Energy Research & Social Science 111 (2024) 103489

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Assessing the social and environmental impacts of the just energy transition in Komati, Mpumalanga Province, South Africa

Bonolo Tladi, Njabulo Kambule, Lee-Ann Modley *

Deaprtment of Geography, environmental management and energy studies, University of Johannesburg, South Africa

ARTICLE INFO

Keywords:
Just energy transition
Community participation
Societal impacts

ABSTRACT

In response to the Paris Agreement, South Africa has committed to decommissioning its coal-fired power stations and transitioning to renewable energy technologies. The pilot project for the energy transition that is planned for the place is the decommissioning of the 1000 MW Komati power station, in Mpumalanga province. Despite the existence of these guidelines, the energy transition may not be just for the society, power station workers and community in Komati. As such, evaluating the social impacts and investigating the environmental impacts associated with the energy transition, i.e., the decommissioning of the Komati power station was necessary, this also includes investigating the involvement or participation of the community in the transition. To conduct the study, questionnaires and in-depth interviews were administered to residents in Komati and to environmental experts, to evaluate the above-mentioned objectives. The study found that residents are concerned with the impacts that the closure of the Komati power station may give rise to, about their job security, livelihood, well-being, community development and energy provision. They are also concerned about environmental impacts associated with the lack of rehabilitation. Furthermore, the findings in the study indicate that the community is not aware of or involved in the discussions of the energy transition of Komati.

1. Introduction

Fossil fuels have played an important role in the energy sector, as well as in industrial development. According to Makgetla [1], 80 % of global energy is generated from fossil fuels. To meet energy consumption needs, coal-fired power plants offer consistent, dependable, and economical power that is available on demand [2,3]. Coal continues to be crucial to reducing global energy poverty since a large portion of the globe lacks access to modern, and clean electricity [3]. The electrical energy generated by fossil fuels such as coal is used to power up residential and commercial buildings, industrial processes and manufacturing activities, all of which contribute to socio-economic development. Estimates of reserves show that there is still enough coal available to last more than 200 years, however, the usage of coal is accompanied by several issues [2,4].

The combustion of coal in coal-fired power stations and coal mines emits various chemicals which cause air pollution. These chemicals include carbon dioxide, particulate matter, heavy metals, sulphur dioxide, and nitrogen oxides, and can cause effects such as acid rain, smog, and human health effects such as cardiovascular, respiratory and neurological disorders [5–7]. The other major concern is that the use of coal contributes to greenhouse gas emissions as it releases large quantities of carbon dioxide into the atmosphere, which increases the impacts of climate change as well as contributes to global warming. Plans for greenhouse gas emission reductions are facilitated by the Paris Agreement, which is an international treaty on climate change. It has set the goal of limiting global warming to 1.5° Celsius compared to pre-industrial levels [2,8]. To achieve this goal, countries that are signatories to this treaty aim to reach the global greenhouse gas emissions peak as soon as feasible to reach global net zero emissions by 2050 [9]. As such, in the Paris Agreement, the phasing out of coal has been identified as the primary step to achieving the targeted global warming level since coal is the most carbon-intensive energy source.

The Intergovernmental Panel on Climate Change (IPCC) issued the Special Report on Global Warming of 1.5 °C which assessed energy transformation pathways for the coal phase-out [10]. The main findings of the report are that the power supply by coal power plants should globally be reduced to 80 % below 2010 levels by 2030 and be phased out before 2040 [11]. All regions should phase out coal use between 2030 and 2040 [11]. By 2031, the OECD, Eastern Europe, and former

* Corresponding author.
E-mail address: lee-annm@uj.ac.za (L.-A. Modley).

https://doi.org/10.1016/j.erss.2024.103489
Received 8 August 2023; Received in revised form 8 February 2024; Accepted 22 February 2024
Available online 6 March 2024

Soviet Union member states will be the first to phase out coal, followed by Latin America, the Middle East, and Africa by 2034, non-OECD Asia by 2037, and the rest of the world by 2040 [1,10,11]. By phasing out coal, nations are transitioning to the use of renewable energy technologies to reduce their carbon footprint as the Paris Agreement requires. This decision of energy transition is not only based on the treaty obligations and climate change, but also because fossil fuels are they are not available for social ownership, they do not address inequality, and are no longer the cheapest form of energy [12,48]. Very few studies in South Africa have atempted to explore the societal impacts of the just energy transition [13–15] and there is currently a gap in understanding the perspectives of key stakeholders and socio-political factors actively shaping the configuration of South Africa's just transition [49]. This current study seeks to understand the societal impacts through engagements with the community in Komati, Mpumalanga.

2. Literature review

2.1. The role of coal in South Africa

South Africa has abundant coal resources, commercial coal mining began in the country around 1857 and is currently the seventh-largest coal producer worldwide [16]. The Waterberg, Witbank, and Highveld coalfields contain over 70 % of the coal, with regions such as Free State, Springbok and Emerlo producing smaller coal amounts [16]. South Africa's coal reserves offer a reasonably affordable and dependable source of energy [17]. The majority of the nation's energy comes from coal. