineering, procurement, and construction. They are responsible for securing land rights, building permits, interconnection rights, and property tax agreements.
  - Developers follow diverse educational pathways into their careers, but may hold a Bachelor's Degree in Science, Engineering, Science, or Finance, and at times an Master's in Business Administration (MBA). They are required to have skills such as networking, finance, organizing, and finance skills. They are further required to have leadership and management skills. They need advanced cost/benefit analysis skills. Further skills include multitasking, negotiation skills etc.

3.2.3 Installation, operation and maintenance

- **The Solar Service Technician** installs PV system equipment, maintenance and repairing electrical wiring. They make sure the work is compliant with electrical and building codes. They assemble, install, test electrical systems and do maintenance of PV-related electrical/ electronic wiring, equipment, appliances, apparatus and fixtures. They connect high-voltage equipment, inverters to the building's power supply.
  - They can train through registered apprenticeships. They need troubleshooting skills, skills to repair and perform maintenance of specific PV equipment. Good judgment and decision-making skills. They require the ability to monitor plant operations and ensure quality control. The management of resources and personnel is another skill expected of the technician.

- **The Roofer with Solar Expertise** installs racking systems, using best practices. They mount photovoltaic panels. They install, inspect, and repair roofs for support of solar array and ensure that any cuts or holes made in the roof during the installation of solar panels and mounting racks are properly repaired and sealed. The Roofer installs mounting systems and structural supports for rooftop solar energy systems.
  - The Roofers with Solar Expertise undergo a 3-year apprenticeship and also are trained on the job. They are required to have a mechanical drawing and carpentry skills. They need to have expertise in installation and repair. They need to have an ability to work at heights. Furthermore, they need general electrical or plumbing skills.

- **The Solar Crew Chief** is the supervisor of teams of basic PV installers and reports to a Project Manager. They determine work requirements from specifications, verify the safety of equipment and provide quality assurance. They coordinate and encourage their team and keep them focused and on schedule. They check tools, keep track of the installation progress, and inspects and documents work.
  - The minimum qualification for Solar Crew Chief is a grade 12 Certificate. They do not necessarily advance through formal education; they learn on the job. The Solar Crew Chief is required to have basic skills in mechanical, electrical and construction. Be knowledgeable about the fundamentals of solar PV. They must have basic knowledge of best practices of PV installations. Ability to work at heights and have good communication skills.

- **The Solar Project Manager** is responsible for the coordination of all workers and materials involved in a solar installation. They manage time and budgets. They aim for efficiency in the implementation of project plans, keep track of tasks, the resources, schedules and costs.

- Their responsibilities include ensuring the quality of work and manage safety on site. They coordinate various stakeholders' subcontractors, installers, technicians, vendors, and they monitor their work to ensure that they are compliant with expectations. They report on progress to owners, project developers, and financial partners. A suitable qualification is a Bachelor's Degree, however, the skill is learned on the field and enhanced in the classroom. The Solar Project Managers are required to have a deep understanding of solar energy systems. Skill in management of personnel and resource is critical. They must have time management skills, multi-tasking and coordination skills. Also they must have skills to perform complex problem solving, troubleshooting and decision making. Furthermore, to have critical skills like budgeting and planning, monitoring of operations and quality control analysis are key. They also need to be familiar with construction tools and technology. Solar Project Manager needs to be software proficient.

- **The Solar PV Installers** have extensive knowledge of electrical wiring and the electrical codes. They have technical and engineering skills with the ability to work with power and hand tools at great heights. They pay attention to quality control.
  - The Solar PV Installers are responsible for professional installation on either residential or commercial installation. They use specific site characteristics, and design and prepare the system layout. They also obtain permits. Some of the responsibilities include measuring, cutting, assembling, and to bolt structural framing and solar modules. They attach the panels to the roofs or ground mounts safely and complete the wiring and connection of the system. They perform an inspection on the equipment installed and structures to ensure compliance with safety codes. The commission the system and further set up and maintain the equipment and wiring that connects the solar energy system to the electrical grid. Most Installers have engineering, skilled trades, and/or electrical background.

- **Residential PV Technicians** monitors analyses, optimize and repairs a PV system that might be underperforming. They are quality assurance professionals. They drive to multiple sites to perform various tasks including inspection, testing, cleaning, calibration, and maintenance of solar module systems and other related hardware. The work they perform may include electrical troubleshooting, diagnostics and repair of the inverter, integration of network and optimization.
  - Qualifications for the Residential PV Technicians is a degree in Mechanical, Electrical or related. Skills requirements for Solar PV Technicians includes troubleshooting, complex problem solving, monitoring of the operations. They require experience in mechanical and electrical construction. Also, the ability to work at heights. Other skills include verbal and written communication skills.

- **Electricians with Solar Expertise** are responsible for installations, maintenance and repair of electrical wiring, equipment and other fittings for PV systems. Also, they need to ensure that the work complies with codes: electrical and building. Some of their tasks may include the connection of solar panels, inverters and other high-voltage equipment to the power supply of the building. The electricians are responsible for preparation of the layout and installation of PV-related electrical wiring, equipment and fixtures, as per the job specifications. They assemble, install, test and maintain PV-related electrical/electronic wiring, equipment, appliances, apparatus and fixtures. They perform tests on the PV electrical systems to ensure their safety and compatibility.
  - They can train through registered apprenticeships that combine worksite and classroom instruction, to gain the skill. The electricians require troubleshooting skills, decision making and plant operation monitoring abilities. They are skilled in the repair and maintenance of specific PV equipment. They ensure quality control, management of personnel and resources.

- **The Solar Fleet Managers** manages third-party vendors to service residential or commercial solar installations, to ensure service level agreements are met. They oversee the coordination of logistics for existing and new solar installation equipment. They manage the system for monitoring, to guarantee the quality operation of residential or commercial solar energy systems. They develop strategies and implement processes in ensuring service levels agreements are maintained. They address the quality of both technical services and customer relations. Fleet managers may coordinate the remote monitoring of installed solar systems, and enforce a decision-making structure for dispatching O&M technicians.
  - The ideal combination of skill is a degree in business with solid field experience in solar energy operations. Certification is advantageous. The Fleet Manager is required to have a technical and an understanding of solar energy systems in residential or commercial. Also, to have the general understanding of the solar industry. They are to have an active listening skill, complex problem solving and critical thinking skill. Also, the Fleet Manager is required to have the ability to coordinate people and resources. They must have additional skills like organizing and multi-tasking. Furthermore, they must have experience in vendor management programs and logistics services. Abilities on written and oral communication skills.

3.3 Wind technology skills assessment

Wind energy is a specialized sector that comprises of various career discipline at different project stages. The skillset required stems from the generic profession (e.g. Civil Engineer), with additional knowledge required specifically for the wind energy. Some of the professions are found across the different project stages, performing tasks that might differ slightly amongst the stages. An example is a Wind Mechanical Engineer. The skillset unpacked below is found mainly in the construction, operation and maintenance stages of the value chain (as per the diagram below in Figure 11, which are areas of interest for the South African market, in unpacking the skills required for the industry.

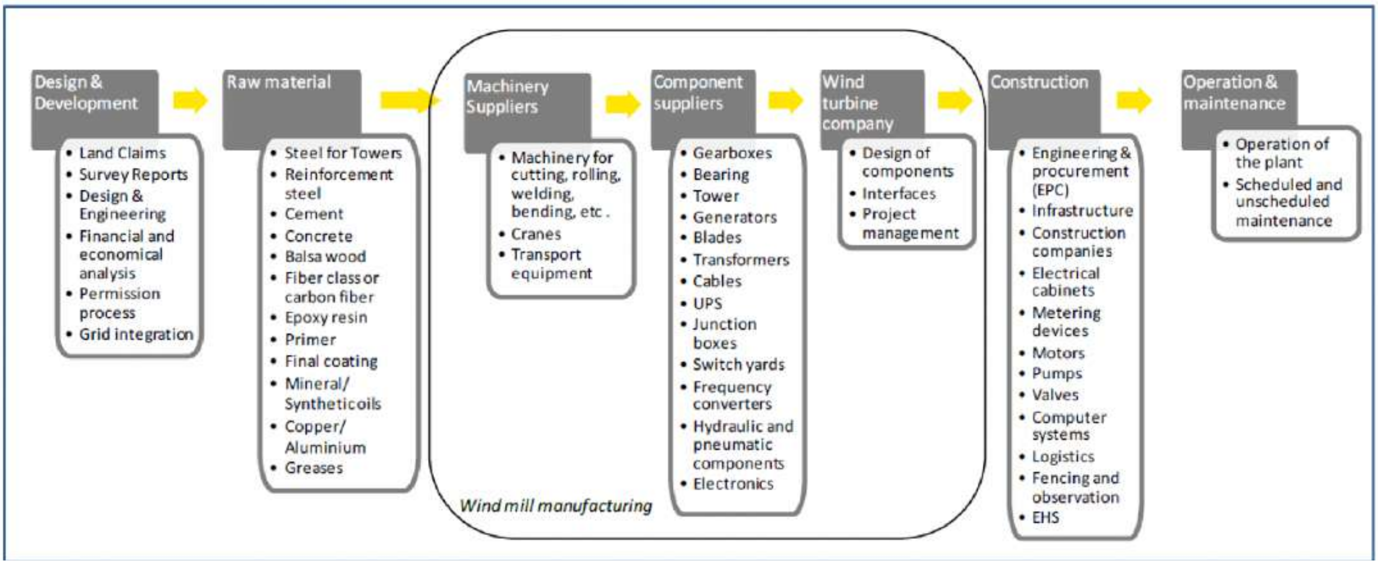

Figure 11: Wind energy value chain analysis (Source: SADC Energy Foresight Study)

Wind component manufacturing is a high-tech field that is currently done in certain developed countries such as Germany, and Denmark, therefore, less focus is put on this field. However, South Africa has several component manufacturers located in different provinces, including Gauteng, Eastern Cape, Kwa-Zulu Natal, Western Cape, producing components such as turbines, wind energy towers and structures, grid connection system, battery charging systems etc. on a small scale (Momentum Technologies 2016).

The stages of project development of the wind farms include the following stages, which are followed from conceptualization through the establishment, where various stakeholders participate and give input. Below is a brief overview of the activities in different stages.

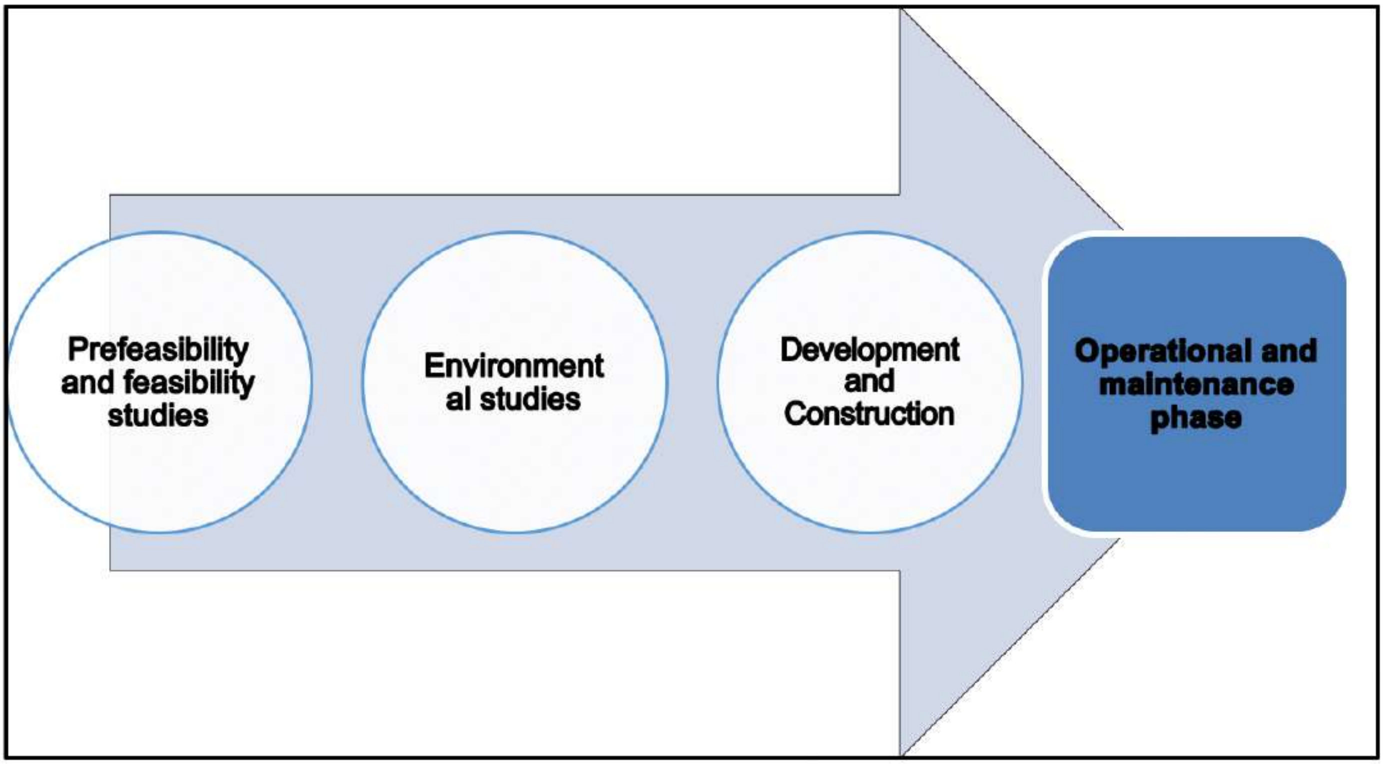

Figure 12: Prefeasibility to operations and maintenance value chain

3.3.1 Prefeasibility and feasibility phase

The phase is referred to as a conceptualization phase, where the idea of developing a wind farm is unpacked, looking at the conditions of the farm, the location of the plant and viability thereof. On a high level, aspects of the project that include the availability of wind in a particular area has to be determined to ensure, the suitability of the location for the wind farm. Furthermore, viability of the project is assessed, in regards to the finances and the factors that are in relation to the social and environmental issues. In-depth analysis is done as soon as the preliminary analysis has been concluded, for specific wind scenario. The entire wind system is designed, the mechanical and electrical, sizing of the equipment and planning of the point of connection to the energy grid. Once the site has been identified and selected, the landowners are to permit the wind farms to be developed. Once the land has been acquired, an application with the Department of Mineral Resources and Energy (DMRE) is done, through submission of a proposal of the development of the wind farm. Skills required in this phase includes design engineers, environmental scientists, lawyers and others.

3.3.2 Environmental studies phase

The proposed project before the approval, according to the regulations in South Africa governing the construction of wind farms, the project application needs to go through an Environmental Impact Assessment (EIA). The exercise undertakes to evaluate the impact the project will have on the environment, noise levels, wildlife and others to ensure the development of the project do not negatively impact on these. Granting of the EIA is based on meeting the strict criteria set. This gives authority for the project to continue to the next stage of development. The outcome of the study will be evaluated by the department, where the advantages and disadvantages of the establishment are weighed. Where the positive impact outweighs the negative impact, then the project will be approved. The main skills requirements for this phase is Environmental Specialists.

The main purpose of the Environmental Specialists is to protect the human health and the environment, using the knowledge of natural sciences. The qualification they are required to have, is the Bachelor's Degree.

3.3.3 Development and construction phase

The construction phase sees final engineering of the equipment, procurement of the equipment and the installation. The construction team is identified and appointed, and the necessary resources are sourced and transported to the site. The equipment and its components (including electrical components), as well as the associated infrastructure, are installed on-site. Once they are set-up, the connection is made. The commissioning of the plant follows once the installations have been concluded, where all systems are tested for correct functioning and efficiency. Successful commissioning leads to the wind farm launch. Overall skills requirements for this phase includes civil, mechanical, electrical engineers, project engineers, trade workers and more.

3.3.4 Operational phase

The operation of the wind farms is kept controlled and according to the design. This consists of plant control, which is done onsite or remote, where activities are monitored, this to ensure a smooth plant operation. Continually thereafter, the wind farm is monitored daily, whilst the routine maintenance is also undertaken. Also, a follow-up environmental study is done to assess project impacts. The skillset required in this phase includes wind technicians, site managers, electrical engineers, mechanical engineer and other career disciplines.

3.4 Summary of career disciplines in wind energy

Various career disciplines in the wind industry are divided into four pillars that are aligned with the value chain that includes project development, component manufacturing, construction and operation and maintenance. Some of the fields are generic, however with specialized knowledge to the wind industry. The information is sourced from O- Net Online (O Net Online 2019) as well as Solar Energy International (Solar Energy International 2018)
The summary of the value chain of the wind technology is shown, in figure 13, with the respective skillset required on each one.

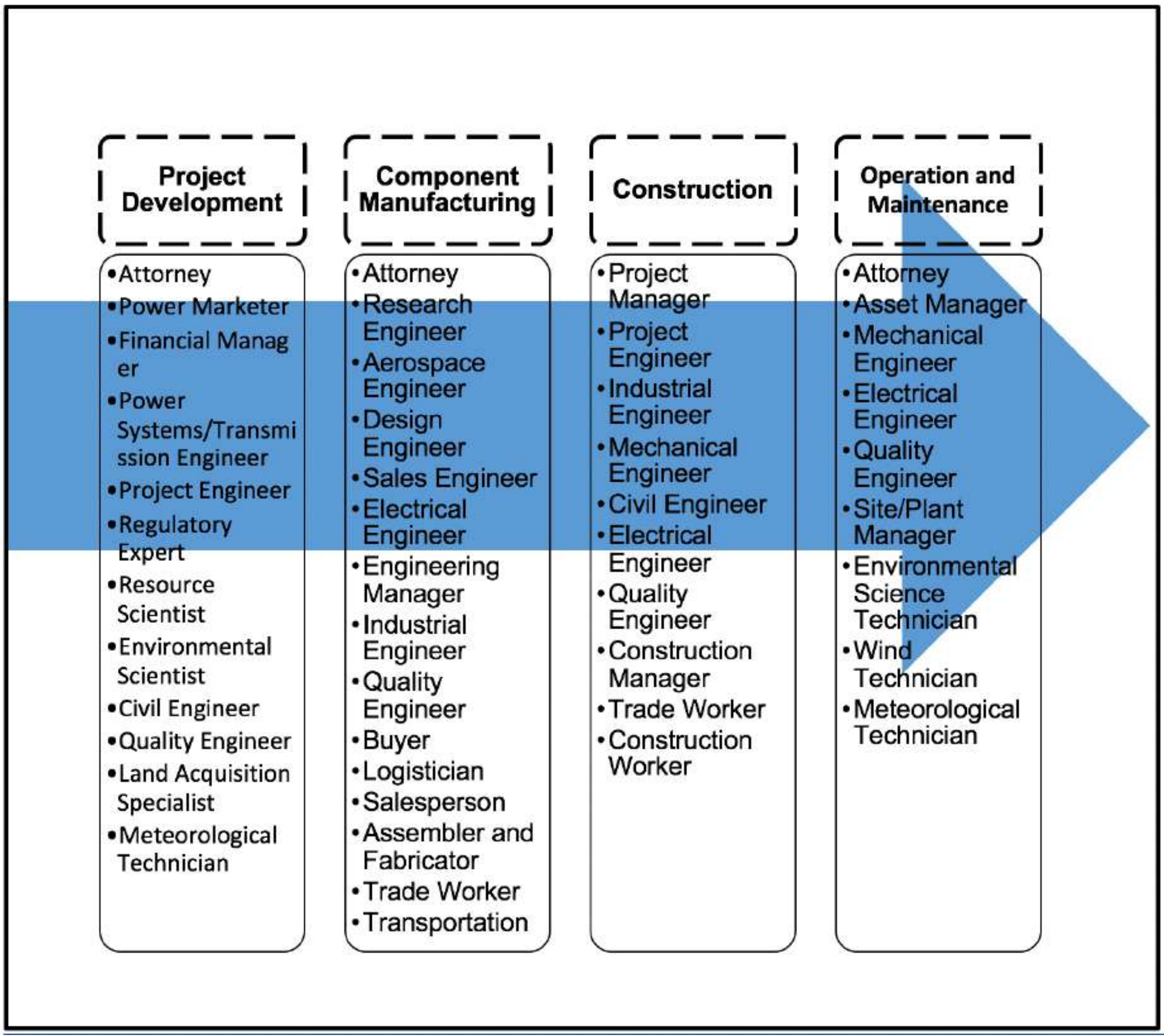

Figure 13: Wind sector skills requirements

3.4.1 Design and development

- **Meteorological Technician** has a specific role to play in the development phase of wind energy farms. Their responsibilities include installations of the meteorological towers and equipment at identified locations to capture information regarding the potential wind resource. They also perform maintenance of the equipment, relocation and decommission thereof. They ensure the tower communicates properly and all the sensors connect accordingly with the logger.
  - Skills the Meteorological Technicians are required to have included troubleshooting skills, communication, mechanical skill and navigation skill. They are required to have physical stamina as well.

- **Resource Scientists** play a role in the development stage, where they make assessments on the establishment of renewable energy technologies, through studies of weather, climate and the site conditions. They utilize the sourced data to make energy predictions of the wind plant. They further assess the placement and suitability of sites for technology deployment.
  - Some of the skills required by the Resource Scientist include communication skills, critical thinking, mathematics and writing skills. They need to be familiar with software for wind design, meteorological instrumentation and data management. They also need to be familiar in using the SCADA system and have a knowledge of statistical methods.

Formal qualification for Resource Scientists is the Bachelor's degree Atmospheric Science, Mathematics, Engineering, Statistics. Master's degree or a PhD is advantageous.

- **Design Engineers**. At the conceptual stage of development, one of the critical skills required is that of the Design Engineers. They play a critical role in formulating plant layouts, drawings, and visual material. They prepare site specifications for the designs, generate models to the wind farm layout for things like the crane paths, substations, transmission lines, crane pads, collection system and provide engineering technical support to those designing the prototypes of the wind turbines. They do experimental work on the turbines technologies for particular properties that includes noise, production, load, aerodynamics. Design Engineers further give recommendations on compliance with the regulations, input on the infrastructure and process changes which can improve the performance of the wind turbine and also on how to minimize the operational costs.

- **Project Engineers** are required during the conceptual phase, where they provide support to the Project Developers and Project Managers, by integrating the wind assessment studies during the project development stage. They further assist with layout designs, managing pricing for the construction process. The Project Engineers either becomes the Construction Manager or assist Construction Managers when the project transition to construction when it has been awarded the Power Purchase Agreement (PPA). Where there's a third technical party on-site for the project, they manage them.
  - Some of the skills required by the Project Engineer include project management, communication, problem solving, mathematics skill, and decision making and leadership skills. They also need to be familiar with wind resource assessment, wind energy, quality management and construction management processes. Formal qualification required for the profession Bachelor's degree in one of the disciplines: Mechanical, Aerospace or Electrical engineering.

3.4.2 Component manufacturing

- **Aerospace Engineer** in the component manufacturing stage plays a role in designing the wind structures and systems from concept phase until production. They create plant layout and do estimates of the energy production for the wind plants. The engineers design, test, and supervise the manufacture of turbine blades and rotors. They further conduct aerodynamics assessments. Also, they get involved in site selection and work closely with the meteorologists to determine the optimal configuration of turbines.
  - Skills required for Aerospace Engineers include analytical skills, critical thinking skills, and mathematics and writing skills. Also the ability to be a good team player. They need to have exposure to composite manufacturing, wind turbine design and wind plant layout and optimization. Formal qualification required for Aerospace Engineer is Aerospace Engineering or another field of engineering/science related to aerospace systems.

- **Design Engineers** in this phase are responsible for designing and analysing the structures of the wind turbine and components, to ensure the system generates the most power. They work on the entire life cycle of the products, from conceptualization, designing, and development. They further provide support during tests, manufacturing, installation, as well as during operation.

- Skills required for the Design Engineers include technical skill, analytical and problem solving skills. Also, they are required to be creative, be a team player and have good communication skills. Qualified Design Engineers possess qualifications such as a Bachelor's degree in Electrical or Mechanical Engineering or a related discipline.

- **Assembler and Fabricators** are responsible for the assembling of parts and products of different equipment. They are expected to read and understand detailed schematics and blueprints and work closely with the designers and engineers in product development. To perform their tasks, they use tools, machines, and their hands to make generators, computers, electronic devices, towers and blades, and other parts. They further perform quality control checks.
  - Skills required include mathematics, mechanical and technical skills. They need to have physical stamina and have a clear colour vision. Achievement of a grade 12 certificate and experience as well as additional training is required for more advanced assembly work.

3.4.3 Construction, operation and maintenance

- **Wind Construction Managers** are responsible for the coordination of supervision of the construction of wind plants. They provide support to Project Managers with project planning and the estimation of costs. They supervise the building of utility-scale wind plants that includes electrical systems, turbine and infrastructure installations, and building roads. They work closely with civil engineers, welders, electricians and others, to ensure successful implementation.
  - They are required to have skills in decision making and problem solving skills. Also to have managerial and technical skills, to have time-management and communication skills. A bachelor's degree in construction is a qualification requirement.

- **The Wind Turbine Technicians** are responsible for installations, inspections, maintenance, operation and repair of the wind turbines. They are to ensure the turbines are functional and effective. They further service the underground transmission systems, field substations, or fibre optic sensing and the control systems. They monitor operations, replace parts and do repairs. Wind Turbine Technicians can diagnose and fix any problem that could cause the turbine to be shut down (hydraulic, mechanical or electrical malfunctions).
  - Some of the required skill for Wind Turbine Technician includes mechanical, situational awareness, to be results-driven, and to be customer focus. Furthermore, they are required to have good communication skills, to be a team player and have skills to manage stress. The Technicians need to have the ability to work at heights, performing various tasks. A certificate or a four-year degree is acceptable. The training normally lasts for two years, but some of the courses can be more intensive

- **The Repair Wind Turbine Technician** performs routine maintenance on wind turbines. They are expected to read, analyse and interpret various technical documents such as the manuals, procedures, technical reports and some business correspondence. They climb towers to conduct troubleshooting, to repair the equipment or for inspections. They perform troubleshooting on electrical malfunctioning, hydraulic and any mechanical issues. They also write reports, manuals etc.
  - Skills requirements include the ability to climb the stairs and ladders a height above 125m, be certified in rigging and signaling, have the comfort of working at remote sites with

extreme weather conditions. The technicians to have the ability to interpret technical procedures, reports, manuals etc. as well as basic drawings and schematics. Furthermore, to have skill in solving problems. Formal training includes Technical 3 or 4-year diploma/ degree. Certificate related to mechanical maintenance, mechanical engineering or wind energy is required.

- **Wind Mechanical Engineers** have many different applications in the wind industry. Their main responsibilities include researching, designing, developing, testing mechanical devices, tools and machines. They work on wind turbines, determining how to optimize the performance. They analyse problems to solve mechanical issues. They contribute to creating blueprints for new devices to be built, by designing or redesigning mechanical devices. They develop a prototype for the devices.
  - Overall, they oversee the manufacturing process, providing technical expertise to support staff and ensure quality control. During the project development phase, they contribute by assisting project developers in identifying project performance requirements, cost estimation and in developing bids. During the manufacturing phase, Mechanical Engineers play a role in selecting optimal materials for the wind turbines. Whilst at the construction phase, they work on wind turbine resource assessment, construction and commissioning. They oversee installations of the equipment to ensure they function accordingly. During the operational phase, the engineers ensure the continual operation and perform according to specifications of the individual the wind turbine and the entire plant and further coordinate maintenance of the equipment. Skills requirements include an ability to solve problems, and they must have analytical and creative skills. Engineers need to have mathematics and mechanical skills. They must also have communication and interpersonal skills. Formal qualification required is the Bachelor's Degree in Mechanical Engineering.

- **The Wind Site Manager** oversees the systems or facilities that are responsible for the generation and distribution of power. They direct the operations of the plant, the repairs and maintenance, plant performance, plant safety and the profitability of the site. They manage the entire staff, including contractors, employees, support teams in ensuring the wind plant operations and other activities proceed accordingly. They further engage regulatory bodies, communities, local government in ensuring good relationships between landowners and the public.
  - The skills requirements for Mechanical Engineers include having physical strength and stamina, have mechanical skill and a person with a vision. Mechanical Engineers pays attention to detail and have management and leadership skill. They must have interpersonal, communication and problem solving skill.

- **Electrical Engineer's** responsibilities include designing, developing and testing the turbines electrical components which includes lighting, machinery controls, electric motors, generators, wiring, and electricity transmission systems. They also supervise the manufacture of electrical components of the turbines. The engineers are responsible for the development and implementation of the systems that use electricity to control turbine systems or signal processes.
  - The skills requirements for the Electrical Engineers includes an active learning attitude, have mathematics and communication. They need to be a team player and pay attention to detail. Qualification for Electrical Engineers is Bachelor's Degree in Electrical Engineering.

- **Analysts and Researchers** from industry, government and academic tests the wind turbine technology. They learn about wind power systems. They research wind energy costs and analyse the local and international power markets and their workforce. They investigate ways of improving technology (acceptance and understanding of wind power systems). The researchers publish their findings and distribute through various platforms. The skills requirements include being analytical and being able to solve problems; have planning skills and communication skills. Analysts and Researchers are required to embrace teamwork, have market awareness and mathematics skills. Formal qualification required is a Bachelor's Degree in Engineering.

3.5 Conclusion

It can be concluded that both solar PV and wind energy projects utilise a wide range of career discipline, throughout the value chain. The level of skill differs per profession and job expectations. Some professions are generic, but with an expectation of further training in the particular sector. Some professions are selective to the project stage, whilst others may be used across the entire value chain, performing different tasks. Therefore, the use of labour from other sectors in the country for either solar PV or wind technology projects can be possible, however, additional training that is specific to that industry will be required.

4. ASSESSMENT OF EMPLOYEE TRANSFER / RELOCATION OPTIONS

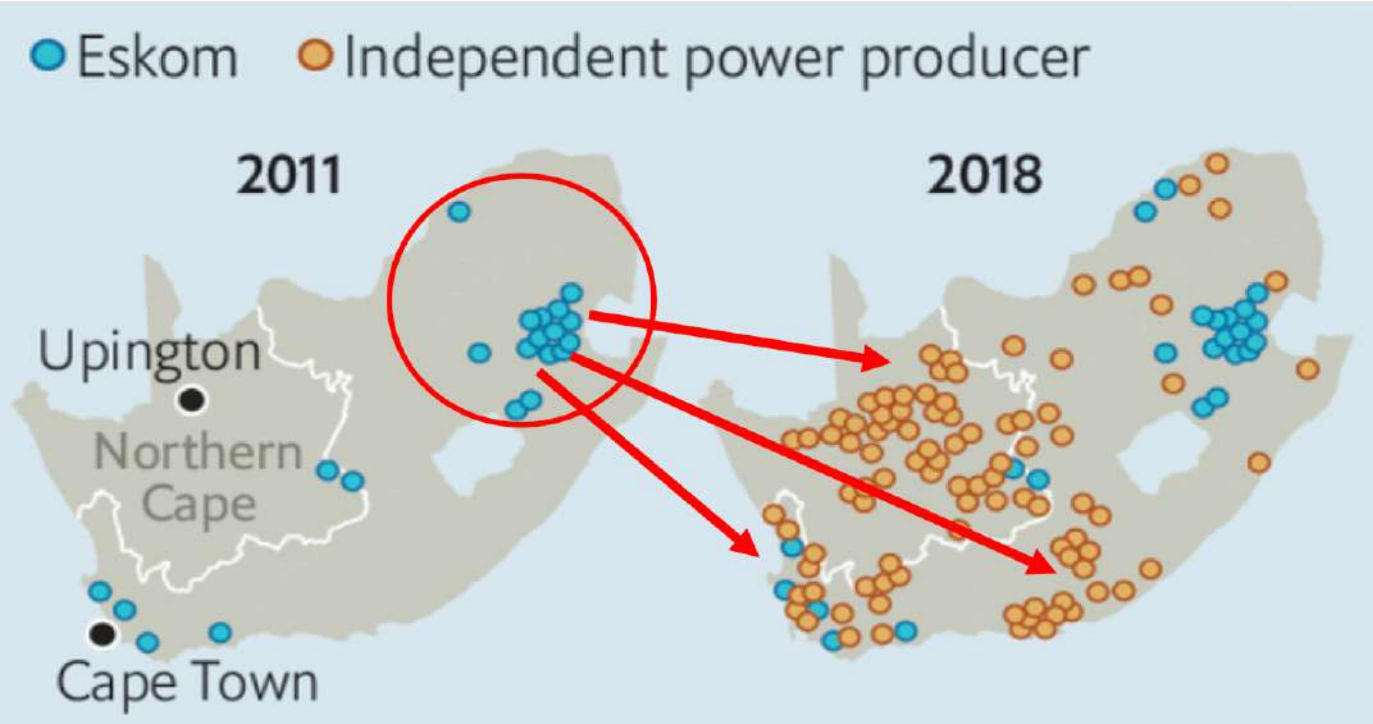

Figure 14: Renewable Energy Development Zones.

The South African Nation Development Plan (NDP) envisions an inclusive economy that will contribute to economic growth, job creation, alleviate poverty and reduced inequality. The diversification of the energy mix that is emerging globally indicates that renewable energy technologies like solar photovoltaic (PV) will rapidly increase their share in the energy system. The South African IRP shows that over 11 000 MW of coal will be phased out between 2020 and 2030 [12]. This means that jobs will be lost in the coal sector due to power station decommission. This is shown in Table 3 below. The coal phase out is not only happening in South Africa, however, and countries such as Australia, Colombia, Germany, Poland, Spain, China, India and the UK also face a similar predicament [3], [13]–[17]. This offers South Africa an opportunity of draw lessons from countries that are going through the coal decommission process.

The South African renewable energy projects have been deployed in areas demarcated for renewable energy plants, this areas are shown in Figure 15. However, most of the power stations are located in the Mpumalanga province. This means that if the deployment of renewable energy in South Africa continues to be in the Northern, Eastern and Western Cape, the might be grid infrastructure that could be left stranded in areas like Steve Tshwete and Emalahleni that hosts over 12 of the 16 power stations. As a result, policy instruments can be utilised to encourage Independent Power Producers (IPPs) to consider developing projects in coal phase-out regions as a contribution to a just energy transition. Incentivising project developers to prioritise the deployment of a region like Mpumalanga that does not have the greatest wind and solar resource when compared to Renewable Energy Development Zones (REDZ) phase 1 demarcated areas.

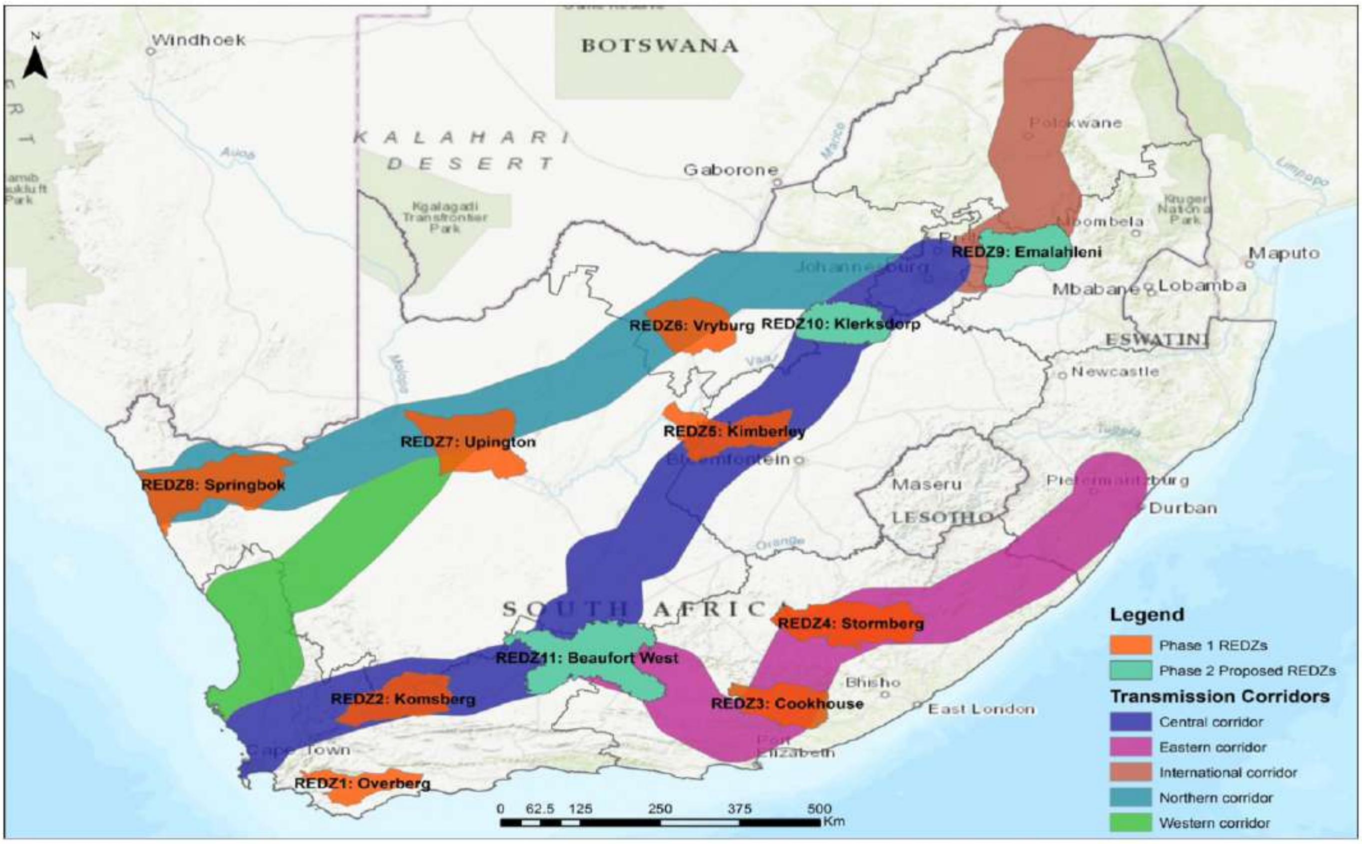

Figure 15: The South African Renewable Energy Development Zones [18]

Moreover, there would be a need to develop a reskilling program if renewable energy would be deployed in coal phase-out regions. This also requires a reskilling framework that this study has developed. The framework identifies want needs to be done for a reskilling programme to be established. Further work for establishing a skills lab still needs to be unpacked. This may involve various stakeholders like Eskom, mining sector, training institutions and government The reskilling framework is important for the following reasons:

- The coal sector is the biggest mining contributor to gross domestic product (GDP) and the third-largest employer when compared with other domestic mining activities [19].
- The country's coal sector has about 92 000 direct employees with earnings of approximately R22 billion [20]
- 170 000 indirect jobs are created by the coal sector [19].
- According to [19], the South African coal sector created approximately R129 billion in sales in 2017 (28% of the country's total mineral sales).
- South African has an unemployment rate of 29% [21], therefore, it is important to understand the role that the employee transfer/ relocation can play in creating jobs.

This chapter builds upon the South African REDZ to assess the employee transfer and relocation possibilities as part of the energy transition. However, the focus for this exercise is mainly in the Mpumalanga province (Steve Tshwete and Emalahleni Local Municipalities. The South African state power utility (Eskom) is responsible for generating electricity in South Africa. Most of the power plants operated by Eskom are based in Mpumalanga (80%). This coal region is mainly dependent on the coal economy for employment and various economic activities that are linked to the coal value chain. Some of the Eskom power stations have reached their full operational lifetime and might need to be shut down. Shutting down coal power stations is a complex subject of national interest. Moreover, this subject matter has shaped news headlines due to possible job losses, reduced economic opportunities and the unknown future of local communities. These underlying social challenges might result in renewable energy adoption contests and affect social stability. The South African energy transition calls for a need to develop plans that will manage the socio-economic impact of shutting down coal power stations. While closing coal power stations is inevitable, plans to manage this transition need to be scientifically and socially sound. Increasing the diversity of South Africa's energy production mix is important to mitigate against climate change while enhancing supply security. As a result, the feasibility of transferring coal sector employees towards solar PV and wind sector is significant (see Chapter 3) for all the skills required. The approach for this section was conceptualised based on the need to utilise the energy infrastructure that might be left stranded and result in job losses. Therefore, at a high level, a solar and wind resource assessment was conducted for the Emalahleni and Steve Tshwete Local Municipalities. The availability of solar resources in the study area makes the production of electricity possible in areas that have sufficient sunshine. Several sites in South Africa have the potential to generate large-scale solar PV due to the abundant solar energy resource available throughout the country. The average South African sunshine is estimated to be roughly 2 500 hours per annum [22]. Figure 17 shows that both municipalities have an adequate solar resource to generate competitive solar power. The solar resources characteristics of this region make it suitable for optimizing the benefits of adopting solar PV and create jobs. RetScreen[1] modelling results shown in Figure 17 indicate a solar radiation average of 5.61/kWh/ m2/day for both municipalities. The Ret Screen software allows for the comprehensive identification, assessment and optimization of the technical and financial viability of potential renewable energy, energy efficiency and cogeneration projects; the measurement and verification of the actual performance of facilities; the identification of energy savings/production opportunities; and portfolio management of multiple facilities. The solar energy resource in this region is exceptional especially because the coal phase-out will leave sufficient grid infrastructure that solar PV power plants can easily utilize to transmit power. The available grid infrastructure positions this area as suitable solar PV deployment as it is likely to incur less power distribution and transmission losses [23]. The RetScreen assessment did not indicate a viable wind resource thus wind is excluded. For a large-scale wind project to be considered economically viable, the available wind speed need to be at least 6 m/s. In this case, the RetScreen results shown in Figure 16 indicate an average of 3.2 m/s.

[1] The RETScreen Clean Energy Management Software (usually shortened to RETScreen Expert)

Month	Air temperature	Relative humidity	Precipitation	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days 18 °C	Cooling degree-days 10 °C
	°C	%	mm	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	21.3	63.6%	116.87	6.82	85.4	2.9	22.6	0	350
February	21.2	62.4%	89.60	6.37	85.5	2.8	22.4	0	314
March	19.8	62.3%	87.73	5.73	85.6	2.7	20.8	0	304
April	16.9	59.1%	37.80	5.03	85.7	2.8	17.4	33	207
May	13.6	51.9%	13.02	4.56	85.8	2.9	13.4	136	112
June	10.4	51.7%	6.60	4.14	86.0	3.2	10.0	228	12
July	10.4	47.3%	2.79	4.47	86.1	3.2	10.2	236	12
August	13.4	42.1%	8.06	5.11	85.9	3.5	13.9	143	105
September	17.5	39.3%	20.70	5.86	85.8	3.9	18.9	15	225
October	19.5	49.8%	79.98	6.18	85.7	3.8	21.2	0	295
November	20.2	57.3%	104.10	6.40	85.5	3.5	21.7	0	306
December	20.9	62.5%	127.41	6.73	85.4	3.0	22.3	0	338
Annual	**17.1**	**54.1%**	**694.66**	**5.61**	**85.7**	**3.2**	**17.9**	**791**	**2 580**

Figure 16: RetScreen energy generation parameter results

4.1 Solar resource in Emalahleni and Steve Tshwete LM

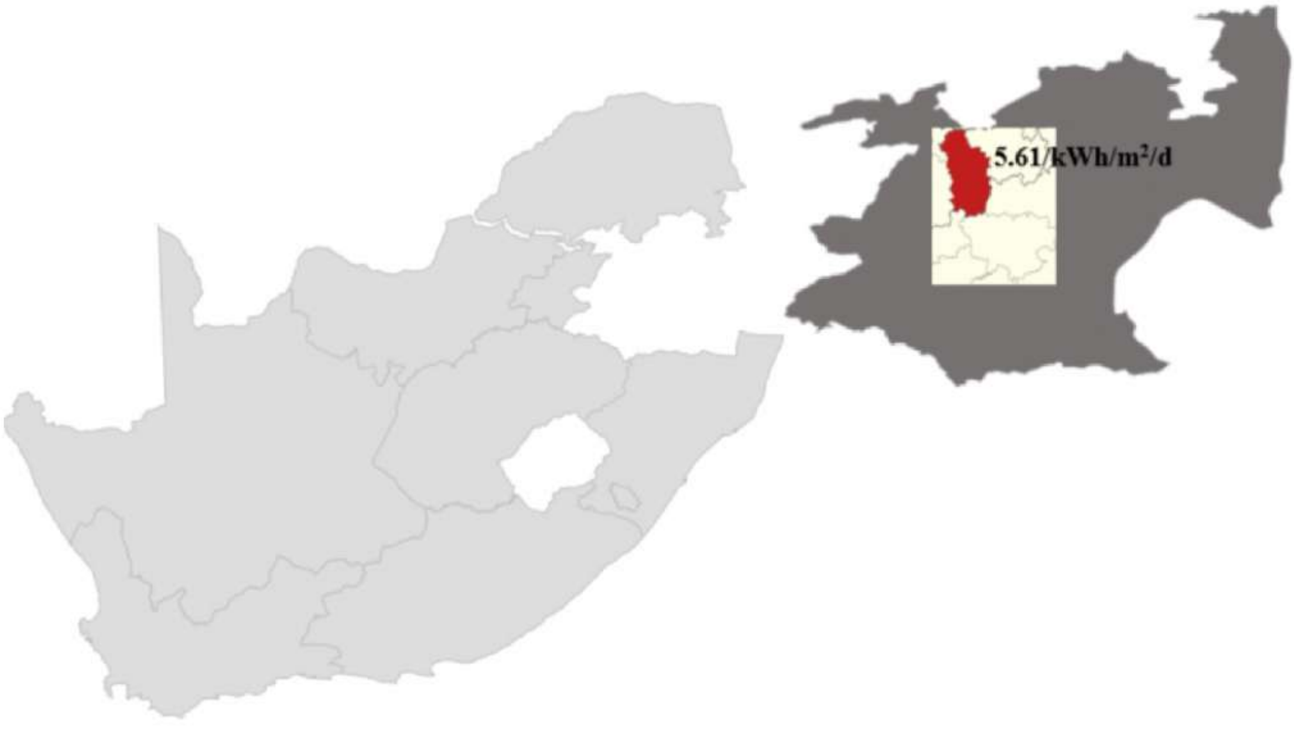

Figure 17: RetScreen analysis for Nkangala District Municipality solar resource

Table 3 shows solar and wind that will be procured until 2030. As part of the just energy transition, this means that any employee transfer from coal to either solar or wind will only leverage opportunities created by the 6 814 MW of solar PV or 15 762 MW of wind that would have been procured by 2030. According to the [24] procurement of solar and wind power has been generally been located outside the Mpumalanga province (see Figure 14). The quantified solar resource shown in Figure 17 indicates that there is a potential to develop renewable energy projects, particularly solar PV.

As the study by [25] shows that areas with a good energy resource like the Emalahleni and Steve Tshwete Local Municipality can be suitable sites to economically viable solar power plants. Furthermore, coal-mining and power stations closure has a legal obligation to restore and rehabilitate the land on both the coalmines and power stations owners, which provides new businesses opportunities to deploy solar PV in restoring the land. Figure 18 confirms that the area has a Direct Normal Irradiation (DNI) of 2224 kWh/m2 and a Global Tilted Irradiation of 2283 kWh/m2 per annum [26]. Moreover, the analysis by [25] shows that 1 MW plant of solar PV can generate 1 831 MWh per year. This corresponds with the PV output of 1835 shown in Figure 18.

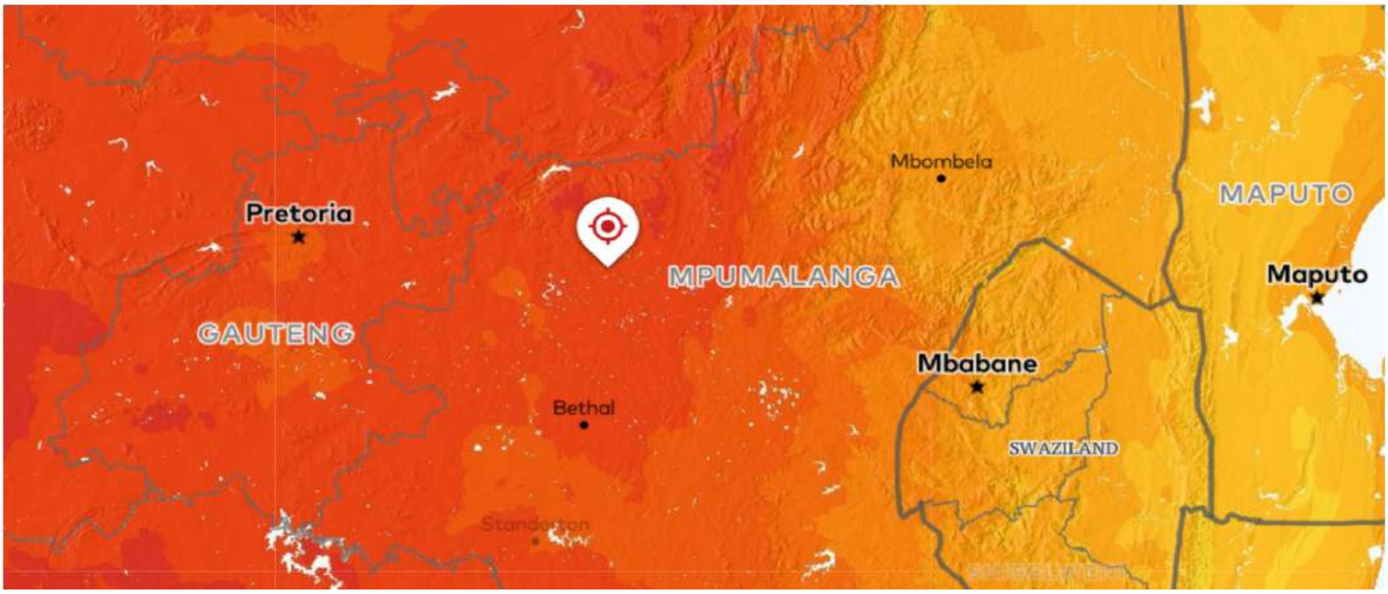

Figure 18: Solar resource in Emalahleni and Steve Tshwete LM

The energy resource shown Figure 18 indicates that businesses located in Steve Tshwete and Emalahleni can benefit from diversifying their business activities towards solar PV. in Steve Tshwete and Emalahleni has an outstanding solar resource and this represents new opportunities for enterprises that operate in this region. Moreover, [25] shows that solar PV deployment in mining regions is profitable. Henceforth this is a great opportunity for businesses operating in in Steve Tshwete and Emalahleni.

A South African low-carbon transition will not only result in new industrial and employment opportunities but also stranded assets, workers and communities. The carbon-intensive infrastructure and activities may grow be outdated in the short to medium term. Sufficient time or warning is required to mitigate the adverse impacts of coal phase-out. At the same time, a rush towards low-carbon energy sources could risk disenfranchising livelihoods of those that are dependent on the coal economy. Some adverse consequences could result, for example specific industrial sectors, regions and communities dependent on such carbon-intensive activities could see industrial decline and job losses; states dependent on revenues from fossil fuel extraction would see the loss of a valuable source of income; some communities could be adversely impacted by the arrival of new low-carbon technologies and activities if these encroach on their land and livelihoods; and households could see their affordability weaken while expenses like energy costs rise. This, in turn, could lead to resistance to change, embodied by the social and political backlash and a potential slowing or reversal of the transition. As such, it is important to establish which economy sectors, regions and socio-demographic groups are most at risk, and to explore ways in which these risks can be mitigated to achieve a manageable and just transition to a low-carbon future. As a result, it is important to understand employee transfer potential from the coal sector to renewable energies. The transfer potential is assumed to correspond with the REDZ shown in Figure 14.

Eskom aims to collaborate with industry players, stakeholders, government and sector-specific programmes to manage the energy transition. This collaboration will be implemented through developing social plans that will ensure that economic activities continue to be stimulated in the affected regions. The social plan should cascade from districts and local municipalities. This requires developing a solid social plan with timelines, key activities and outcomes. The main objective of the social plan will ensure that opportunities associated with the transition area to be agreed upon with implementation plans that will enable and manage the coal phase-out dialogue. This should lead to a solid social plan that can be accepted by Eskom the affected regions.

4.2 Energy transition window of opportunity

The window of opportunity framework illustrated in Figure 19 assists in understanding the condition required in the energy reform. This means that for coal sector workers to be transferred into the wind or solar sector there has to be a structural change in the energy system (South Africa is currently undertaking this process). Moreover, all spheres of government are aware of the energy transition, however, they are not champions as the framework by [27] suggests.

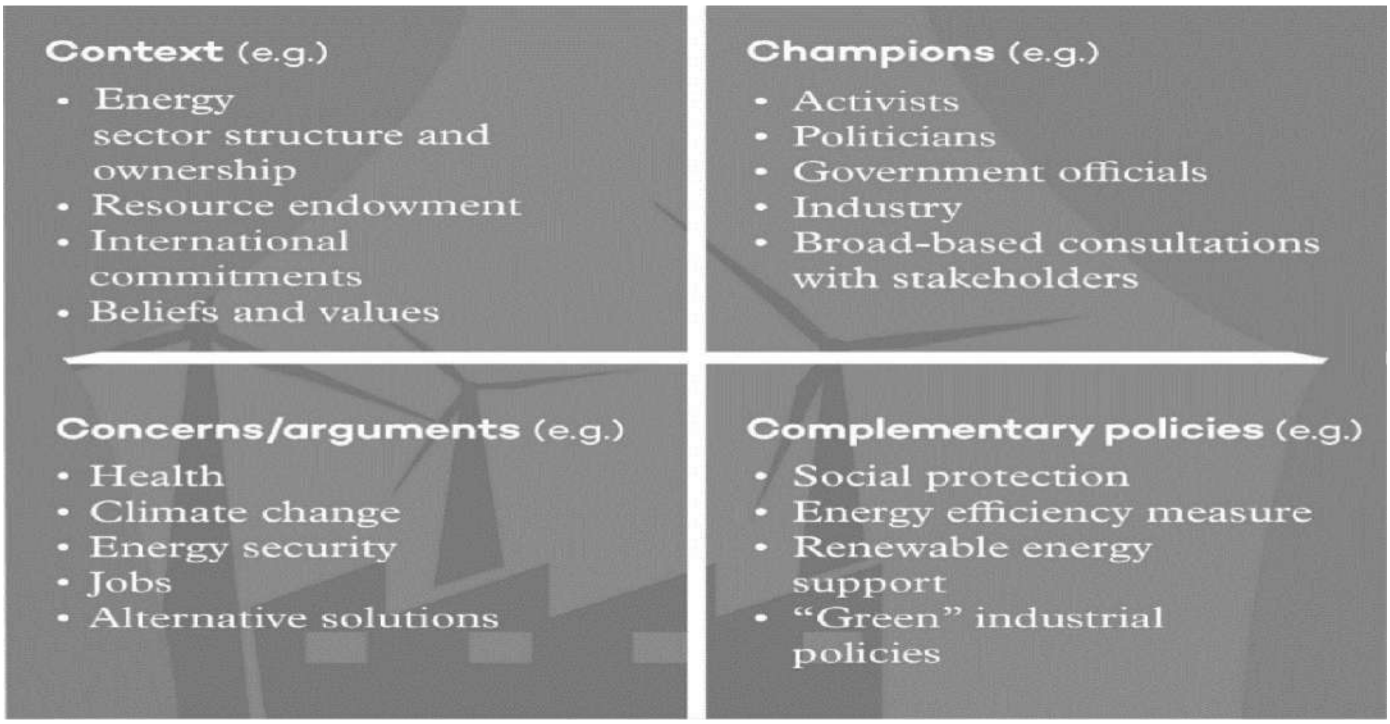

Figure 19: Energy transition window of opportunity framework [27]

The concerns that the framework highlights are similar in the South African context. The concerns like health, climate change energy security, jobs and alternative solutions are common challenges that needs to be addressed for a just energy transition in South Africa. The uncertainty in the just energy transition complementary policy is one key phenomenon that needs to ensure that a reskilling framework for energy transition is developed for South African coal sector workers. Moreover, there is minimal participation in technologies like solar and wind in coal regions at this stage. The jobs that can be created have been highlighted in Chapter 2.

The South African coal phase-out, planned wind and solar deployment is shown in Table 3

Table 3: Solar and wind procurement plan until 2030 [12].

	New Coal MW	Coal Decommission MW	Solar PV MW	Wind
	37 149		1 4 74	
2019	2 155	(2 373)	0	244
2020	1 433	(557)	114	300
2021	1 433	(1 403)	300	818
2022	711	(844)	400 1000	1 600
2023	750	(555)	1000	1 600
2024	0	0	0	1 600
2025	0		1000	1 600
2026	0	(1 219)	0	1 600
2027	750	(847)	0	1 600
2028	0	(475)	1 000	1 600
2029	0	(1 694)	1 000	1 600
2030	0	(1 050)	1 000	1 600
	44 381 MW	(11 017) MW	6 814 MW	15 762 MW

Under construction

Coal decommission

To be procured

According to [28], the South African renewable energy sector will not have an adequate pipeline of competent individuals to train if it does not endeavour to re-engineer the skills of workers in the Limpopo and Mpumalanga coal mining regions. This was evidenced in the training that was provided by the South African Renewable Energy Technology Centre (SARETEC) for wind turbine technicians. Since SARETEC was established in 2016, their major challenge has been finding individuals who can complete its renewable-energy training and meet the high standards required by renewable energy Original Equipment Manufacturers (OEMs). The degree of technical requirements for wind and solar technologies are discussed in detail in Assessment of skills requirements in the solar photovoltaic (PV) and wind sector chapter. Re-engineering the skills in the country's coal sector will not only enable a just transition from coal to renewable energy, but it will also transfer skilled individuals from one energy sector to another while the potential socio-economic impact of South Africa's divestment from coal is mitigated [28].

According to [29] there are many challenges associated with developing the skills needed in the mining. This means that the majority of skills levels available in the coal sector are generally low. This is due to the legacy of poor educational opportunities, a complex tertiary education and training landscape, and a poor basic education system has resulted in many employees having little or low levels of skills development.

The national shortage of skills in all economic sectors accentuates the challenges associated with employee transfer into the renewable energy sector. Therefore, it increases the demands for training and development in the energy transition from coal to the renewable energy sector. The energy transition skills development environment is need decisive policy, regulatory and legislation that will ensure that the transition is just. Navigating these requirements and challenges can be resource-intensive and exhaustive to individual organisations [29]. The skills development team at the Minerals Council specialises in soliciting and consolidating stakeholder views and lobbying, advocating and influencing these views to realise a skills development solution that is in the interests of all stakeholders. The Minerals Council is involved in all levels of skills development from adult education and training to operators, miners, artisans, technicians, professionals and managers. However, the skills development for the energy transition is still non-existent. As a result, the Minerals Council South Africa, Technical and Vocational Education and Training (TVET) Colleges and Universities are key stakeholders that can form part of the reskilling of coal sector workers. Moreover, we can conclude that while relocation from coal regions shown in Figure 20 to other regions that might deploy wind and solar power plants is feasible, job seekers generally urbanised to where opportunities present themselves. There is a need to develop a reskilling program in coal regions to avoid potential ghost towns that can result from coal phase-out.

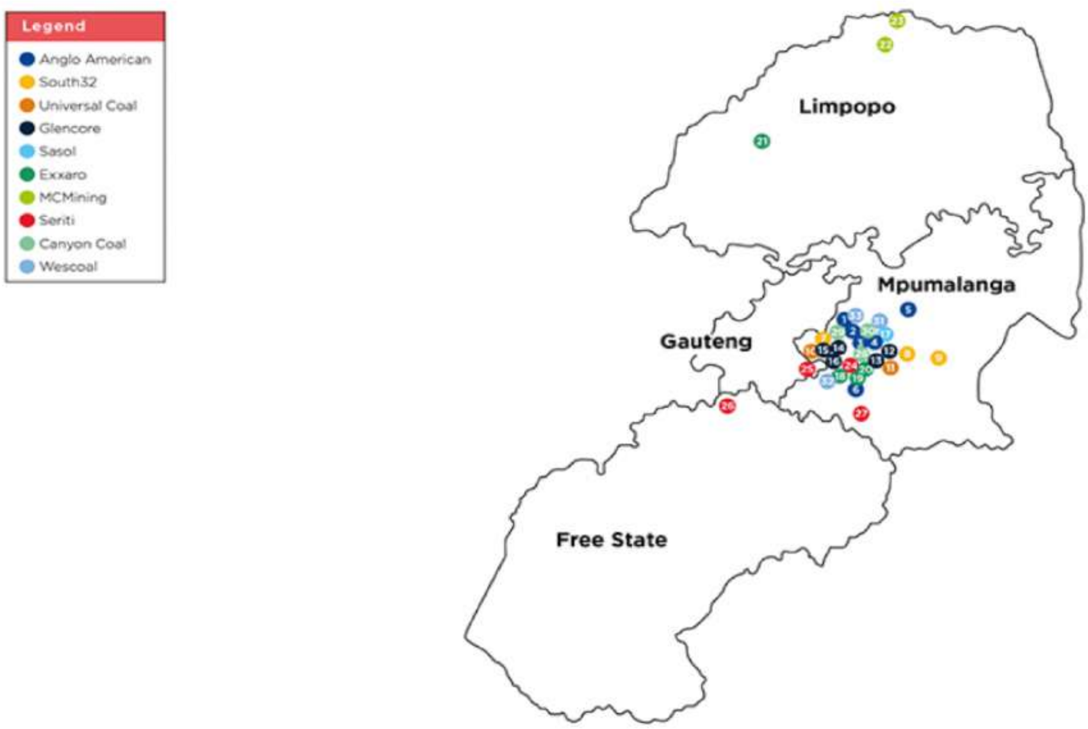

Figure 20: Coal mining activities in South Africa

5. A RESKILLING CONCEPTUAL FRAMEWORK FOR A JUST ENERGY TRANSITION

5.1 Green skills for green jobs

The International Labour Organisation (ILO) has done extensive work on the skills development for the energy transition. According to [30] green jobs are do not guaranteed to be decent jobs. However, green jobs are characterised by prospects for both women and men to realise decent and convenient work conditions that are equal while they provide security and human dignity [30]. Additionally, decent work comprises of opportunities that provide "decent income, rights, voice and recognition, family stability and personal development, fairness and gender equality" [30]. This contribution is perceived as essential to poverty reduction as well as achieving inclusive and sustainable growth. Unskilled employees are in demand in coal mining, however, the electricity generation sector involves high-skilled engineers who are not skills in for renewable energy technologies. Furthermore, to date South African renewable energy projects has only been developed in the Western, Eastern and Northern Cape provinces, which means that the Mpumalanga province has not benefitted in any skill development that might have been initiated previously since there was are no renewable energy project deployed. Therefore, a just energy transition policy intervention for skills development is needed. While the impact of coal phase-out can be quantified, studying the impact of the energy transition on skills requirements needs and acquirement of these skills is not a straightforward exercise.

According to [30], the adoption of a technology like solar PV in a coal region will have an impact on skills requirements in three dimensions, namely:

- Structural changes that will result in an increased demand for some skills and decreases for others;
- New economic activity will create the need for new skills, qualification and training frameworks;
- Several existing skills and businesses will encounter energy transition changes and thus require modifications and training to operate new sectors like solar PV.

In consideration of the inevitable energy transition, employees and entrepreneurs active in coal regions will need to adapt to low-carbon technologies goods and services provision. Moreover, analyses by [31] show that without additional conduct to disrupt the connection between economic activity and energy demand, the association between technological adoption and socio-economic impact of an energy transition and climate change legislation may aggravate the negative trade-off that will result in negative employment outcomes. One of the key instruments for successful implementation of a skills framework guideline for wind and solar PV is the technological absorptive capability. According to [32], technological absorptive capability refers to a country's ability to conduct research and development that will ensure that imported technologies are localised. This aspect is important for the enterprise skills framework guideline development.

Coal sector employees need to be supported to successfully transfer toward renewable energy technologies. The capacity to achieve a just energy transition is included in the International Labour Organisation (ILO) principles of workforce mobility [33]. Although the contribution is focused on the actual workforce, this study draws lessons from the ILO to incorporate this for a reskilling framework from coal to the renewable energy sector. As a result, the focus of the reskilling framework should cover both the actual workforce as well as the entrepreneurs that currently service the coal sector.

The framework for a just energy transition reskilling plan is built upon the principles provided by [34], illustrated in Figure 21. According to [35], technological and organizational skills development is defined as "an increase in technological skills, communication skills, and organizational skills". Moreover, [35], defines knowledge and skills transfer as the aptitude for «Master Teachers» to transfer information through a skills development program that can involve practical and theoretical learning.

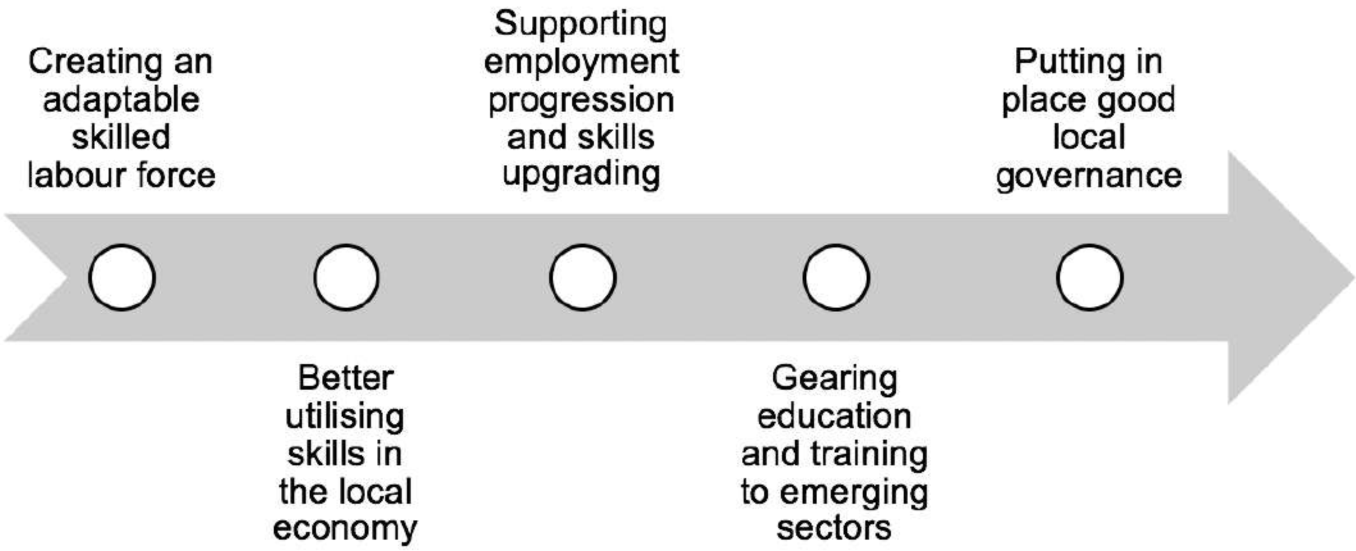

Figure 21: Skill development framework principles [34]

The appropriate legislative framework for skills development has a central role to play in the energy transition discourse. As countries deploy and adjust their green energy systems and associated economic models to consolidate their position in the global adoption of cleaner energy technologies. A reskilling framework from the coal sector to renewable energy becomes significant. Moreover, the study by [36], shows that access to a highly skilled and technically competent workforce base will be central to a successful energy transition. South Africa needs to maintain progressive economic growth rates, and consequently there is a need to respond to the challenges of coal phase-out. Therefore, developing a reskilling framework is crucial. Every economy has met the skills development "trap" before or they will need to deal with it soon [36]. Additionally, branching out in a transition space is challenging since escaping the 'trap' involves a central reconfiguration of skills [36]. For coal sector employees to switch towards wind and solar PV and enabling environment that will allow affected workers be reskilled for opportunities in the renewable energy sector.

Competences in green jobs like wind and solar PV sector are generally low in areas that have been coal dominated. Moreover, a transition towards wind and solar PV is relatively low in areas that are dependent on the coal of their electricity generation. However, there is no significant wind (see Figure 16) in the Mpumalanga coal regions. Moreover, technological competencies essential for goods and services, like engineering, design and project development skills, especially for large power plants, are currently generally very weak in coal regions[33].

In 2007, China became the global leader in solar PV sector manufacturing, with approximately 35% market share. The EU was second after China with a 29% market share [37]. During the same period, the South African energy system was still coal-driven thus to date, the adoption of cleaner energy technologies like wind and solar PV lags behind when compared to other developing nations like Brazil and India. Consequently, the opportunities available in the renewable energy value chain service offering are limited. In 2011, the South African IRP was gazetted as a policy that will inform the South African energy mix until 2030 [38]. This meant that for the reskilling process towards renewable energy should have commenced then, however, due to the dominance of coal power station the necessary plans for a smooth energy transition that is "just" was lacking.

5.2 Skills development lifelong learning

According to [39], lifelong learning has developed as one of the key instruments for improving the quality of life in the 21st century. Formal education alone is not sufficient to enable employees to benefit from new opportunities that advance in science and technology development. Lifelong education goes outside formal learning and training to involve 'skills development'. This is a specialist term to describe the methods in which people learn and obtain skills and competencies that influence their prospects to get employed or offer services [40]. Additionally, training facilities like schools, Technical and Vocational Education and Training TVET and tertiary institutions (colleges and universities) participate in skills development for work or in some instances through apprenticeships, enterprise-based training, professional development, informal learning, as well as government and non-government training initiatives [36]. It is important to highlight that "vocationalisation" of secondary education provides the basis for lifelong learning in skills development [36].

Embracing all kinds of learning from 'cradle to grave', lifelong learning is occasionally denoted as being 'life-long and life-wide' [36]. The EU defines lifelong learning as "all purposeful learning activity is undertaken throughout life to improve knowledge, skills and competencies within a personal, civic, social and/or employment-related perspective" [41]. According to [36], learning is characterised into three categories namely, formal education, non-formal and informal learning. The conceptualisation of formal, non-formal and informal learning represent both vertical (learning throughout life) and horizontal (life-wide learning) dimensional learning [39]. Life-wide learning enables learners to acquire and integrate different sets of knowledge and skills that they can apprehend or utilise to generate new knowledge and skills [42]. As a result, the development of an enterprise skills framework guideline will follow as a life-wide approach. Moreover, [36] shows that the characteristics of thriving enterprises are a result of their capacity to continue to learn. Therefore, the development of an enterprise skills framework guideline for entrepreneurs operating in coal regions will stimulate research and innovation as well as optimal utilisation of coal sector existing skills towards the solar PV sector.

5.3 Local skills development ecosystems

The local skills ecosystems comprise of organisations, institutions and firms situated in the local jurisdiction. This includes labour market, industries and training centres like TVET and universities among others. Establishing partnerships in the local skills development ecosystem has advantages due to its ability to pull resources from various stakeholders [43]. Moreover, the study by [44], shows that skills have conventionally been acquired from formal training systems. However, other types of training show that skills are now acquired from several structures including workshops, short-courses, online learning, self-learning and learning by doing [36]. Additionally, skills are increasingly developed through direct and online communication, this means that some of the coal sector workforces can receive online renewable energy training while they are still involved in coal jobs.

Energy transition opportunities are characterised by globalisation and trade liberalization that enhances competitiveness exposure to internal markets. The scholarly argument raised by [33] where a joint venture between international companies and local participants is forged can be a possible solution for developing a reskilling framework. This will allow South Africa to learn from international experiences while a distinctly South African just energy transition is mapped.

5.4 Conclusions

The reskilling of coal sector workers towards the renewable energy sector will contribute to a just energy transition. The 2019 IRP presents a planned energy transition for South Africa, with emphasis on the period 2020 to 2030. The 2019 IRP shows that nationally, coal power currently dominates power supply, but declines as wind & solar PV capacity grows along with gas and storage deployments[12]. Aggregated net jobs (direct and indirect) in construction and operations and maintenance for all the technologies shown in Figure 22 indicate a net increase of 226 020 jobs that will be created by the unconstrained scenario while the coal sector net job losses are 51 080.

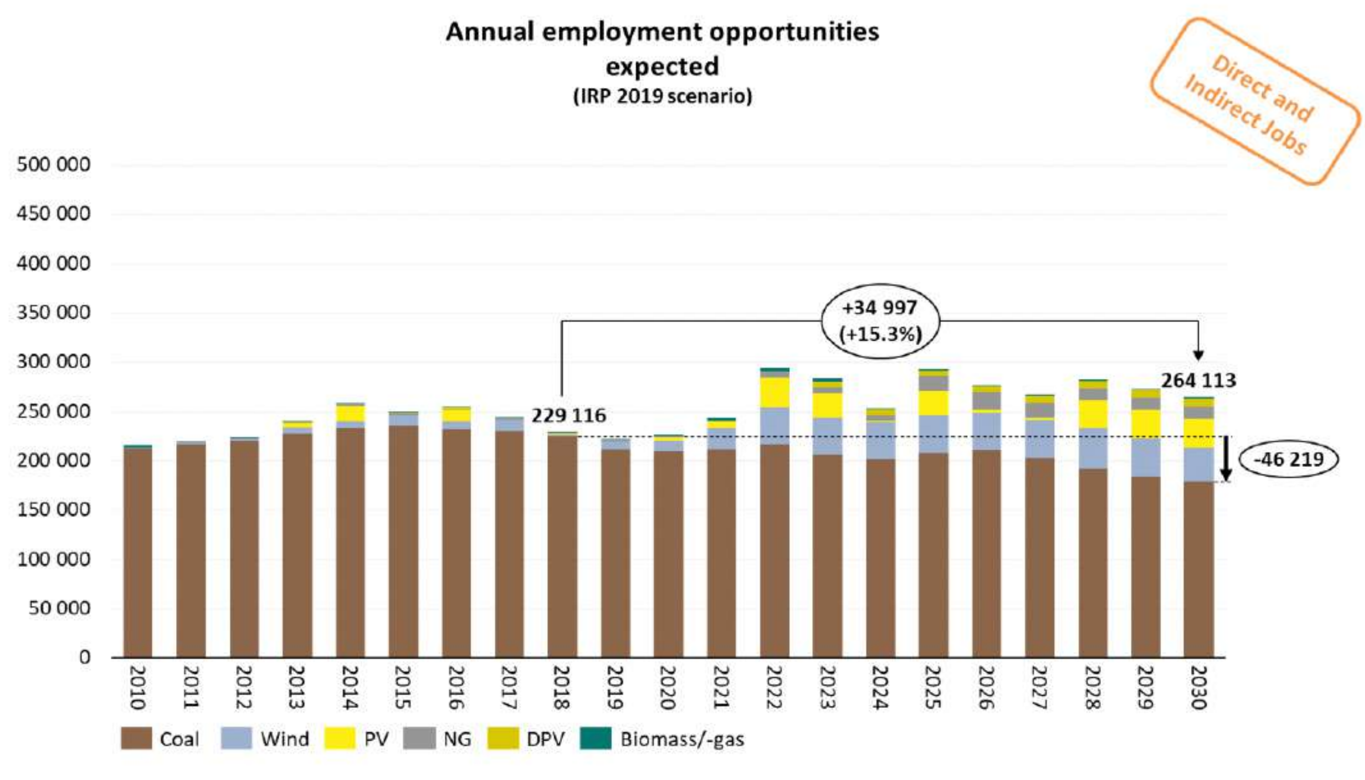

Figure 22: Employment opportunities from the IRP 2019

Jobs that will be created by the wind and solar PV sector based on the planned IRP procurement are shown in Table 4. This is the impact that the deployment of renewable energy in coal phase-out region can have.

Table 4: Combined Construction phase - Operation and maintenance phase

	WIND	PV
Direct	184 546	81454
Indirect	203 422	81 161
Induced	206 130	90 001
Total (Direct and Indirect)	**387 968**	**162 615**

5.5 Recommended key enabling factors for a reskilling framework

The following recommendations are put forward for a South African "Development of a reskilling framework in support of a just energy transition:

- The need for partnerships and social dialogue between governments, local municipalities, enterprises and labour unions to guarantee a just energy transition;
- The need for social protection that will secure salaries, pension rights, healthcare benefits, cash transfers for early retirement packages for coal sector employees;
- The need to invest in infrastructure, skills and reskilling for the affected workforce as well as the formation of alternative industries that will mitigate the impacts of coal phase-out (economic diversification)
- Training centres, TVET Colleges and Universities are key stakeholders that need to form part of the reskilling of coal sector workers.
- The establishment of a just energy transition fund that will reactivate the reskilling of coal sector towards the renewable energy sector.
- Coal sector employers need to support the development just energy transition framework
- Lastly, the need to invest in education and innovation, to enable new industries investments that will contribute to long-term regional growth and prosperity.

5.6 Key enabling instruments for a reskilling framework

- Policy certainty – IRP 2019 procurement plan
- Policy instruments that will encourage the use of coal power infrastructure to possibly transmit potential renewable power projects
- Support job creation through renewable energy localisation
- Reskilling plan that has realistic deliverable and timelines
- Repurposing of the current infrastructure, should be considered for diversification of coal regional economies to other potential sectors.

Partnerships and collaboration with international partners need to be supported. This means that government authorities need to ensure that policies that will ensure that international players in the renewable energy sector collaborate with local players to achieve a just energy transition for South Africa is enabled.

5.7 Further work that is required for the South African energy transition

- Energy transition capacity building for national, provincial and local government spheres
- Mapping the political, socio and economic impacts of an energy transition on South Africa's power sector
- Analyses of positive and negative impacts of an energy transition (at national, regional or even plant level)
- Analysing socio-economic and economic losses and gains in the energy value chain (Mining, renewable energy, gas, coal, etc.)
- Energy sector value chain analysis which includes economic and jobs analysis modelling, economic baseline profile assessment as well as techno-economics
- To quantify the impact of the energy transition from coal to lower-carbon sources such as renewables, profitability analysis and economic analysis needs to be conducted
- Identification of localisation opportunities in the energy transition and quantifying metrics such as jobs and economic impact when localising various components and activities of the renewable energy value chain in South Africa
- Conduct Jobs and Economic Development Impact (JEDI) modelling for the South African energy transition
- Energy resource measurements and Levelised Cost of Electricity (LCOE)
- Investment business case development ROI, IRR and NPV projection for economic diversification pathways
- Financial modelling for localising renewable energy technologies (i.e. local manufacturing of energy component)
- Understanding trade-offs of the energy transition as well as the implication of coal consumption and production change on the GDP
- Trade-offs for a South African just energy transition (earning potential in different developing and declining industries).
- Impact of the energy transition on coal production and consumption and how this will affect the South African coal sector
- Repurposing of South African coal power stations options and cost-benefit analysis for all the repurposing options
- Evidence-based decision enabling decisions making tools using techno-economic techniques
- Train government officials on how to respond to the just energy transition impact.
- Promote localized green jobs, including in decentralized energy and energy efficiency, and link this explicitly to the energy transition
- Stages of energy transition processes, including engagement with labour, businesses, civil society, especially for the coal sector context
- Just energy transition case study analysis from other countries

Lastly, the study by [45] found that skills in the coal sector need to be retained. It is therefore, proposed that the reskilling framework should focus on both upstream and downstream wind and solar PV opportunities. The proposed reskilling is illustrated in Figure 23, and should focus on the coal sector workforce. Moreover, the reskilling framework from coal to the renewable energy sector needs to ensure that there is collaboration between key stakeholders like the training institution, the coal sector, government, energy sector associations and relevant councils form.

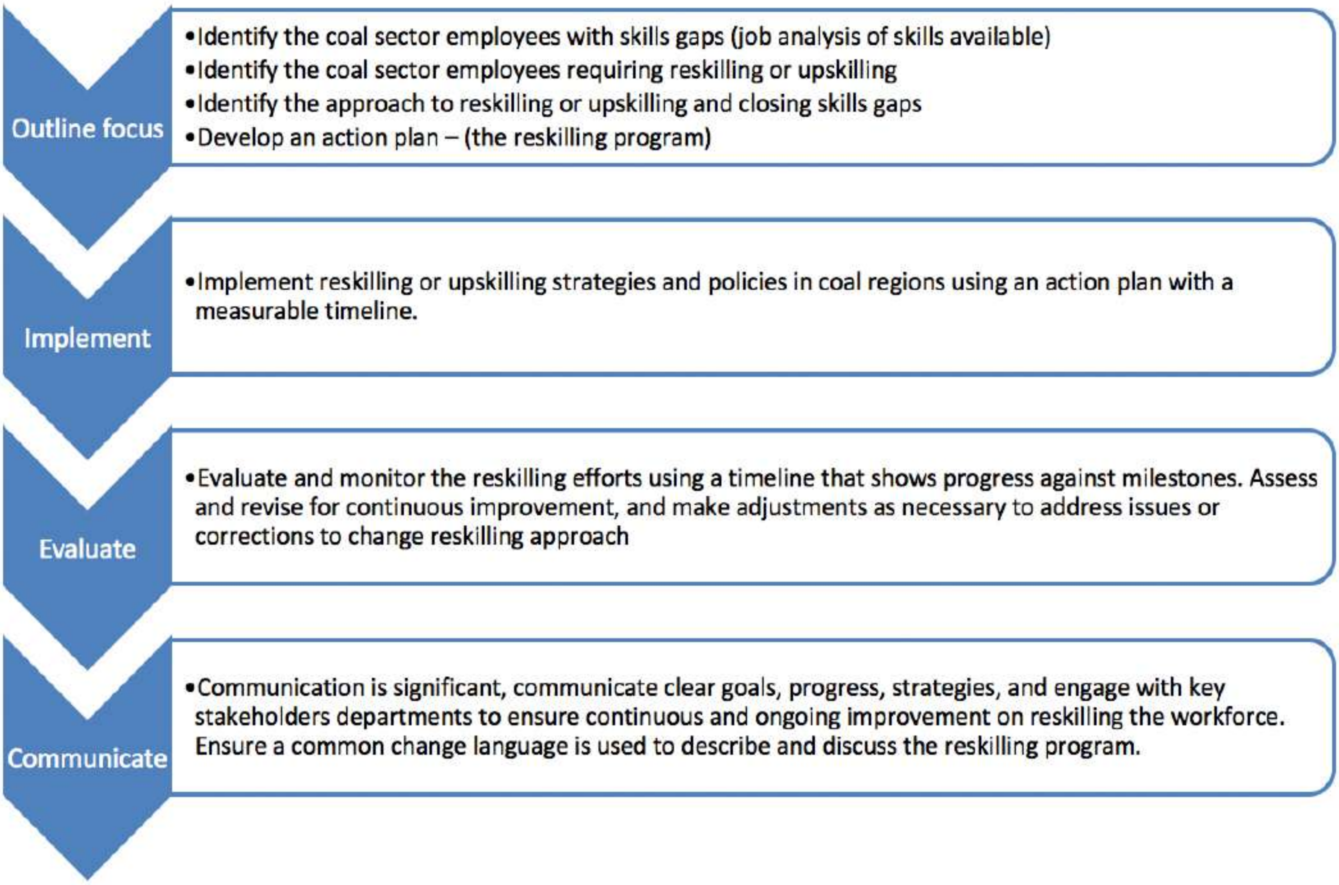

Figure 23: A recommended reskilling framework

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Defining Best Practices and Lessons Learned from other Countries

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In partnership with:

EXECUTIVE SUMMARY

According to the 2019 Integrated Resource Plan (IRP2019), South Africa's national power utility, Eskom, plans to decommission 5 400 Megawatts (MW) of electricity from coal generation by year 2022, 10 500 MW by 2030 and 35 000 MW by 2050. Furthermore, investors and the private sector are also starting to dis-invest in coal assets across the country. The dis-investment will have significant and lasting socioeconomic consequences for local mining towns and communities as well as the broader national and regional economies. While the South African coal industry is declining, it is estimated that by 2030, renewables such as hydro, photovoltaic (PV), wind and concentrated solar power (CSP) will constitute 31 230 MW (or 40.1%) of the total installed capacity. This represents enormous potential for the growth of alternative green industries and job creation that is related to renewable energy sources. Therefore, this transition from coal to renewable energy presents both challenges and opportunities for national and local policy makers.

In the 1990s, North American trade unionists coined the phrase "Just Transition" to mean a programme of support for workers who lost their jobs due to environmental protection policies. Over time, however, Just Transition came to mean something much broader for unions and their partners such as a deliberate effort to plan for and invest in a transition to environmentally and socially sustainable jobs, sectors and economies enforceable. As understanding of the climate crisis grew, unions began to tie Just Transition specifically to action on climate change. Subsequently 2015, the UN's International Labour Organization (ILO) produced a definitive model for Just Transition: Guidelines for a Just Transition towards environmentally sustainable economies and societies for all. The ILO (2010) defined 'Just Transition' as: "the conceptual framework in which the labour movement captures the complexities of the transition towards a low-carbon and climate resilient economy, highlighting public policy needs and aiming to maximize benefits and minimise hardships for workers and their communities in this transformation."

Within South Africa's reality of depressed economic growth, high levels of inequality, poverty and youth unemployment, it is important to understand the challenges and opportunities associated with its own "Just Transition". To this end, the Renewable Energy Solutions for Africa Foundation (RES4AFRICA) provided funding for research to help support the South African Government and various stakeholders better prepare for the journey that lies ahead. This report focuses on how five other countries namely Germany, India, Poland, Romania and the United States of America have addressed key challenges during their respective energy transition journeys. While each of these countries have unique socio-economic and political realities, they offer lessons and examples that South African leaders can learn from and potentially apply within their context.

This extensive literature review, covering decades of experience, ten key lessons have been identified that are applicable to South Africa's Just Transition journey. These include:

- **Lesson 1**: **Strong leadership plays a key role in the Just Transition journey**. A clear vision, political will and strong political and business leadership is required.

- **Lesson 2: Comprehensive and proactive planning is required**, by all stakeholders, in order to help increase the likelihood of an orderly transition. This will include transition planning that considers all those that will be affected, throughout the energy system and not just coal companies and workers.

- **Lesson 3: The involvement of a broad spectrum of stakeholders from the start is critical to success**. Genuine stakeholder consultation starting at the planning stage and continuing throughout the mine and power plant closures and transition process, can significantly reduce the possibility of social conflicts.

- **Lesson 4: An integrated policy framework in phasing out coal assist Just Transitions.** Successful transitions were supported by integrated policies and supportive legislation.

- **Lesson 5: Financial support is required from Government**. Case studies indicate that governments tend to shoulder a large share of the cost of the transition; as more often than not, the cost of not supporting a transition can be much higher than the costs of the transition. The South African government's constrained fiscus, especially after COVID-19 is therefore an additional consideration to be considered during a Just Transition in South Africa.

- **Lesson 6: Innovative and collaborative funding mechanisms and technical assistance** can help accelerate the Just Transition journey. This can also help lighten the financial burden on the fiscus.

- **Lesson 7: The establishment of a mine closure agency can assist in a nation's Just Transition.** A mine closure agency to manage the closure, environmental rehabilitation and ensuring targeted labour market transition programmes is crucial for coal transitions. It should also ensure that coal mine rehabilitation and reclamation not only address environmental degradation but also create support for alternative livelihoods.

- **Lesson 8: Sound implementation is required to ensure that the growth in the clean energy sector offset the direct and indirect future job losses in the coal industry**. While the number of renewable energy and energy efficiency jobs have been steadily growing in many countries, these jobs have not necessarily been located in the same place as disappearing coal mining jobs. Transition planning and implementation thus have to ensure regional development and economic diversification.

- **Lesson 9: Reskilling of affected workers, as well as other community members, is an important part of the Just Transition movement**. Clear guidance and skills development plans, as well as funding, will need to be aligned with the broader energy sector skills plans.

- **Lesson 10: Market dynamics remain a key determinant of a successful transition**. While environmental policies and regulations have an impact on the coal industry and the Just Transition movement, the fundamental economics underpinning the energy markets are likely to remain the key determinant on how fast and disruptive any transition is likely to be. Economic diversification is also critical to generate new economic market dynamics and revenue streams to sustain livelihoods.

It was also noted that South Africa already has various building blocks in place to ensure a successful Just Transition. The following key recommendations should be considered to enhance its position:

- Clearly articulate the **Just Transition Vision** – not just in terms of coal exit and use of renewables, but also how job losses will be mitigated.
- Decide which **entity** that will take accountability for the planning and implementation of the Just Transition, working with the various identified stakeholders.
- Ensure **capacity** exists to manage the coal mine and power plant closures and consider a closure agency.
- Determine **funding** needs of the Just Transition and design innovative funding mechanisms to support it.
- Consider **reskilling hubs** to take advantage of the opportunities renewables offer across the energy value chain to mitigate job losses.

It is positive to note that it has been found that it is feasible to transfer and reskill the workforce from coal to renewable energy job opportunities and that innovative and collaborative funding mechanisms are possible to financially support South Africa's Just Transition Journey.

1. BACKGROUND TO STUDY

1.1 Introduction

According to the 2019 Integrated Resource Plan (IRP2019), South Africa's national power utility, Eskom plans to decommission 5 400 Megawatt (MW) of electricity from coal generation by year 2022, 10 500 MW by 2030 and 35 000 MW by 2050. This will not only affect locations where these coal fired power stations are, but also the mines supplying coal as well as secondary and tertiary service providers. It will therefore be important to explore what lessons South Africa can learn on 'Just Transition' implemented elsewhere. The impacts on employment as well as socio-economic wellbeing of mining towns given the imminent decommissioning of coal-fired power stations and the closure of coal mines will have to be understood and socio-economic fall-outs mitigated.

In light of these developments, the Renewable Energy Solutions for Africa Foundation (RES4AFRICA) has been promoting Just Energy Transition research packages in South Africa to improve the country's preparedness to navigate this journey.

This report focuses on how five other countries namely Germany, India, Poland, Romania and the United States of America have addressed key challenges during their respective Just Transition journeys when phasing out coal. The selection of these countries followed an assessment of various countries where the best examples of a Just Transition away from coal with positive outcomes existed. In addition to the selected countries, other countries that were initially considered included China, Columbia, Italy, Mexico, South Korea and the United Kingdom.

While the countries that were ultimately selected as case studies for this report have different socio-economic structures and realities; each of these countries offer lessons that South Africa can learn from and adjust to its specific circumstances and socio-economic landscape.

Topic	South Africa	Germany	India	Poland	Romania	USA
Human Development Index *(i)*	0.413	0,939	0.647	0.872	0.816	0.920
Percentage of population living under 1.9 USD per day (%) *(ii)*	18.9	0.0	21.2	0.0	5.7	1.2
Unemployment rate (%) *(iii)*	29.2	3.5	3.5	5.1	5.1	4.4
Youth unemployment rate (% of labour force 15-24) *(iv)*	53.2	5.7	10.5	10.1	15	8.4
Coal in electricity generation (%) *(v)*	89	39	74	30	39	18

Figure 1: Mapping socio-economic differences per country

1.2 Problem statement

The term "Just Transition" first surfaced in the late 1990s when it became obvious that preservation of the ecosystem and resources, and employment are inextricably linked.

The International Labour Organisation (ILO) defines 'Just Transition' as: "the conceptual framework in which the labour movement captures the complexities of the transition towards a low-carbon and climate resilient economy, highlighting public policy needs and aiming to maximize benefits and minimise hardships for workers and their communities in this transformation." (ILO, 2010)

The 2011 Policy Framework on Climate Change developed by the Congress of South African Trade Unions (Cosatu) defines it as: "A 'Just Transition' means changes that do not disadvantage the working class worldwide, that do not disadvantage developing countries, and where the industrialised countries pay for the damage their development has done to the earth's atmosphere. A Just Transition provides the opportunity for deeper transformation that includes the redistribution of power and resources towards a more just and equitable social order."

South Africa is plagued by inequality, poverty and unemployment (triple challenge), thus presenting further challenges in attaining a Just Transition. The recent COVID-19 pandemic and the projected economic decline have exacerbated unemployment, increased poverty levels and thus heightened the need for economic growth and job creation. Job loss sensitivities will increase, and any potential job losses in the coal or power sectors will have to be offset by other opportunities to ensure the success of any Just Transition initiatives.

Internationally, various systematic challenges have been identified among societies going through a Just Transition. Included among these are:

1. Structural unemployment;
2. Community relocations;
3. Poorly planned and managed urban development; and
4. Poor skills development and transfer.

1.3 The curious case of coal

Coal remains a major component of global fuel supplies, accounting for 27% of all energy used worldwide, making up 38% of electricity generation, and more than 40% of energy-related carbon dioxide emissions. Coal remains the second largest energy source after crude oil, and plays a crucial role in industries such as iron and steel.

However, the stabilisation of the climate system in line with the Paris Agreement on climate change is impossible without the timely phase out of unabated coal from the global energy system. Phasing down the use of coal is also increasingly looking feasible and politically desirable in large parts of the world.

A significant number of countries, especially in the industrialised North, have started to make commitments to phase out the use of coal in the coming decades e.g. Canada, Britain, Denmark, Italy, Austria, Mexico and The Netherlands (Plumer & Popovich, 2017). That being said, most countries in the world are still reliant on coal, primarily as an energy source (Figure 2 and Figure 3). Therefore, the Just Transition movement is very much a "work in progress" across the globe, and there are many rich examples of how different communities, states or provinces, and countries are developing strategies to deal with these complex systems in transition. History tells us that economic transitions can sometimes be rapid and disorderly, and therefore adjustments to the supply side of global coal markets could come faster and less smoothly than workers, companies and regions currently expect (Geck, 2019). The most successful case studies appear to be emerging from regions where leaders were able to proactively formulate and implement their responses.

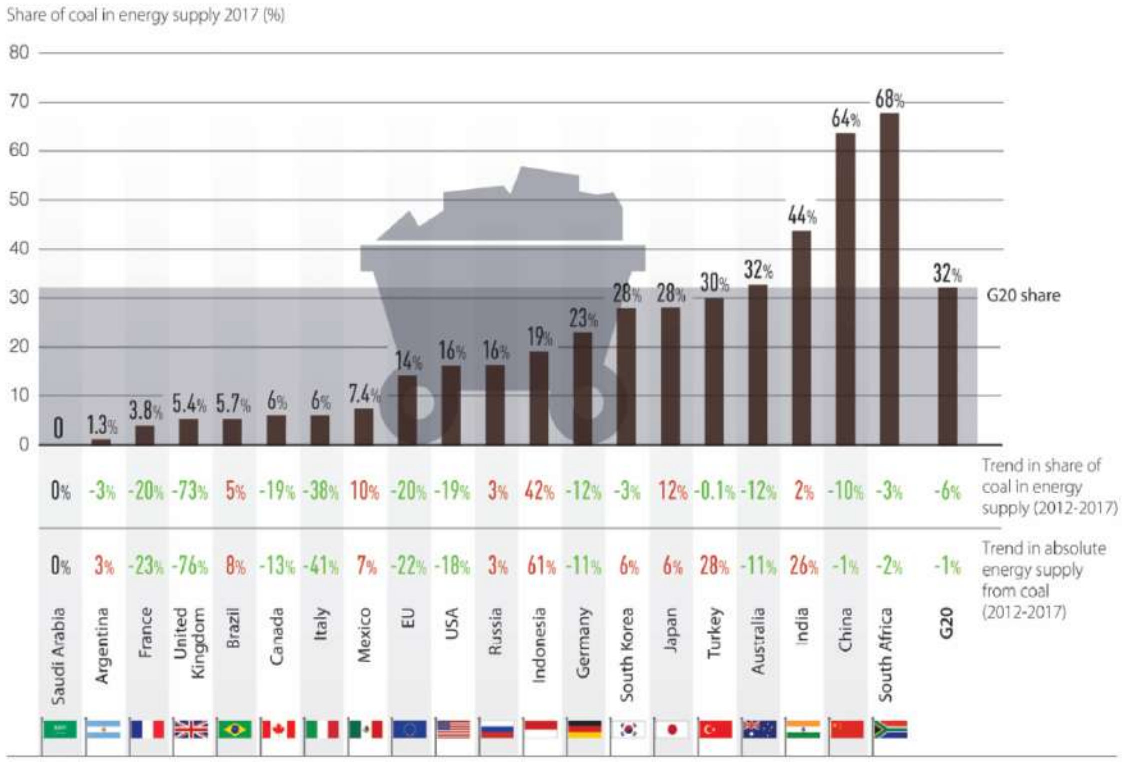


Figure 2: Share of coal in total primary energy supply (2017)
Source: Climate Transparency, 2019

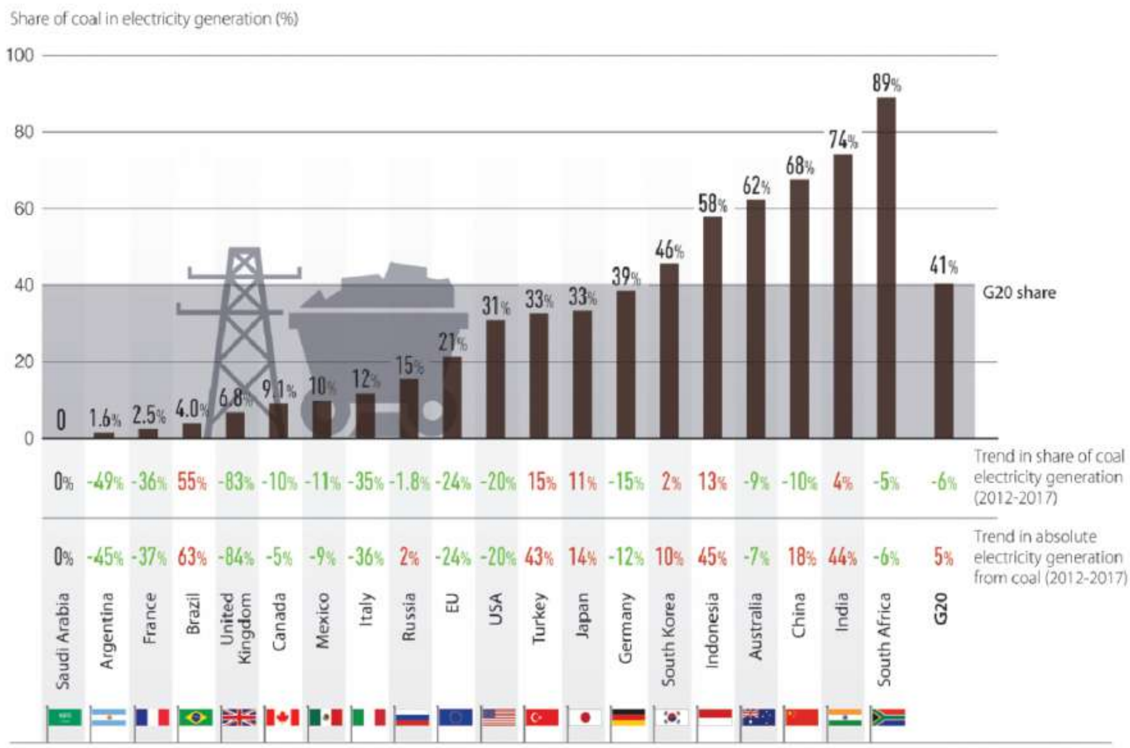


Figure 3: Share of coal in electricity generation (2017)
Source: Climate Transparency, 2019

According to Climate Transparency, 2019, a government's decision to phase out coal sends strong signals to investors and thus prevents the lock-in of fossil fuel-based infrastructure. Canada, France, Italy and the United Kingdom lead the G20 with Paris-compatible plans for phasing out coal for power by or even before 2030 (Climate Transparency, 2019). Germany is currently discussing phasing out coal by 2038, which would be a crucial achievement, but is not aligned with a 1.5°C pathway. The G20 countries with the highest use of coal, highest coal exports or most coal capacity in the pipeline are lacking a long-term vision to phase out coal (India, China and South Africa) (Figure 4).

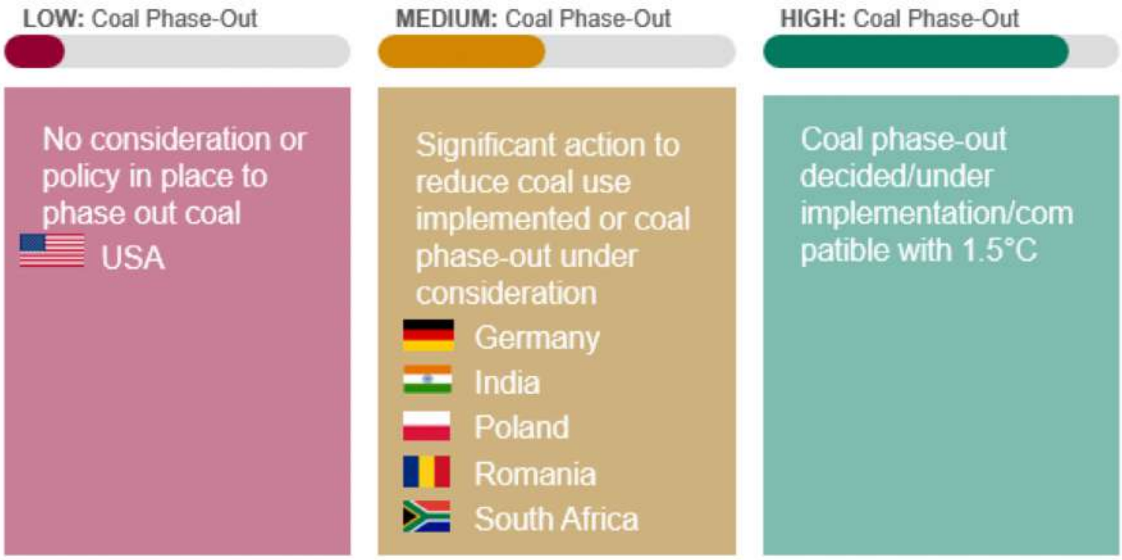


Figure 4: Decision to reduce or phase out coal use by country
Source: Climate Transparency, 2019

Often, a coal phase-out requires broad political and societal support. It is important that it is considered just for those potentially adversely affected by it: workers, communities, enterprises, and lower-income households. What is therefore needed is a Just Transition of the workforce through compensation and retraining for those people who lose their jobs, and national policies to support the development of green and decent jobs (ILO, 2015).

In various G20 countries, the debate on Just Transition has started with the engagement of trade unions and the regions affected. For example, Germany's multi-stakeholder Commission on Growth, Structural Change and Employment recommended in January 2019 that €40 billion be provided to coal-intensive states until 2038, to compensate and retrain coal workers and reduce the financial burden on electricity consumers, industry and utility companies (Climate Transparency, 2019).

Phasing out coal also requires public finance institutions to end finance for coal mining and coal-fired power. A shift from fossil fuel-based to low-carbon, climate-resilient spending by these institutions is also an important signal for private financiers to align their investments.

An encouraging development in recent years has been the commitments from some multilateral development banks and nationally owned development banks to mainstream climate considerations into their operations and lending decisions (Whitley, 2018)

1.4 South African context

According to the IRP2019, new capacity demand in South Africa will primarily be driven by the decommissioning of the existing coal-fired plants and contains a detailed decommissioning schedule (Figure 5). A further 24 100 MW of coal power is expected to be decommissioned in the period beyond 2030 to 2050.

The IRP2019 states that coal will continue to play a significant role in electricity generation in South Africa in the foreseeable future as it is the largest base of the installed generation capacity. However it also states that new investments will need to be made in more efficient coal technologies such as High Efficiency Low Emissions Technology (HELE) including power plants with Carbon Capture, Utilisation and Storage (CCUS) to comply with climate and environmental requirements. HELE coal technologies include underground coal gasification, integrated gasification combined cycle, carbon capture utilisation, supercritical and ultra-supercritical power plants, and similar technology.

It notes that all new coal power projects must be based on high efficiency, low emission technologies and other cleaner coal technologies. The assumption in the IRP2019 is that all new coal to power capacity beyond the already procured 900MW will be in the form of clean coal technology.

	Coal	Coal (Decommis-sioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed Generation, CoGen, Biomass, Landfill)
Current Base	37,149		1 860	2,100	2 912	1 474	1 980	300	3 830	499
2019	2,155	-2,373					244	300		Allocation to the extent of the short term capacity and energy gap.
2020	1,433	-557				114	300			
2021	1,433	-1403				300	818			
2022	711	-844			513	400 1,000	1,600			
2023	750	-555				1000	1,600			500
2024			1,860				1,600		1000	500
2025						1000	1,600			500
2026		-1,219					1,600			500
2027	750	-847					1,600		2000	500
2028		-475				1000	1,600			500
2029		-1,694			1575	1000	1,600			500
2030		-1,050		2,500		1000	1,600			500
TOTAL INSTALLED CAPACITY by 2030 (MW)	33,364		1,860	4,600	5,000	8,288	17,742	600	6,380	
% Total Installed Capacity (% of MW)	43		2.36	5.84	6.35	10.52	22.53	0.76	8.1	
% Annual Energy Contribution (% of MWh)	58.8		4.5	8.4	1.2*	6.3	17.8	0.6	1.3	

- Installed Capacity
- Committed/Already Contracted Capacity
- Capacity Decommissioned
- New Additional Capacity
- Extension of Koeberg Plant Design Life
- Includes Distributed Generation Capacity for own use

- 2030 Coal Installed Capacity is less capacity decommissioned between years 2020 and 2030.
- Koeberg power station rated/installed capacity will revert to 1,926MW (original design capacity) following design life extension work.
- Other/ Distributed generation includes all generation facilities in circumstances in which the facility is operated solely to supply electricity to an end-use customer within the same property with the facility.
- Short term capacity gap is estimated at 2,000MW.

Figure 5: Energy mix proposed by IRP2019

The IRP2019 also notes that hydro, photovoltaic (PV), wind and concentrated solar power (CSP) should constitute 31 230 MW of the total installed capacity by 2030. This constitutes 40,1% of the total installed capacity and leaves room for alternative green industries and job opportunities related to renewable energy sources.

2. LITERATURE REVIEW

2.1 Introduction

Global coal demand has shown an increase in production and consumption during 2017 and 2018. The COVID-19 impacts on coal demand still has to be fully assessed, but it is surprising that coal production and consumption have increased during recent years, despite the uptake of renewable and alternative energy sources.

This chapter focusses on the global coal usage and outlook as well as the Just Transition trends.

2.2 Global coal trends and outlook

Global coal demand increased in 2017 and 2018. These are following a two consecutive years of decline in 2015 and 2016, making 2014 the peak year where demand was at 3.927 Mtoe (Figure 6). In 2018/2019, coal contributed 26% to global primary energy consumption, second after crude oil (Cornot-Gandolphe, 2019). Coal accounts for 38% of global electricity power generation, making it the largest source in the world (Cornot-Gandolphe, 2019). The main driver of increasing coal demand is coal use in electricity power generation which also increased by 2% in 2018.

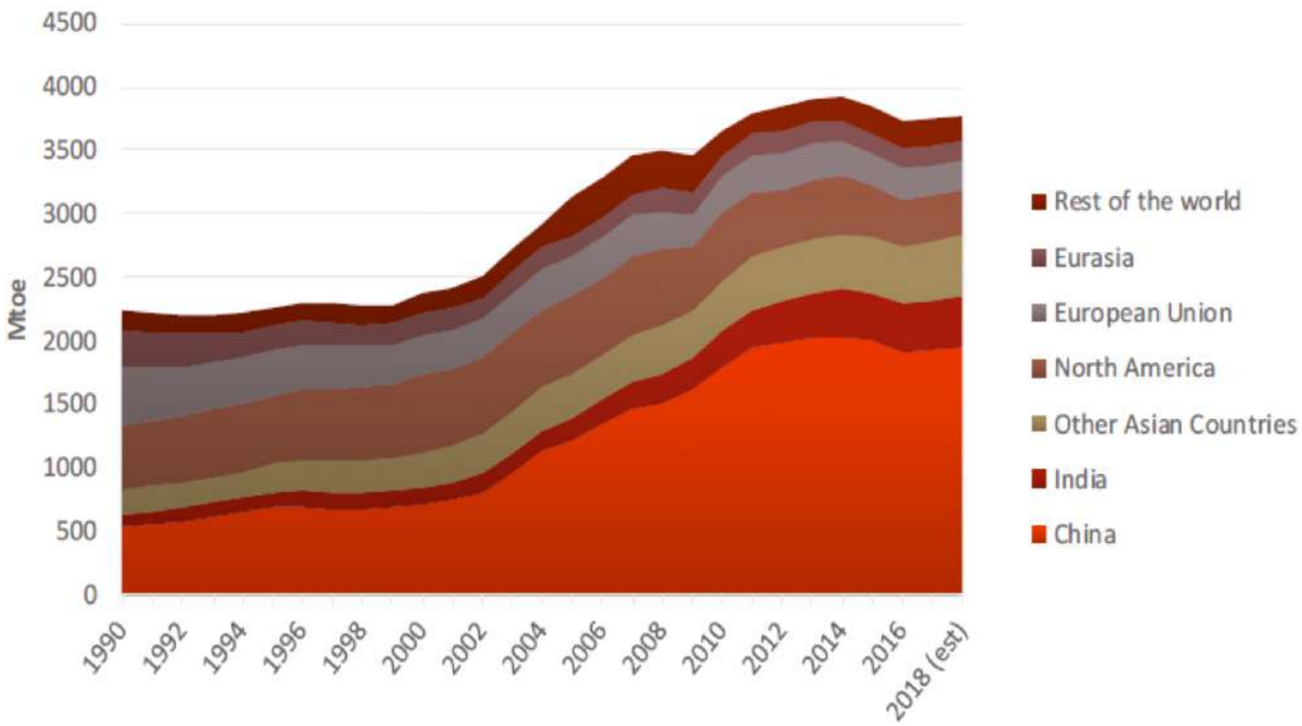


Figure 6: Global coal consumption by major region/country (1990 – 2018)
Source: International Energy Agency, 2018

Coal production (in tonnes) increased by 3.3% from 2017 to 2018. Four of the largest six coal producing countries increased their production with three of these countries, namely India, Indonesia and Russia, recording their largest output to date (Figure 7) (IEA, 2019). Increased production is predominately driven by China, India and other Asian countries while the European and North American economies have been seeing a constant decline. Additionally, average prices in 2018 were more than 60% higher than in 2016.

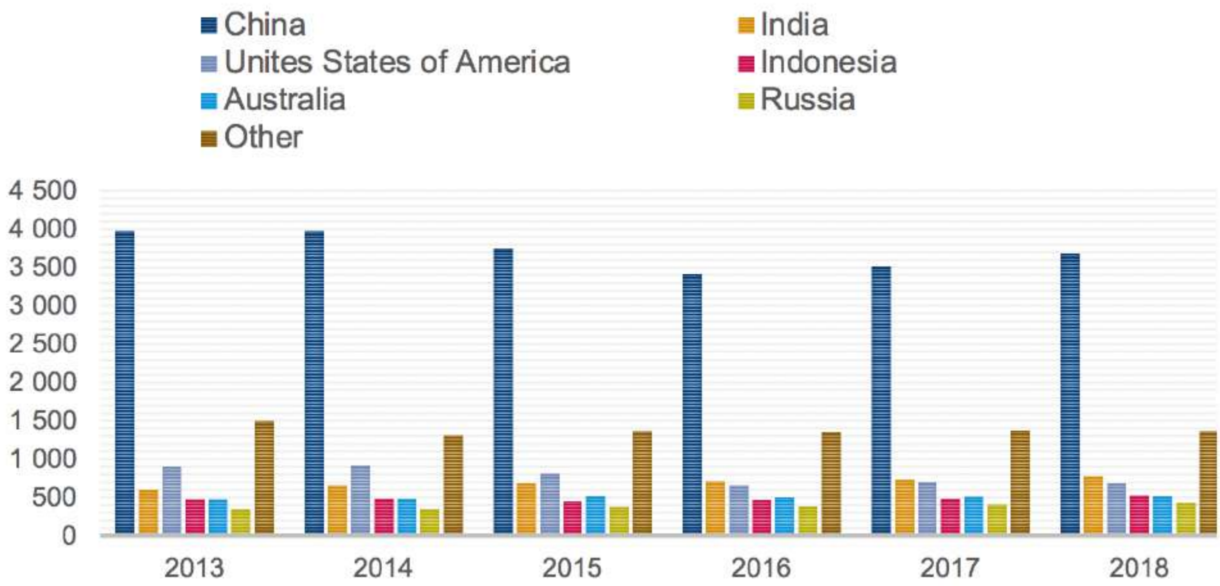


Figure 7: World coal production (2013 – 2018)
Source: International Energy Agency, 2018

When the Paris Agreement was signed in 2015, coal demand was in the midst of a three-year decline. Generally, the investment climate has also shifted with growing concerns around climate change. Financiers and companies are being publically interrogated on their stance on fossil fuels. The growing regulatory environment (e.g. carbon pricing) coupled with competing natural gas and competitive renewable energy investment costs are all suggesting a phase out of coal, predominately in power generation. Although these changes are noted, projections from IEA (2019) are at this stage not showing a collapse in coal, but rather a slight decline in 2019 and a steady trend thereafter to 2024 (Figure 8).

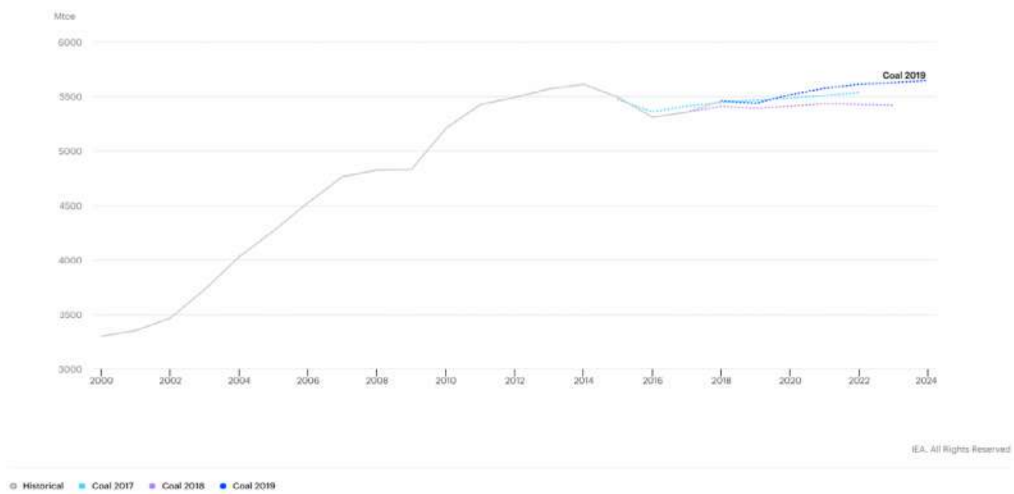


Figure 8: Global coal demand by forecast, 2000-2024
Source: International Energy Agency, 2018

2.3 Global overview of Just Transition

In the 1990s, North American unions began developing the concept of Just Transition. Initially, trade unionists understood Just Transition as a programme of support for workers who lost their jobs due to environmental protection policies. Over time, however, Just Transition came to mean something much broader for unions and their partners such as a deliberate effort to plan for and invest in a transition to environmentally and socially sustainable jobs, sectors and economies enforceable (Just Transition Centre, 2017).

As understanding of the climate crisis grew, unions began to tie Just Transition specifically to action on climate change. They also began campaigning to insert just transition into international regimes, including United Nations Framework Convention on Climate Change (UNFCCC) negotiations. In 2015, the UN agreed on Sustainable Development Goals (SDGs) that collectively represent the agenda of Just Transition, particularly the goals of decent work for all (Goal 8), clean energy for all (Goal 7), climate protection (Goal 13) and poverty eradication (Goal 1). Again, unions had campaigned for these goals, in particular Goal 8 (Just Transition Centre, 2017).

Subsequently 2015, the UN's International Labour Organization (ILO) produced a definitive model for Just Transition: Guidelines for a Just Transition towards environmentally sustainable economies and societies for all. The Guidelines are the result of a tripartite multilateral negotiation between unions, employers' organizations and governments. In the negotiations leading up to the Paris Agreement, the global climate deal negotiated in 2015, unions and their partners worked hard to get strong text on just transition in the Agreement. In the end the Parties agreed to include the text in the Agreement's explanation.

Key Concepts and Principles

For most in the trade union movement, business and government, the ILO guidelines provide the accepted definition of a Just Transition. The ILO's vision of Just Transition is broad and primarily positive. It is a bridge from where we are today to a future where all jobs are green and decent, poverty is eradicated, and communities are thriving and resilient. More precisely, it is a systemic and comprehensive approach to sustainability. It includes both measures to reduce the impact of job losses and industry phase-out on workers and communities, and measures to produce new, green and decent jobs, sectors and healthy communities. It aims to address environmental, social and economic issues together.

The process, its participants and its goals are key. Workers, employers and government are active and collaborative partners in developing plans for transition and transformation that simultaneously consider environment, social justice and poverty alleviation. Other actors, such as community organizations, investors and civil society, may participate, but they are not always partners in the formal process (Just Transition Centre, 2017).

Demands for a Just Transition

According the Just Transition Centre, a Just Transition should:

- respect the contribution that workers in fossil fuel industries have made to today's prosperity and provide income support, retraining, redeployment and secure pensions for older workers;
- recognise that investing in community renewal is critical to gain the hope and trust of affected regions and townships whether energy transition, industrial transformation or disaster;

- support innovation and shared technology to enable energy and manufacturing companies to make the transition with 2020 and 2030 targets for emission reductions and for jobs;
- involve workers in the sectoral plans for the development of clean mega cities;
- formalise the jobs in rescue, rebuilding and resilience associated with climate disasters;
- ensure investment in the jobs and decent work vital to both adaptation and mitigation;
- guarantee essential social protection and human rights ;
- be backed up by a Just Transition fund in every nation, and
- be based on social dialogue with all relevant parties, collective bargaining with workers and their unions and the monitoring of agreements which are public and legally enforceable (Just Transition Centre, 2017).

Coal Transitioning

Coal currently accounts for 29% of global primary energy supply and generates 44% of global CO2 emissions. Carbon capture and storage technologies notwithstanding, this transition implies a substantial reduction in global coal demand (Spencer et. al, 2017).

Mitigation scenarios to limit warming to less than 2°C require a large-scale and rapid transition in the global coal sector. This is even more so for scenarios limiting warming to 1.5°C. Historically, however, policy efforts to transition away from coal have come up against a number of challenges (Spencer et. al, 2017). Limiting warming to 1.5°C would require an extremely rapid transition in the coal sector. The prospective outlook on long-term energy systems model (POLES) is calibrated to meet a net carbon budget of 400 Gt CO2 between 2011 and 2100. The scenario assumes a continuation of current trends until 2020, and then from 2020 the abrupt implementation of policies consistent with the carbon budget, approximated in the model by a carbon price (Spencer et. al, 2017).

Table 1 and 2 below display the main global results of the POLES 1.5°C scenario as they pertain to coal.

Table 1: Primary consumption of coal, 1.5°C scenario (Mtoe)

	2010	2030	2050	% change year over year 2000-2020	% change year over year 2020-2050
World	3725	1878	570	3	-7
Germany	77	30	32	-1	-2
Poland	55	22	2	-1	-10
China	1842	988	273	7	-7
India	291	170	47	5	-7
Australia	52	13	1	-1	-11
South Africa	101	53	23	0	-4

Source: Spencer et. al, 2017

Table 2: Installed electric power capacity from coal, 1.5C scenario, including CCS (GW)

	2010	2030	2050	% change year over year 2000-2020	% change year over year 2020-2050
World	1692	2059	604	4	-4
Germany	53	40	23	0	-3
Poland	29	22	7	0	-5
China	707	1110	348	8	-4
India	118	194	70	5	-3
Australia	31	16	2	0	-8
South Africa	38	31	27	1	-2

Source: Spencer et. al, 2017

The decline in world primary consumption of coal is rapid, averaging −7% per year in the period 2020 to 2050. Such a rapid transition requires either the cut off of existing coal assets on the production and consumption side, or massive retrofitting of carbon capture and storage (CCS), or a combination of both. This result is consistent with the results in Davis and Socolow (2014) which find that 'committed emissions' from existing coal power plant stock as of 2012 was 206 Gt CO2. Using the commitment factor in Davis and Socolow (2014), one can update committed emissions from global net coal capacity additions built between 2012 and 2016, which add an estimated 39 Gt CO2 to global committed emissions from coal. Thus the total committed emissions from coal electricity capacity amount to 245 Gt CO2 in 2016, which compares with a global carbon budget from the electricity sector consistent with 1.5°C of 118 Gt CO2 and 332 Gt CO2 for 2°C (both at 50% probability) Therefore, the current coal power capital stock implies committed emissions that are already more than double the electricity sector carbon budget for 1.5°C.

Given the slow uptake of CCS globally, and associated challenges with the technology, coal consumption in the electricity sector will need to fall even faster than the tables above suggest to meet a 1.5 degree target – even as new plants are planned and under construction. Indeed, as shown, analysis for 2°C, persistent coal power must be phased out by 2050. Thus, mitigating climate change to 1.5°C is not possible without either the cut off of coal assets or massive addition of CCS or both, as indeed is required in the scenario described in tables above (Spencer et. al, 2017).

By extension, 1.5°C pathways also imply the cut off of upstream coal reserves/resources and capital beyond that required for 2°C, where 80% of coal reserves cannot be burned. Potential emissions of 425 Gt CO2 contained within existing coal mining areas, highlighting that production from developed reserves (existing mines and mining areas) already exceeds a 1.5°C budget (Spencer et. al, 2017).

Main motivators and push factors

The first driver of transition is mine mechanization. Technical improvements in coal extraction methods and technologies continue to be introduced in response to macroeconomic and business pressures. The effect is a consolidation of operations by shifting production from less efficient and un-mechanized mines to more efficient mechanized operations. The end result is a net loss of jobs. Practically, as seen in the United States and Russia over the past four decades, the coal industry first sheds the least efficient operations and then consolidates around the remaining technology intensive operations. Mechanization induces coal mines to shed labour, which helps create greater financial resilience by increasing productivity. Even under the International Energy Agency's (IEA) business-as-usual forecast scenario, which predicts global coal production to remain relatively constant at current levels to 2040, countries will face strong disruptions on the regional level as less efficient coal mines close under continued industry consolidation. In the affected regions, this will lead to significant losses in coal sector employment. In this situation, job losses will be significant locally or regionally, but may be less visible when viewed across the total labour pool nationally (World Bank Group, 2018).

The second driver of change is clean energy policies. This includes local and regional air pollution prevention programs, low carbon and clean energy development agendas, and worker and community safety initiatives. In general, progressive government policy interventions in favour of alternative energy sources over the last fifty years have included:

i. Policies to reduce extensive air pollution, for example, Western Europe in the 1960s and todayin South and East Asia and Poland; and

ii. More recently policies and programs that address climate change, including an energy transition favouring lower carbon or zero carbon energy resources, away from coal. The global movement to reduce greenhouse gas (GHG) emissions has moderated overall energy demand (especially coal) and shifted energy use to more flexible energy sources with lower or no carbon emissions (World Bank Group, 2018).

The third driver of change is the changing dynamics of the energy sector affecting coal consumption. This has two aspects. First is a slowing of demand largely resulting from energy efficiency improvements. Unlike past decelerations of energy demand that were driven by broad economic slowdowns, this decrease has been driven by energy efficiency measures, enabling a decrease in global energy intensity by 2.8% in 2015 and 2.0% in 2016. Governments' energy efficiency policies and regulations have supported this transition through standards, building codes, public financing, and tradable energy certificates. As a result, there has been a strong increase in the uptake of energy efficiency investments like light-emitting diode (LED) lighting and energy efficient heating and cooling. Alongside demand, the second aspect is a broad shift in energy supply or use with decreased costs and increased availability of alternative fuels, such as renewable energy and gas. From 2014 to 2015 global energy production grew by 0.3% with non-organisation for economic cooperation and development (OECD) countries energy production growing by 0.5% and OECD countries declining 0.3% much lower than 2% as was typical in the past (World Bank Group, 2018).

Challenges

Some of the challenges Just Transition face include:

- Economic restructuring, resulting in the displacement of workers and possible job losses and job creation attributable to the greening of enterprises and workplaces;
- the need for enterprises, workplaces and communities to adapt to climate change to avoid loss of assets and livelihoods and involuntary migration; and
- Adverse effects on the incomes of poor households from higher energy and commodity prices (International Labour Organization, 2015).

Guiding Principles

The following principles should guide the transition to environmentally sustainable economies and societies:

- Strong social consensus on the goal and pathways to sustainability is fundamental. Social dialogue has to be an integral part of the institutional framework for policymaking and implementation at all levels.

- Adequate, informed and ongoing consultation should take place with all relevant stakeholders.

- Policies must respect, promote and realize fundamental principles and rights at work.

- Policies and programmes need to take into account the strong gender dimension of many environmental challenges and opportunities. Specific gender policies should be considered in order to promote equitable outcomes.

- Coherent policies across the economic, environmental, social, education or training and labour portfolios need to provide an enabling environment for enterprises, workers, investors and consumers to embrace and drive the transition towards environmentally sustainable and inclusive economies and societies.

- These coherent policies also need to provide a Just Transition framework for all to promote the creation of more decent jobs. Anticipating impacts on employment, adequate and sustainable social protection for job losses and displacement, skills development and social dialogue, including the effective exercise of the right to organize and bargain collectively.

- There is no "one size fits all". Policies and programmes need to be designed in line with the specific conditions of countries, including their stage of development, economic sectors and types and sizes of enterprises.

- In implementing sustainable development strategies, it is important to foster international cooperation among countries. In this context, we recall the outcome document of the United Nations Conference on Sustainable Development (Rio+20), including section VI on means of implementation (International Labour Organization, 2015).

Main actors, programmes and some of the most important instruments of restructuring

Main actors in the Just Transition restructuring include the ILO, UNFCCC, Trade Unions, climate change activists, investors and regulators.

Programmes	Instrument of Restructuring
Successful 1st Global Forum on Just Transition	In December 2017 the ILO hosted the first Global Forum on Just Transition in partnership with UNFCCC. The Forum aimed to establish a global platform, share national and international experiences on Just Transition in country contexts, take stock of global research and build momentum for action on climate change.
Make green opportunities real: Major investments are needed to develop long-term sustainable industrial policies, aimed at retaining and creating decent and "green"/ sustainable jobs, "greening" all workplaces and developing and deploying technology	The French "Observatoire Français de Conjoncture Economique" has announced that 500,000 green jobs will be created by 2020 as a result of the implementation of the "Grenelle de l'Environnement", in sectors such as renewable energies, recycling, clean transport, and energy efficiency in buildings. In Japan, employment in environmental industries is expected to double to 2.8 million people by 2020.
A sound starting point: Research and early assessment of social and employment impacts are crucial for better preparing change.	The European Trade Union Confederation (ETUC) undertook a study to find out the potential repercussion on employment of a reduction of 40% in the European Union's CO_2 emissions by 2030. The study points to the need for clear and foreseeable climate policies, substantial public investment in R&D, renewable and combined heat & power (CHP) energy, public transport systems and renovation of buildings, in addition to well-designed economic instruments taking into account the impact on low income households and energy intensive industries. A new, in-depth study on climate change, new industrial policies and ways out of the climate and economic crises is now being undertaken.
Come & talk! : Governments have to consult with and encourage institutionalized formal involvement of trade unions, employers, communities, and all groups which need to be part of the transformation. Consultation and respect for human and labour rights form the baseline conditions in order to ensure a smooth and effective transition towards a sustainable society.	Spanish trade unions (CCOO & UGT), government and business organisations have established a platform for tripartite social dialogue on climate change to prevent, avoid or reduce the potentially adverse effects that could result from compliance with the Kyoto Protocol, in particular those related to competitiveness and employment.

Programmes	Instrument of Restructuring
You train the workers, the future gets closer: Changes on the ground require workers to be trained in clean processes and technologies; this is key for absorbing and developing new technologies and for realising the potential of green investments. Educational leave for workers to acquire new skills might be needed.	The Argentinean construction workers' union UOCRA promotes workers' training in the field of renewable energies, providing workers with certified skills for bio-gas production installations, solar water heaters, solar and wind power installers.
It's also about protection! Vulnerability may be a source of reluctance to support change. Social protection schemes, including active labour market policies (social security including social insurance and public employment guarantee schemes, job creating public works programmes for the unemployed and working poor, income maintenance, and job placement services, among others) are key for ensuring justice in the transition.	The American Clean Energy and Security Act of 2009 contains a dedicated chapter on "Green Jobs and Worker Transition" that would establish a "Climate Change Worker Assistance Fund" to provide income support, health care coverage, career counseling, and education and skill training services to workers who are adversely affected by federal climate change legislation. It also creates a clearinghouse for information and resources on vocational education for jobs in renewable energy, and a "Green Construction Careers demonstration project". In addition, economic stimulus legislation provides up to $1 billion for training for green jobs. Social protection is also needed to address the consequences of climate change and extreme weather events on the poorest and most vulnerable (for example, the Indian "super cyclone" in Orissa led to more than 10,000 deaths, the demolition of millions of dwelling units, damage to over 80% of standing crops, and a loss of about 454,000 heads of cattle).
One size does not fit all: Each region and community at risk requires its economic diversification plan, a "freemarket adaptation" will only lead to suffering and opposition to climate measures.	Agriculture programmes to support job creation and climate change adaptation, should ensure correct ones are chosen: There is a general tendency to replace rice production by mango in semi-arid Bangladesh. While correct from an economic and agronomic standpoint, without planning and local consultation there is a risk of social unrest. Mango requires much less work than rice. That is bad news for the one third of households in the region who depend on their work as daily labourers in agriculture. There is a need for adapting general policies to local conditions in order to introduce truly sustainable policies. Communities need to be consulted and must be able to decide on food/agricultural choices (https://www.ituc-csi.org/IMG/pdf/01-Depliant-Transition5.pdf).

3. CASE STUDIES AND DISCUSSION

3.1 Introduction

This section focuses on how five other countries namely Germany, India, Poland, Romania and the United States of America have addressed key challenges during their respective energy transition journeys. Each country's case study was analysed according to similar topics and key questions which were agreed at the start of the study.

3.2 Case study 1: Germany

3.2.1 Key questions summarised

The key questions relating to Germany's Just Transition journey are summarised below:

Key Questions	Germany's Approach
Were people relocated or planned to be relocated?	• No specific plans to relocate people • Compensation Fund plan to assist in local areas
Were alternative economies created/planned to be created?	• Yes. A key focus on creating alternative economies • Repurposing and renewables • Alternative economic sectors created
Were skills development undertaken/planned to be undertaken?	• Yes, Ruhr Area case study serve as key case study • Part of Compensation Fund intent
Did/do strong policies exist?	• Yes, evident over time • Strong commitment to phase out coal by 2038
Did/do subsidies or funds exist to assist transition?	• $45 billion Compensation Fund • Subsidies being phased out

3.2.2 Background to Germany's Just Transition

Germany can be regarded as one of the frontrunners globally in combatting climate change and ongoing commitments are being made to accelerate the fight against climate change. Early in 2020 Germany committed to phasing out coal by 2038 and is looking to renewable energy sources for its power generation (WEF, January 2020).

The agreement between the government and regional leaders sets an 18-year timeframe to phase out Germany's coal-fired power stations and a $45 billion compensation fund will support areas that are dependent on the coal industry.

The fund will compensate mines and utilities for lost production revenues, fund new infrastructure projects in coal-dependent areas, and help coal-industry workers retrain for new jobs in their local area.

Germany's lignite industry employs around 20,000 people, three-quarters of which are pit workers and the rest work in lignite-fuelled power stations. A further 5,000 people work in black coal-fired power plants, despite the country's last black coal mine closing in 2018.

International Renewable Energy Agency (IRENA) figures for 2018 show around 284,000 people working in Germany's renewable energy sector, the vast majority in wind energy.

To reach the government target of 65% renewables by 2030, the sector will need to increase its current share of the energy mix by half, creating numerous new jobs for people living in Germany.

3.2.3 Policies

Germany has over time implemented various policies and set ambitious targets to reduce CO2 – emissions and phase out coal. In the most recent years, i.e. December 2014 the German government approved the Climate Action Programme 2020 to ensure the country meets its 2020 climate targets and in 2016 the Climate Action Plan 2050 was approved to make Germany close to CO2 neutral by 2050.

Germany's Coal Exit Commission was established in 2018 to help manage the complex transition in coal-producing areas also supporting the European Union's stricter emissions limits from 2021. (Wehrmann 2018)

Coal Exit Commission's primary aims were to:

- Develop "concrete prospects" and transition plans for the economic future of lignite-mining regions and identify strategies to reconcile climate action with economic stability
- Identify measures to ensure Germany meets its 2030 climate target by reducing emissions from the energy sector by 61% to 62%, compared to 1990 levels
- Agree on a roadmap and an end date to phase out coal-fired power production completely and in line with Germany's Climate Action Plan as well as its national contributions to the Paris Climate Agreement
- Make recommendations for closing the gap to Germany's 2020 climate target "as much as possible" (Clean energy wire, 2018)

Various drivers have been identified to phase out coal use as well as reducing CO2 – emissions and increasing renewable energy initiatives. Some of these drivers have created momentum which may result in a coal phase out plan. These drivers include the following:

- Raising global pressure on climate issues (Paris Agreement);
- The German climate protection plan (implying the phase out of coal);
- Realisation that Germany will most likely not reach their 2020 climate targets;
- Increasing pressures from civil society for a coal phase out; and
- Rising economic situation for renewable energy sources.

Aspects for achieving a coal phase-out by 2050 latest in Germany include the following:

- Set end dates for coal as well as phasing out coal through promulgation of laws;
- Ceasing construction of new power plants;
- Cost effective decommissioning plan; and
- Safeguarding security of supply as well as the economic competitiveness in the energy sector.

Instruments for reducing coal-based power generation include:

- Setting a floor price for CO2
- Closing inefficient mines
- Creating a climate contribution fee
- Forbidding new coal/lignite mines
- Coal phase-out laws allowing fixed production or emissions

The commission will continue to support the practical implementation of the Climate Action Plan 2050 which will include plans on economic transition as well as legislation in support of the phasing out of coal and CO2 emission reductions.

The process of implementing the phase-out of coal focuses on two key aspects namely:

- Structural economic change in support of lignite mining regions; and
- Energy and climate policy legislation

Two major laws Germany will have to implement as part of the phasing-out plan include 1) the support for mining regions and 2) the timetable for coal-fired power plant shutdowns i.e. the coal exit law. In addition, several additional laws, amendments to existing legislation or regulatory changes will be necessary.

3.2.4 Key case study: Alternative land-use and economic sectors created

Although various actions are being taken in support of the Climate Action Plan 2050, current examples already exist of what Germany has done to support areas where dependency on coal had to be reduced.

The following section describes initiatives that were taken in the Ruhr area which is a polycentric urban area in North Rhine-Westphalia, Germany with a population of over 5 million and which is the largest urban area in Germany.

In the Ruhr area the employment in the coal mining industry decreased from 600 000 people in 1957 to 6 000 in 2016 with a 4-fold increase in labour productivity since 1950. When referring to job replacement the main focus was on education as well as the service industry and strong social security net, while an increase in unemployment has also been evident. Most employees from the coal sector entered new employment opportunities or went into early retirement. Other measures in terms of employment included the retraining of workers. In the Ruhr area job creation struggled because of various reasons including resistance from mining companies. Roughly 334 000 people in 2016 compared to 160 000 people in 2004 were employed by the renewable energy sector. It is expected that by 2030 two thirds of the workers currently employed in the coal mining industry would have reached an age above 60 years and therefore reducing the amount of employees that will be affected directly.

One of the reasons for a rather successful shift of workers from the coal mining industry was because the metal industry absorbed employment from the fossil-fuel sector in the Ruhr area. In the Ruhr area the mining economy from the past was partly shifted to high value-adding economic sectors such as the establishment of universities but also to other alternative energy generation initiatives.

A number of such initiatives include:

- Photovoltaic plants on mining areas. Apart from their height, mine dumps have other advantages too. There are many free areas and hardly any shading. Therefore, they are ideal locations for photovoltaic systems; like-wise, the large roofs of factory buildings can be used for these, too.
- Heat from mine water or exhaust heat. Every year, approximately 90 m cubic meters of pit water are pumped in the Ruhr area. The temperature of this pit water is 35-40°C (95-105°F) and can be used for supplying heating to buildings by means of heat exchangers or for accelerating the bio mass production when generating energy.
- Wind wheels on refuse dumps. The mine dumps in the Ruhr area are often 80-100m above ground surface; thus, they often feature high wind speeds which allow for an economically reasonable use of wind wheels, and three wind wheels have already been erected.
- Energy-producing utilization of methane that is released from coal beds.
- Production of biomass on former mining areas;
- Pump-storage power plants either on refuse dumps or underground in existing mine structures.

A key feature of the Ruhr transition was the management of the employment change, using a work redistribution programme and early retirement. The introduction of a Ruhr Coal Vocational Training Society (RKB), 100% subsidiary of Ruhr coal mining company, was put in place to manage labour market transitions. A map of existing and future skills demand was used to set up objectives and develop model projects. For each affected worker, an individual re-employment strategy was developed in co-operation with the regional government, the company management and the works councils. Ruhr has undergone permanent structural change over the last sixty years and has achieved a fundamental transformation from coal and steel to a knowledge-based economy.

In the Ruhr area, infrastructure investments were a crucial aspect of the first structural policy program "Development Program Ruhr", since the "new economy" beyond the mining industry relied on an enhanced mobility of the people. The area now plays a major role in the logistic sector due to its links to economic centres within Europe.

In summary, positive aspects included:

- A Ruhr Coal Vocational Training Society (RKB), as a 100% subsidiary of Ruhr Coal AG, was put in place to manage labour market transitions.
- Transition to value-add economic sectors such as industrial development or tertiary education.
- The transition to renewables is safer, easier and cheaper in comparison to long term coal-powered energy.

Negative aspects include the resistance and delay of transition by major contributors in coal mining industry i.e. government organisations and surrounding coal mine companies as well as the outmigration of young and skilled people.

3.2.5 Lessons learned

Lessons learned include the following:

1. **Mine closure agency**: Having a specific mine closure agency to manage the closure and ensuring targeted labour market transition programmes is crucial for future coal transitions.
2. **Collective bargaining and contractual regulations**: Facing the challenges posed by a restructuring process of such magnitude required a targeted and coordinated set of statutory, collective bargaining and contractual regulations and initiatives with active contributions from the social partners.
3. **Integrated policies**: While it is important to have policies in place to address unemployment, policies should also include alternative economic development of former coal regions, environmental health improvement of these regions as well as energy system transition.
4. **Collaborative transition structures**: Transition is realistic when all government spheres work together and planning a phase – out on a multilevel structural policy mix.
5. **Funding mechanisms**: Establishment of a Compensation Fund to assist with the closure of lignite mines and power plants and help reskill the sector's workers.
6. **Legislative changes**: Just Transition requires the creation of new and/or the amendment of current legislation and bylaws.

3.3 Case study 2: India

3.3.1 Key questions summarised

The key questions relating to India's Just Transition journey are summarised below:

Key Questions	India's Approach
Were people relocated or planned to be relocated?	• Relocated for coal mines • Suitable renewable geographic areas might not correlate with current coal mining areas
Were alternative economies created/planned to be created?	• Renewables bring economic opportunities • However, renewal job opportunities might not replace all coal sector jobs
Were skills development undertaken/planned to be undertaken?	• Not purposefully, but renewables growth leads to that
Did/do strong policies exist?	• Yes and array of policies exist including Coal transition policies. • "Coalgate" cancelled 214 coal leases
Did/do subsidies or funds exist to assist transition?	• Green Bonds • Blended Finance

3.3.2 Background to India's Just Transition

India is a signatory to the Paris Climate Change Agreement (PCCA) and thus needs to shift to cleaner, renewable forms of energy. Its renewable energy ambitions are quite aggressive as evidenced by the country's 2014 commitment to its short-term target of 175 GW of renewable energy by 2022. (Vishwanathan et al, 2018)

However, India's financial balance is precarious and its social welfare redistribution has long been a key aspect of energy policy, with commercial and industrial users paying more to cross-subsidized homes and agriculture. (WEF, May 2020). So any plans around Just Transition will have to be carefully weighed especially because of the country's dependency on coal for energy generation and jobs as well as cross subsidization.

Coal provides for about 70% of power generation in India while emitting approximately 65% of CO2 emissions. The transition to alternative energy sources will be a lengthy and tedious process as coal currently provides for energy security while providing jobs. The amount of coal extracted since 1950 up to 2017 amounts to about 15 Bt. It is also predicted that about 220 Bt will remain unutilised which might possibly result in great socio-economic losses, should the transition to renewable and alternative energy sources take full effect. Between the years 1978 and 2010 coal production increased more than six times while the production rates decreased between 2009 and 2014. (Vishwanathan et al, 2018)

India employs about 485,000 coal miners who work in the production of over 700 million tonnes of coal annually and with many indirect jobs linked to the broader coal mining industry. However to transition those directly employed by coal mines India would need to scale up its current solar capacity to nearly 30 times, or about 1,000 gigawatts which is a big ask. (Pai et al, 2020)

However, coal also plays a fair part in environmental damages, air pollution as well as being a social and political concern. With increasing technology, renewable energy sources becomes more affordable, thus making the latter a more viable option. It must however, be noted that coal is expected to be the main energy source till at least 2030.

Steps have been taken in order to improve the overall performance of power plants and thus reducing CO2 emissions, savings on transportation costs, reducing dependence on imported coal. Further, there are plans of shutting down 37 GW of anti-quated, heavily polluting subcritical coal plants in the near future. Since 2006 India has added 151 GW of new coal power, where 75% of these are subcritical.

India contributes close to half of the world's SOx emissions, mostly derived from the thermal power plants and due to insufficient operations. Norms that was set in place in relation to these operations stated that the installation of flue-gas desulfurization which helps remove Sulphur dioxide from exhaust flue gasses of fossil fuel power plants, are required. An application 'ashtrack' has been launched to establish a link between fly ash users and power plant executives in order to increase the fly ash utilization to 100%, from 63%.

Rather than to move away totally from coal use, India currently plans to diversify the country's energy sources in order to reach the goals as set out in certain policies such as to increase the renewable energy goals from 100 GW to 175GW by 2022.

3.3.3 Policies

One of the main objectives of Indian energy policy is to provide access and affordability of energy to all the various sectors. The policies in India aims to accelerate the move towards renewables to mitigate climate change, but also to reduce the environmental footprint of coal and associated air and water pollution challenges.

A number of institutions are involved in energy policy in India as depicted in Figure 9 below.

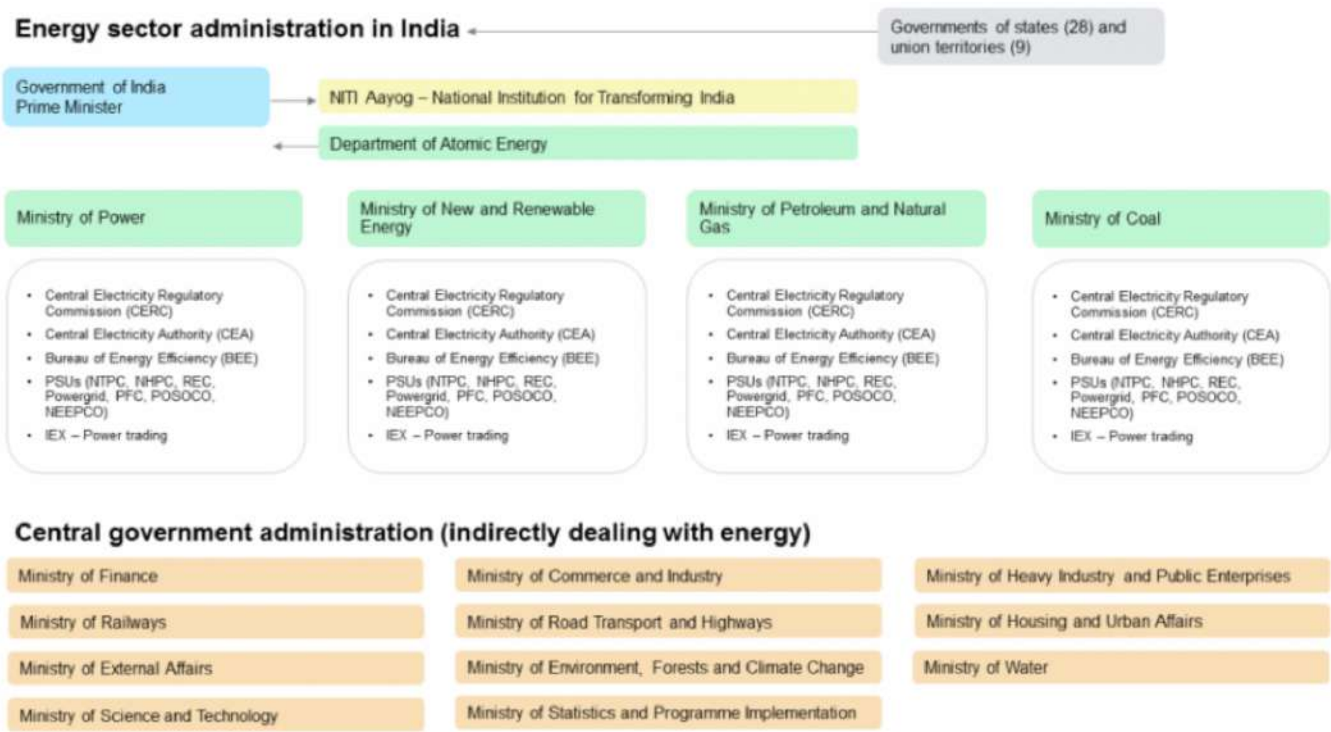


Figure 9: Major institutions involved in energy policy in India
(Source: IEA, India, 2020)

Of key importance is that Coal Transition Policies in India have resulted in the cancelation of 52% of planned capacity of coal-based power plants between 2006-2007 and 2016-2017. The country plans to phase out old and inefficient power plants due to air and water quality concerns.

In 2014, the Supreme Court cancelled 214 coal mining leases allocated between 1993 and 2013. The latter because of a scam called 'Coalgate' which led to the conviction of the former coal secretary and 2 top bureaucrats. In the judgement very little attention was given to the affected communities located in coal rich areas. It was evident that major job losses going forward, key policies and actions would have to be in place to mitigate the socio-economic fallout and prevent poverty levels to deepen.

An enabling environment through regulatory and economic instruments that is in congruence with innovative business and financial models by regional/geographic location, is needed to scale up the penetration of the various renewable energy technologies and support job and skills transition.

3.3.4 Key case studies

3.3.4.1 Successful mine rehabilitation and reclamation

Mining is an activity which greatly contributes to various environmental issues such as deforestation, degradation of land and water pollution. Government organisations have focused on the ecological restoration of Gondudih-kusunda colliery and have developed 45 forest and vegetation sites since 2011 on dumps and mined out areas spread over 260 hectares. These efforts aid in achieving the NDC goal to create additional carbon sink of 2.5-3 Bt of CO2 equivalent through additional forest and tree cover (increase of about 680 - 817 Mt of carbon stock).

Although such steps towards a Just Transition have been taken, the country faces some resistance from the coal sector. In the process of transitioning to alternative resources, a great concern is what will happen with the existing mines that will not be utilized anymore and become stranded assets.

BCCL, the pioneer company in the mining industry, conducts ecological restoration in order to replicate natural forest with native species and biodiversity rejuvenation on the degraded areas of past mining activities. Thus far 294 ha of ecological restoration has been conducted by BCCL in the Jharia Coalfield.

Successful coal mine rehabilitation and reclamation holds promise for the Just Transition journey in India by ensuring that environmental degradation is addressed whilst creating alternative livelihoods and providing eco-tourism potential.

3.3.4.2 Jobs transition from coal to renewables

India is one of the countries with the highest number of renewable energy jobs. These jobs are mostly focused in the areas concerning sales, distribution, maintenance, installations and operational aspects of the renewable energy sector. Estimations made between 2006 and 2015 showed significant increases in employment opportunities in the renewable energy sector worldwide. It must, however, be noted that rather than creating new job opportunities these supplemented the lost opportunities in the coal mining sector.

As at 31st December 2019, India had an installed solar capacity of 33.73 GW. India has a target of 175 GW of renewable power by 2022 and of that 100 GW is from solar power. The building of 960 GWs of solar capacity is a huge task. Some of the biggest challenges include the acquisition of land and ensuring coal miners can make an employment transition to the renewables industry.

States like Chhattisgarh, Jharkhand, Odisha, Telangana and Madhya Pradesh account for over 85% of the country's coal production. Each coal mine will need nearly two gigawatts of solar power to be installed to absorb all coal miners working in the mines. Although no clear policy direction was evident on this matter it is widely accepted that skills and job transfer will be important in India's Just Transition to address social and poverty challenges. (Pai et al, 2020)

3.3.5 Lessons learned

Lessons learned include the following:

1. **Key policies drive action in the Just Energy transition** and have to be integrated with various cross functional policies and mitigating socio-economic impacts.
2. **Renewable energy job growth may not offset job coal mine losses**: The growth in the clean energy sector, may not offset future job losses in the coal industry. (Pai et al, 2020)
3. **Economic diversification** is critical to generating new revenue streams to sustain livelihoods that are deeply affected by an over-reliance on the coal industry.
4. **Mitigate the social and economic impacts**: Given India's poverty rate and projected coal mine job losses, government support will be necessary to mitigate the social and economic impacts of the coal transition.
5. **Coal mine rehabilitation and reclamation** not only address environmental degradation but also create support for alternative livelihoods.
6. **Energy markets remain a key determinant of transition**: While environmental policies and regulations have an impact on the coal industry as well as the Just Transition movement, the fundamental economics underpinning the energy markets are likely to remain the key determinant on how fast and disruptive any transition is likely to be.

3.4 Case study 3: Poland

3.4.1 Key questions summarised

The key questions relating to Poland's Just Transition journey are summarised below:

Key Questions	Poland's Approach
Were people relocated or planned to be relocated?	• Support existed within affected communities
Were alternative economies created/planned to be created?	• Examples exist such as the Walbrzych Special Economic Zone
Were skills development undertaken/planned to be undertaken?	• Social packages were available
Did/do strong policies exist?	• Yes - Coal restructuring already started in the 1990's • EU climate and energy policies drove Just Transition actions
Did/do subsidies or funds exist to assist transition?	• National large scale support packages available

3.4.2 Background to Poland's Just Transition

Coal mining has a long tradition in Poland, especially in two southern regions. Coal mines were first mentioned in Poland in the 14th century (Lower Silesia region) and 16th century (Upper Silesia region). However, the true growth of the sector took place in the 18th and 19th centuries when new industries, urban centres and transport lines developed around three major coal fields – Upper Silesia, Dąbrowskie and Krakowskie. Two regions were particularly affected by the fast development of mining – Upper Silesia and Małopolskie - both in the south of Poland. Coal mining triggered progress in the regions thanks to the rich coal reserves. The development of mining and related industries (particularly metallurgy) was followed by demographic, social, economic and cultural changes. Mining speeded up technological progress, i.e. the use of steam engines, railroad electrification etc. It triggered the development of the education system (especially engineering) and speeded up urbanization. Mining was also the first sector where a modern social security system was developed. Social rights and their awareness led, in turn, to faster socio-political changes and the formation of workers' movements.

At the end of the 19th century and the beginning of the 20th century, hard coal became the main resource of the mining sector in Poland, ahead of ore, gas and petrol. In 1929 the production of coal, over 70% of which came from the Upper Silesia region, reached over 46 million tonnes and accounted for 4% of Polish GDP.

During the communist regime, the new model of a centrally-planned economy was introduced, in which coal played a prominent role. As private property was considered a source of inequality, it was almost entirely abolished. For that reason, the government nationalised (i.e. acquired from domestic and foreign private owners) all large and medium-sized companies, including all companies in the mining and electricity sector.

The empowerment of the working class, which was at the heart of the communist system, as well as the emphasis on the development of heavy industry and large-scale projects laid the ground for the rapid growth of the mining regions. During this time coal production reached its peak (1979 at 201 million tonnes).

The choice of coal as the backbone of the economy was not random. Because of the composition of its natural coal reserves, Poland was assigned by the Union of Soviet Socialist Republics (USSR) to play the role of coal and steel supplier within the Eastern Bloc. This economic direction had a negative effect on the production of consumer goods.

The phasing out of coal was mainly driven by profitability and productivity of coal mines and the Just Transition movement became more mainstream when renewables became economically viable to implement.

3.4.3 Policies

Coal plays a prominent role in electricity production and delivered annually around 95% of total electricity production during the 1990's. Other fuels such as biofuels, gas, wind, and solar have grown since the mid-2000s and partially replaced coal. This change is, to a large degree, a result of EU climate and energy policies which enforced the use of renewables and Poland is expected to reach a 15% share of renewables in 2020. (Szpar, et al, 2018)

Various programmes were implemented from the early 90s to date. It started with changing the management and organisation systems, followed by the restructuring of the sector in 1992. During the mid to late 1990s there was much focus on ensuring profitability of the coal mining sector and closures related on mines' declines. Focus on the Just Transition was motivated by the EU climate and energy policies.

A number of key policies have influenced Poland's Just Transition including the Polish Energy Policy until 2040 (PEP 2040), the National Energy and Climate Plan for 2021-2030 (NECP) as well as the European Union's stricter emissions limits from 2021.

3.4.4 Key case study: Wałbrzych regional development programme

Poland closed 16 of the countries' coal mines between 1997 and 2002. The physical mine closure and environmental reclamation were comprehensive and included a very broad range of activities such as filling roadways and closing galleries with fly ashes mixed with mine water; recovering some potentially reusable underground equipment; undertaking ventilation and methane monitoring for safety purposes; continuous dewatering, necessary to prevent water hazards to the neighbouring operating mines; control of saline water discharges to protect the local water systems; demolishing and clearing surface structures, buildings, plants, and equipment, and where necessary, stabilization of any work dumps; filling shafts with different materials and capping them off with a cement cap; demolishing existing buildings that could not be reused; dismantling surface structures and equipment; stabilizing waste dumps; liquidating tailings ponds; and reclaiming land either for industrial use which required clean up and ground levelling or for recreational use which required cultivation.

In Wałbrzych (Poland) two shopping centres were built on the site of an old mine. Regional restructuring programmes were prepared annually. The idea of restructuring the Wałbrzych region was raised in the year 1989. In 1992 the Wałbrzych province was recognised as a region particularly threatened by structural unemployment. In 1993 the first provincial restructuring programme, the "Wałbrzych Province Development Plan," was presented. In subsequent years, annual restructuring programmes for the Wałbrzych Province were developed. They specified projects, how they were to be carried out and how they were to be financed. From 1994 to 1996 regional restructuring programmes were supported on a large scale by the national government (approx. ECU1 10 million).

In 1997 the Wałbrzych Special Economic Zone "Invest Park Ltd" was established. It is among the best developing zones in the country. Since the start of business activity it has been co-operating in the form of a partnership with the Wałbrzych municipality on constructing the technical infrastructure in the zone and on other activities to attract investors. By resolution of the city council, a new investment area was designated in the territory of the municipality, a "Zone of Economic Activity" for small and medium-sized companies (area of approx. 120 ha). Addressing SMEs, this initiative complements the existing Special Economic Zone "InvestPark", mainly designed for large industrial enterprises.

These changes were possible by multi-stakeholder engagement and to ensure a complex revitalisation which includes such issues as transport, environment, health or social protection.

This revitalisation, in ideal conditions, is a bottom-up process, shaped by local communities and their leaders with in-depth knowledge of local specificities. Such approach is a key to creating tailor-made policies. Empowerment of local communities with regards to their competences for self-organisation, management and financial support should be considered at the very beginning of the process.

The representation of trade unions in the process of preparing the mining social package allowed the implementation of the programme of employment reduction without significant social turmoil.

3.4.5 Lessons learned

Lessons learned include the following:

1. **Key policies drive action** away from a strong reliance on coal to accepting a Just Energy transition driven by regional policies such as the EU climate and energy policies.

2. **Involvement of a broad spectrum of stakeholders** is necessary as no successful economic restructuring and transitioning away from coal will be possible without it.

3. **Economic considerations remain key in coal mine closures**. Poland's closure of mines were firstly driven by profitability and productivity measures, Just Transition measures followed when regional policies forced attention on climate and energy policies.

4. **Define the coal phase-out as a regional issue and not to a specific community**. During coal mining the reliance on the commodity and associated secondary economic impacts benefit a larger region. Regional economic strategies therefore have to be considered when phasing out coal to mitigate socio-economic impacts.

5. **Financial support** has to be provided to ensure rehabilitation is undertaken and alternative economies are created when coal mining is phased out.

3.5 Case study 4: Romania

3.5.1 Key questions summarised

The key questions relating to Romania's Just Transition journey are summarised below:

Key Questions	Romania's Approach
Were people relocated or planned to be relocated?	• Various lay-offs, but no planned relocation
Were alternative economies created/planned to be created?	• Some cities have substantial wind and solar potential • Infrastructure plans incorporate renewable options
Were skills development undertaken/planned to be undertaken?	• Community capacity programmes. • Mine closure programmes
Did/do strong policies exist?	• No substantive phasing out coal policies • EU climate change policies drive changes
Did/do subsidies or funds exist to assist transition?	• EU DFI approaches followed

3.5.2 Background to Romania's Just Transition

Romania has two main coal basins, the hard coal in the Jiu Valley (Hunedoara County) and lignite in the Oltenia region (Gorj, Mehedinți and Vâlcea counties). According to Eurostat, out of a total electricity generation of 59.8 TWh in 2017, coal-powered capacities covered 25%, behind hydropower (28%) and followed by nuclear (17%), natural gas (15%), wind (11%), solar (3%), and biomass (1%). (Dudău et. al, 2019)

Coal mining was an essential part of the Romanian industrial revolution in the 19th century and retained this significant role well into the 20th century. During the 1980s, the Ceaușescu regime failed with its policies of economic dictatorship, heavy industrialization, state control and centralized planning. Access to new technologies and know-how was reduced and coal mining became increasingly inefficient. After the political change of 1989, the difficulties were compounded by the fall of energy demand on account of closing old industrial capacities and economic restructuring. (Dudău et. al, 2019)

Since the early 1990s, production has ceased in 344 of the most unprofitable coal mines. Those that are still operating remain dependent on budget subsidies and debt write-offs. The workforce dropped from 171,000 in 1997 to 50,000 in 2004 with layoffs still continuing since then, with 5,000-10,000 workers leaving the industry annually.

In addition to this, the coal sector is heavily subsidized by the state. One example is the Hard Coal National Company (CNH), which was founded in 1998. In its first three years of activity, CNH registered €350 million in losses and in 2012 it was liquidated, leaving behind a nearly €1 billion debt to the national budget. In 2004, the Romanian state approved a strategy for the mining sector, which addressed its cost inefficiency and unsustainable debt. The strategy also took into account the EU pre-accession requirements of eliminating subsidies to all minerals other than coal by 2007 and to coal by 2010. Even so, as it joined the EU in 2007, Romania was granted an exemption until 2011 for the hard coal sector to subsidize production costs, a term that was thereafter extended up to 2018.

3.5.3 Policies

Currently, the Romanian government does not have a substantive coal phase-out strategy and wants to keep the existing status quo of maintaining and extending the coal mining activities. As such, the Energy Strategy 2019-2030, with an outlook to 2050 emphasized the role of lignite in ensuring the grid stability and energy security in 2030 and beyond. One of the strategy's main investment objectives is a new 600 MW lignite-fuelled plant in Rovinari. (Dudău et. al, 2019)

Nevertheless, it must be noted that over the last couple of years, a model for a responsible transition from coal has been taking shape. The main reasons for that are economic unprofitability of coal production, a continuous decrease in the costs of renewable energy sources and decarbonisation commitments due to the Paris Climate Agreement and strict EU climate policies.

The Jiu Valley has been selected as a pilot region for the Coal Regions in Transition Platform, established by the European Commission in December 2017. According to the European Commission, its aim is to facilitate the development of long-term strategies to boost clean energy transition by bringing more focus on social fairness, new skills and financing for the real economy. As a result, five non-governmental organizations from the Jiu Valley have already responded to the request of the Ministry of European Funds and submitted proposals for the social and economic transformation of the area. These proposals included the conversion of closed mining sites into new economic, social and cultural centres; setting up a tourist promotion office; establishment of an investor attraction office; setting up a technical assistance unit to support local governments, the private sector and citizens in attracting European funds. (Dudău et. al, 2019)

All in all, the economics of the clean energy transition are making the long-term survival of the coal industry virtually impossible. By 2025, new wind and solar capacities will be much cheaper than new coal-fuelled units from the viewpoint of capital and operational costs on each and every market of the world, and by 2030 new renewable capacities will be cheaper than the operational costs of the already existing coal-fuelled plants. Some studies indicate that Romania's coal regions have a significant solar potential of 2,000 to 5,000 GWh per year, and also a sizeable wind energy potential of 5,000 to 10,000 GWh per year. (Dudău et. al, 2019)

3.5.4 Key case study: Coal sector reform

Romania provides a very good example of coal mining labour shedding. As of 2007, Romania's coal-fired power plant workforce was 5,086, compared to the start of the restructuring process when the coal sector employed more than 113,000 people. Through a generous voluntary redundancy program, 67,000 workers left the sector between 1997 and 2001, two to three times the scale planned by unions and government. As time progressed, the government had to extend these benefits, which ultimately posed an unpredicted fiscal burden to the national budget.

Romania illustrated successful stakeholder engagement processes during their coal sector reform programmes. The engagement with mine workers and community representatives not only contributed to the acceptance of mine closures but also contributed greatly to the design of social and labour support measures for workers, their families, and communities.

In addition, community involvement through a "community capacity building" activity included discussions on the repurposing of infrastructure and other assets which guided realistic expectation. These discussions had the added value of providing some limited direct employment opportunities as part of the mine's decommissioning (Dudău et. al, 2019).

Mine closure agencies play an important role to ensure positive closure outcomes. In the cases of Ukraine, Poland, and Romania, dedicated coal mine closure companies effectively managed the efficient physical closure of mines. Post-closure monitoring and maintenance may also best be undertaken by one or more separate purpose-established institutions or companies.

3.5.5 Lessons learned

Lessons learned include the following:

1. **Mine closure agency can streamline the physical closure component**. Managing the social and labour impacts from coal mine closures are best achieved when multiple agencies participate in the policy development.

2. **Social and labour transition an important part of the labour divestiture process**. Socio-economic impacts related to job losses need to be mitigated to ensure a Just Transition.

3. **Economic considerations remain key in coal mine closures**. Romania's coal mine were driven by profitability and productivity measures. Similar to Poland's case, Just Transition measures followed when regional policies forced attention on climate and energy policies.

4. **Involvement of a broad spectrum of stakeholders from the start**. Genuine stakeholder consultation starting at the planning stage and continuing throughout the mine closure and transition process can significantly reduce the possibility of social conflicts.

5. **Financial support** is important to support redundancies, reskilling and regional economic development.

3.6 Case study 5: United States of America

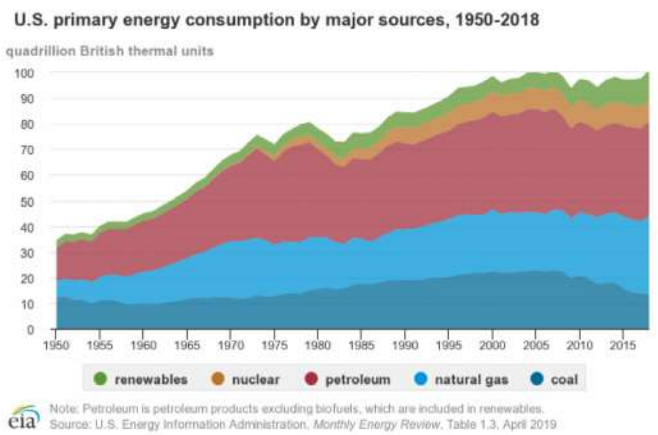
3.6.1 Key questions summarised

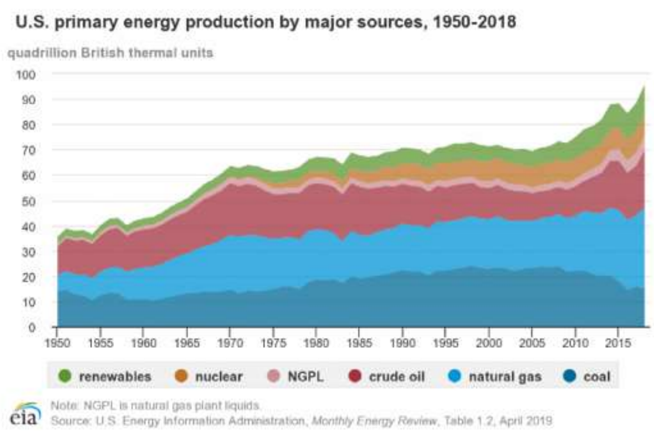
The key questions relating to the United States of America's Just Transition journey are summarised below:

Key Questions	USA's Approach
Were people relocated or planned to be relocated?	• Not specifically
Were alternative economies created/planned to be created?	• Natural decline of coal resource and use led to alternative economic uses
Were skills development undertaken/planned to be undertaken?	• POWER+ Plan assisted in addressing job losses
Did/do strong policies exist?	• Not recently
Did/do subsidies or funds exist to assist transition?	• POWER+ Plan • Just Transition Fund

3.6.2 Background to USA's Just Transition

Coal production and use in the United States (U.S.) has fluctuated over the past one hundred years. Today, approximately 93% of domestic coal consumption is used for electricity generation, while the remaining 7% is used by industry, mainly as coking (metallurgical) coal (Mendelevitch et al, 2019).





Approximately 52,000 people were employed in the coal industry in 2019 which was 0.03% of the total civilian labour force of approximately 164 million people. U.S. coal is extracted primarily in three large regions: the Appalachian region near the Atlantic Coast, the Interior Region near the Great Lakes, and the Western Region with the Powder River Basin. There have always been significant differences among coal producing regions. For example, the decline of Appalachia's coal industry already started in the 1970s when coal production shifted from underground mining to surface mining. The region was then further affected by the Clean Air Act of 1990 which limited SO2 and NOx gas emissions from power plants, which resulted in increased coal production in the Western Basins, particularly the Powder River Basin (Kok, 2017).

Despite these geographic variances, in 2007, domestic coal consumption and the net electricity production from coal, peaked. Since then, the share of coal in net U.S. electricity generation significantly declined from almost 50% in 2007 to 27.5% in 2019 (EIA, 2019). At the start of the last decade, many coal companies were overly optimistic about the future of coal, and are now facing bankruptcy. Over the past several years, the four largest coal producers have seen their combined stock value fall dramatically (Gek, 2019).

While the decline of the U.S. coal industry is attributed to complex local and international market dynamics, several key factors seem to have attributed to the transformation of the industry. These include: 1) the drop of U.S. natural gas prices and the resulting rise of natural gas use in the electricity sector; 2) the increasing share of renewables in electricity generation; 3) stagnating demand for electricity within the country; 4) environmental regulations of the energy sector and 5) technological developments in the national power plant fleet, which increasingly comprises of gas-fired plants (Mendelevitch et al, 2019).

The Just Transition movement has been active in some form or another in the US for decades. As a result, a number of comprehensive and complementary strategies have been developed by different public and privates sector stakeholders in order to manage the socioeconomic consequences of the declining sector. Table 3 below provides a brief summary of the wide-ranging transition strategies that have been employed:

Table 3: Different USA Just Transition Strategies

Compensation (Backward Looking)	Structural Adjustment Assistance (Forward-looking & Narrow)	Adaptive Support (Forward-looking & Broad)
Consumers / Households		
Federal tax credits and the Residential Energy Conservation Subsidy Exclusions offer partial tax incentives to encourage renewable energy investments in home improvements.	For low-income families, LIHEAP and WAP federal programs offer financial assistance to pay energy bills and to increase energy efficiency, including energy conversion to renewable sources.	Community solar business models (for shared solar) allows buying cheaper solar energy from the power grid, lowering utility bills.
Workers		
The Coal Act, Black Lung Act and Pension Guaranty Corporation sets out transitional payments to workers employed in coal companies that went out if business.	Limited federal funding of retraining in alternative industries	Federal and state government funds for retraining or employees in solar jobs, manufacturing, infrastructure and other alternative industries.
Communities		
Federal funding for health, pension and clean-up costs in coal communities in Appalachia.	Power Plan set out a federal budget to fund local projects that target economic diversification and tackle health issues.	Small-scale local projects supported by state and civil society groups to investigate viable alternative businesses and strategies to diversity.
Corporations		
The coal industry has been the recipient of tax subsidises for reclamation , pension and health expenses, land leasing subsidies and investments in clean coal.	State and federal level compensation during restructuring of pension and health liabilities and other legacy costs for bankrupt coal companies.	Low tax and deals with state regulators

Source: adapted from Kok, 2017

This summary highlights that in order to make the transition easier on the communities that are over-reliant on coal, a number of interventions and approaches are required. These include: the broad inclusion of many different community stakeholders (not just companies and workers); the commitment by all levels of government; the involvement of the private sector- the coal companies, as well as the secondary industries that support them; and complementary adaptive (not just reactive) strategies that involves the retraining of workers and the reorientation of the local economy.

3.6.3 Policies

The decline of the coal industry has evoked a nationwide debate on the distributional impacts of a low carbon transition on coal workers and communities. The notion of Just Transition has attained increasing attention among policy and political discourse, campaigners, and civil society groups.
During former President Obama's second term in office (2012-2016), climate change became a top priority and under the Climate Action Plan, the phasing out of coal was seen as critical to transition to a low-carbon economy. As a result, several federal, state and local level adjustment schemes were designed to offer compensation for coal workers and coal impacted communities. More specifically, the POWER+ Plan aimed to address lost jobs in the coal sector by: providing funds for economic diversification, job creation and employment in other sectors; and investing in the health and pension funds of mineworkers, and clean-up costs for abandoned mines. Other projects targeted drug abuse and health related issues, and provided training and strategic planning support to small businesses (Kok, 2017). Procedurally, the federal government explicitly chose to "abandon an outdated top-down approach to investing in communities" in favour of partnering with communities to identify specific developmental needs and priorities (Piggot et al, 2019). As a result, their focus was holistic and focused on the entire community- not just the workers.

Under Obama's POWER+ Plan, the federal government explicitly chose to partner with communities to identify developmental needs and priorities. This resulted in a diverse set of transitional programs that included: creating food, tourism, forestry enterprises, expanding broadband internet and manufacturing, as well as providing support for substance abuse.

Workers have been retrained for employment in the new economies that have been created in the coal mining communities. Furthermore, forward looking low carbon adaptation plans include the training of coal industry workers for employment in the solar PV industry. However, it is unlikely that these jobs will be located in the same place as disappearing coal jobs.

However, with the inauguration of President Trump in 2017, a number of key environmental regulations and commitments have been rolled back. One of the key goals during his election campaign and presidency has been to "End the War on Coal!" and to revitalize the coal sector (Mendelevitch et al, 2019). The subsequent efforts to support coal have been manifold and extend to a broad range of policy areas- such as supporting domestic coal-fired power generation and expanding access to the international markets for U.S. coal. However, despite these policy changes, analysts remain uncertain as to whether the coal industry will be able to be revived in the coming decades. The fundamental economic considerations of: stagnant domestic electricity demand, advances in competing generation technologies, unfavourable export market conditions and diminishing investor appetites; will weigh heavily on any sector growth prospects.

3.6.4 Key case study: The Just Transition Fund

The Just Transition Fund was initially created in response to Ex-President Obama's POWER+ Plan Initiative, which provided the first-ever federal funding to help communities impacted by the changing coal economy and power sector. The Fund is still operational and is assisting communities that have faced or are still facing coal mine or power plant closures.

The Rockefeller Family Fund (RFF) and the Appalachian Funders Network (AFN) created the Just Transition Fund in 2015, in conjunction with six other national and regional foundation partners: blue moon fund, Chorus Foundation, Hewlett Foundation, The JPB Foundation, The Mary Reynolds Babcock Foundation, and the Mertz Gilmore Foundation.

In the last few years, the Fund expanded its mission and scope to more broadly address the coal community transition movement as per stakeholder inputs.

The Fund focuses on coalfield and power plant communities throughout the U.S. and prioritise support for coal communities experiencing the most economic distress and take into account equity factors that make transition an even greater challenge. Decision-making draws from scientific analysis and every two years, a data-driven evaluation of coal-affected communities is conducted.

The fund focuses on three key areas namely the Appalachia region, the Western region and areas where coal-powered plants have closed or are about to be retired.

The Appalachia region accounts for 87% of the nation's coal-related job losses. In the mid-20th century, the industry employed 150,000 people. According to the Appalachian Regional Commission, the region lost more than 23,000 jobs between 2011 and 2015 alone, as production plummeted by more than 40% to reach its lowest historical levels.

Various coal plants and mines are closing in the Western region and job losses are particularly devastating for communities in Wyoming. In the coming years, industry predicts the state could lose upwards of 10,000 coal-related jobs.

According to the Energy Information Administration, more than 130 coal plants have closed since 2015, with many more closures expected throughout the next few years and nearly 40% of the fleet has been announced for retirement.

The Just Transition Fund's Blueprint for Transition is a comprehensive online resource to help coal communities and local leaders create an equitable, sustainable, and inclusive future. It includes information and resources for community-based non-profits and municipal leaders in places where a coal asset has closed or is closing.

The Fund also provides Technical Assistance and collaborates with local partners to:

- Start the transition planning process;
- Connect with other communities facing similar challenges;
- Identify public and private funding sources;
- Offer grant writing assistance;
- Conduct outreach to and facilitate meetings with affected stakeholders; and
- Share information and resources

To date the Fund grants have helped inject nearly $55 million in federal funds to support and scale community-driven transition projects. (https://www.justtransitionfund.org/history)

3.6.5 Lessons learned

Lessons learned include the following:

1. **Complementary programmes and measures**: There is no "silver bullet" and there are no "short-cuts" in the Just Transition movement. A number of thoughtful and complementary programmes and measures are required by both the private and public sectors, for a multitude of community stakeholders, over a number of years.

2. **Economic diversification** is critical to generating new revenue streams to sustain livelihoods that are deeply affected by an over-reliance on the coal industry.

3. **Mitigate the social and economic impacts**: Job losses are intrinsically linked with numerous health and drug abuse issues. National and local government support is necessary to mitigate the social and economic impacts of the coal transition.

4. **Energy markets remain a key determinant of transition**: While environmental policies and regulations have an impact on the coal industry as well as the Just Transition movement, the fundamental economics underpinning the energy markets (such as cost and relative competitiveness) are likely to remain the key determinant on how fast and disruptive any transition is likely to be.

5. **Renewable energy job growth may not offset all coal mine job losses**: The growth in the clean energy sector, may not offset all future job losses in the coal industry. While the number of number of renewable energy and energy efficiency jobs have been steadily growing in the US, these jobs have not necessarily been located in the same place as disappearing coal mining jobs. The energy transition could therefore contribute to a broader trend of geographic disparities in economic opportunities (Piggot et al, 2019).

6. **Government support**: Federal leadership and support is imperative for the Just Transition movement. In the absence of leadership from national government, then sub-national governments and civil society will begin to develop programs at a community level. This may result in "patchwork responses" that leave some regions, sectors or social groups behind.

7. **Innovative and collaborative funding mechanisms** and technical assistance can help communities to become part of the Just Transition journey and create alternative livelihoods in a post-coal world.

4. LESSONS LEARNED

The countries selected as case studies have different socio-economic dispositions compared to that of South Africa and are also in different phases of their respective Just Transition journeys. However, there are certain threads within the lessons learned that could be valuable to apply to South Africa's Just Transition journey.

The lessons learned from the research are summarised below:

1. **Political leadership plays a key role in the Just Transition journey**. A clear vision, political will and a strong leadership is required.

2. **Comprehensive and proactive planning**, that includes all relevant stakeholders, helps to increase the likelihood of an orderly transition.

3. **Transition planning** should consider all those that will be affected, throughout the whole energy system- not just coal companies and workers - but also marginalized and vulnerable groups such as women, low income households, local business owners etc.

4. **Strong policy framework in phasing out coal assists Just Transition**. Successful transitions were supported by integrated policies and supportive legislation.

5. **Involvement of a broad spectrum of stakeholders from the start**. Genuine stakeholder consultation starting at the planning stage and continuing throughout the mine closure and transition process can significantly reduce the possibility of social conflicts.

6. **Mine closure agency**. A mine closure agency or another associated institution to manage the closure, environmental rehabilitation and ensuring targeted labour market transition programmes is crucial for coal transitions.

7. **Coal mine rehabilitation and reclamation** should not only address environmental degradation but also create support for alternative livelihoods.

8. **Financial support from Government**. Case studies indicate that governments tend to shoulder a large share of the cost of the transition; as more often than not, the cost of not supporting a transition can be much higher than the costs of the transition. The South African government's constrained fiscus, especially after COVID-19 is therefore an additional consideration to those seeking a Just Transition in South Africa.

9. **Innovative and collaborative funding mechanisms** and technical assistance can help communities to become part of the Just Transition journey and create alternative livelihoods in a post-coal world. This can also help lighten the financial burden on the fiscus.

10. **Sound implementation is required to ensure the growth in the clean energy sector offset the direct and indirect future job losses in the coal industry**. While the number of renewable energy and energy efficiency jobs have been steadily growing in many countries, these jobs have not necessarily been located in the same place as disappearing coal mining jobs. The energy transition could therefore contribute to a broader trend of geographic disparities in economic opportunities and plans in addressing these challenges need to form part of the national and regional policies around these.

11. **Reskilling of affected workers, especially to take up the renewable energy sector job opportunities.** There is definite job opportunities in the renewable energy sector, but the skill set is quite different from typical mine worker jobs. Clear guidance and skills development plans as well as funding will have to be aligned with the broader energy sector skills plans.

12. **Economic diversification and regional development** are critical initiatives to generate new revenue streams to sustain livelihoods that are deeply affected by an over-reliance on the coal industry.

13. **Mitigate the social and economic impacts**. Where there are high poverty rates in a country and projected coal mine job losses, government, private sector and development agency support will be necessary to mitigate the social and economic impacts of the coal transition.

14. **Energy markets remain a key determinant of transition**. While environmental policies and regulations have an impact on the coal industry as well as the Just Transition movement, the fundamental economics underpinning the energy markets are likely to remain the key determinant on how fast and disruptive any transition is likely to be.

5. APPLICATION IN THE SOUTH AFRICAN CONTEXT

5.1 Highlights for consideration

It is accepted that South Africa has a different socio-economic landscape when compared to Germany, India, Poland, Romania and the United States of America. Within South Africa's reality of depressed economic growth, high levels of inequality, poverty and youth unemployment, it is important to understand the challenges and opportunities associated with its own "Just Transition".

Reskilling of affected workers and communities is crucial for the country to take advantage of the low carbon economy transition, but also to mitigate job losses and socio-economic impacts. Reskilling will require careful planning and budgetary allocations to address a shift in vocational training and higher education centres. It is positive to note that it has been found that it is feasible to transfer and reskill workforce from coal to renewable energy job opportunities.

The South African government's constrained fiscus, especially after COVID-19 is an additional consideration ensuring a Just Transition in South Africa. Exploring innovative and collaborative funding mechanisms are therefore important and the research has shown that not all the funding has to come from Government's coffers and collaboration with private sector and foundations can assist in the upskilling and/or reskilling of workers and job seekers.

Many of the lessons learned from the case studies are applicable to the South African context, but adjustments are required to support the African and South African realities.

5.2 Applying the lessons to South Africa

It is clear from the various case studies that a Just Transition journey requires an integrated, fit-for-purpose approach, adjusted to local conditions to ensure challenges are overcome and opportunities are optimised.
The lessons learned from the case studies also show that there should be a clearly articulated Just Transition vision from a strong leadership core. This vision should be based on an inclusive and integrated planning process where the stakeholders are understood and made part of the transition journey. Sound implementation should be supported by the right enablers including policy, capacity and funding. The current and future workforce should be correctly skilled and reskilled where required. To ensure long term sustainability, market forces should be utilized to drive the transition and create alternative markets to support sustainable livelihoods to mitigate any negative socio-economic impacts.

Ten key lessons are applicable to South Africa including:

1. Strong leadership plays a key role in the Just Transition journey.

2. Comprehensive and proactive transition planning is required.

3. The involvement of a broad spectrum of stakeholders from the start is critical to success.

4. An integrated policy framework in phasing out coal assists Just Transitions.

5. Financial support is required from Government.

6. Innovative and collaborative funding mechanisms and technical assistance can lighten the financial burden on Government.

7. The establishment of a mine closure agency can assist in a nation's Just Transition.

8. Sound implementation is required to ensure the growth in the clean energy sector offset the direct and indirect future job losses in the coal industry.

9. Reskilling of affected workers, as well as other community members, is an important part of the Just Transition movement.

10. Market dynamics remain a key determinant of a successful transition.

A fit-for purpose approach, aligned to South African conditions is considered optimal during the Just Transition journey. The approach is summarised in Figure 10.

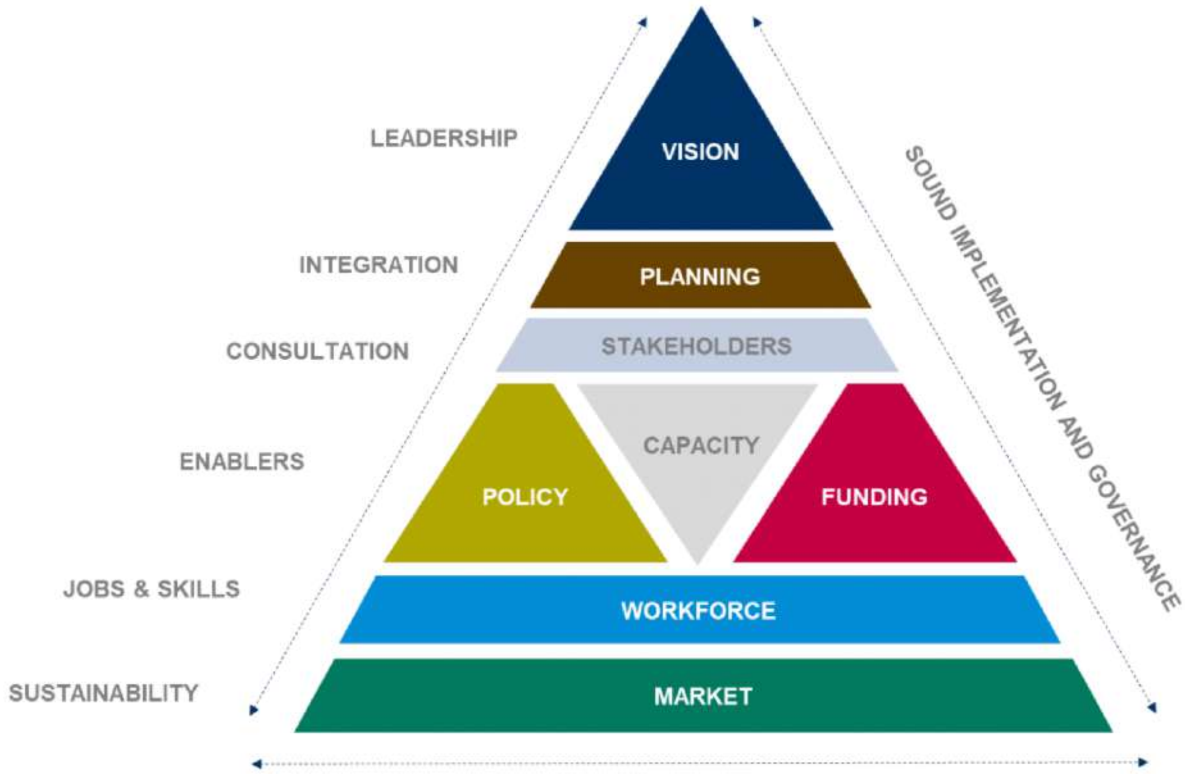


Figure 10: Fit-for-purpose South African Just Transition Approach

5.3 Discussion and recommendations

South Africa's just transition journey is not in its infancy. The country has already taken various steps in the journey. National planning documents, policy papers, just transition offices, legislation, an IPP programme and various other initiatives exist in support of Just Transition. The country's successful Just Transition will depend on how the various components that support successful transitions are aligned, implemented and governed.

5.3.1 Vision

The case studies showed that successful transitions are supported by a strongly articulated vision of phasing out of coal, by which date and an indication that renewable energy sources will replace its use.

South Africa's National Development Plan (NDP) 2030 has already articulated the country's transition to a low carbon economy and the IRP2019 states the transition goals.

Given that the coal mining industry and coal-fuelled power plants employ close to 200 000 people, a clear vision also need to be articulated on how affected people will be reskilled and transitioned.

5.3.2 Planning

Comprehensive, integrated and proactive planning is required to incorporate all stakeholders, in order to help increase the likelihood of an orderly transition.

South Africa has already started the journey with its NDP, climate change policies, Just Transition project office by Eskom, Integrated Resource Plan, Carbon Tax legislation, Independent Power Producer Plans and many more initiatives. South Africa should continue to integrate the various stakeholders in its planning during its Just Transition.

Transition planning should also consider all those that will be affected, throughout the whole energy system. This is not just applicable to coal companies and workers, but also marginalized and vulnerable groups such as women, low income households and local business owners.

Most of the case studies showed that economic diversification at a broader regional level is critical to generate livelihoods and revenue streams and is possible if well planned and executed. Multi-pronged regional development initiatives will be required to mitigate socio-economic impacts of closure of mines, environmental rehabilitation and job losses, but evidence exists that it is possible to mitigate these impacts if a coordinated approach and long term strategy is in place.

5.3.3 Stakeholders

The involvement of a broad spectrum of stakeholders from the start is critical to success.

Genuine stakeholder consultation starting at the planning stage and continuing throughout the mine closure and transition process can significantly reduce the possibility of social conflicts.

All the case studies showed the importance of broad based stakeholder identification and engagement from an early stage. Where people's jobs and livelihoods are at stake, especially in a constrained socio-economic environment the stakeholder landscape should be well understood and stakeholder engagement plans support the holistic planning and execution of a Just Transition. The key question for South Africa is where the identification, coordination and engagement of stakeholders should happen during the Just Transition journey.

5.3.4 Policy

Successful transitions are supported by integrated policies and supportive legislation.

India's integrated policy frameworks is a good example to ensure various ministries and stakeholders direct their efforts in the same direction during its low carbon transition execution. In European countries EU legislation drives policy frameworks and Germany is a key example of strong political will that exist and which is focussed on phasing out coal by a certain date.

South Africa's climate change policies and legislation as well as its Just Transition planning documents indicate that the country understands climate change impacts and have mitigation and adaptation plans in place. A key success factor of Just Transition in South Africa will be the implementation of such policies and plans, in an integrated and well governed manner.

5.3.5 Capacity

Capacity should exist to manage the coal transition in an independent and coordinated manner. Various mine closures and power plant decommissioning in the same geographic area such as Mpumalanga Province in South Africa, could have a devastating effect on the region. The case studies have shown that an efficient a mine closure agency or an appropriate coordinating entity to manage the closure, environmental rehabilitation and ensuring targeted labour market transition programmes, is crucial for coal transitions. This agency should also support initiatives that ensure alternative livelihoods.

5.3.6 Funding

Case studies indicate that governments tend to shoulder a large share of the cost of the transition; as more often than not, the cost of not supporting a transition can be much higher than the costs of the transition.

Innovative and collaborative funding mechanisms and technical assistance can help accelerate the Just Transition journey and lighten the financial burden on the fiscus.

Alternative funding mechanisms to undertake regional economic diversification, reskilling and repurposing of coal based infrastructure should be considered from a financing perspective.

Examples of what is possible and can be considered in South Africa to financially support the Just Transition journey, include the Just Transition Fund in the USA, Germany's Compensation Fund, India's Green Financing and Romania's development finance initiatives.

5.3.7 Workforce

While the number of renewable energy and energy efficiency jobs have been steadily growing in many countries, these jobs have not necessarily been located in the same place as disappearing coal mining jobs. The situation might be similar in South Africa given that the concentration of coal mining jobs are found in the Mpumalanga Province in South Africa.

However, the reskilling of affected workers, as well as other community members, is an important part of the Just Transition movement. Clear guidance and skills development plans, as well as funding, will need to be aligned with the broader energy sector skills plans.

The case studies and CSIR research showed that it is possible to mitigate future job losses in the coal industry and replace those through alternative economies and green growth jobs - if an integrated planning approach is followed during the transition.

5.3.8 Market

While environmental policies and regulations have an impact on the coal industry and the Just Transition movement, the fundamental economics underpinning the energy markets are likely to remain the key determinant on how fast and disruptive any transition is likely to be.

In South Africa it is understood that two new coal fired power stations namely Medupi and Kusile will require coal for life of operation of the plants, whilst the planned decommissioning of many other Eskom plants will directly impact the need for coal in their operational areas.

As seen in the case studies, coal mine closures in South Africa will also be driven by resource depletion and possible disinvestment of many of the major mining companies. These factors will drive transition by default.

The opportunities posed by renewables could not have come at a better time. Economic diversification is critical to generate new market dynamics and revenue streams to sustain livelihoods. The market forces of supply and demand and what makes economic sense will determine long term sustainability and sustainable livelihoods.

5.4 Key recommendations

South Africa already has various building blocks in place to ensure a successful Just Transition. The following key recommendations should be considered to enhance its position:

- Clearly articulate the Just Transition Vision – not just in terms of coal exit and use of renewables, but also how job losses will be mitigated.
- Decide which entity that will take accountability for the planning and implementation of the Just Transition, working with the various identified stakeholders.
- Ensure capacity exists to manage the coal mine and power plant closures and consider a closure agency.
- Determine funding needs of the Just Transition and design innovative funding mechanisms to support it.
- Consider a reskilling hub to take advantage of the opportunities renewables offer across the energy value chain to mitigate job losses.

5.5 Conclusion

South Africa is the largest electricity market in South Africa and depends heavily on coal, but the NDP's commitment to a low carbon economy has been cemented in the country's climate change policies and legislation. Key challenges to overcome are the socio-economic challenges and funding the transition. The research has shown that it is possible to have successful Just Transition journeys and capitalise on what renewables can offer.

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Summary

The first part of this study analysed the employment and skill restructuring required in South Africa for the transition from a coal-based to a renewables-based electricity sector as set out in the Integrated Resource Plan 2019 (IRP 2019). The policy shows that coal currently dominates power supply in the country, but will gradually decline in importance as wind and solar PV generation grows, along with gas and storage capacity. In terms of employment, the construction and operation and maintenance associated with the amounts of installed capacity stated in the IRP 2019 schedule will likely generate a ***net increase of 34 997 jobs by 2030.***

As regards skills, the findings show that both solar PV and wind energy projects employ a wide range of career disciplines throughout their value chains, with the level of skill required differing from job to job. Some jobs are specific to project stages, while others may require the performance of tasks across the value chain. Overall, the use of labour from other sectors is possible for both solar PV and wind technology, but additional, industry-specific training will be needed. A just transition for coal workers will require open dialogue between stakeholders, social protection for coal sector employees, and infrastructure and re-skilling investments, as well as investments in education and innovation to create new industries which will contribute to long-term regional growth and prosperity.

The second section of this study reviewed the transitions of five countries away from coal and distilled key lessons for South Africa to draw on. By identifying the successful elements of the transitions in progress in Germany, India, Poland, Romania, and the United States, this section provided recommendations for South Africa's transition while emphasising the need for a fit-for-purpose approach suited to the local context.

South Africa already has various building blocks in place to ensure a successful Just Transition, such as strong policy commitment, but in order to enhance its position, it should consider electing an entity accountable for the planning and implementation of the transition, building institutional capacity to manage the restructuring of employment in the power sector, and securing a Just Transition fund through innovative funding mechanisms, all the while leveraging the opportunities provided by the large-scale deployment of renewables.

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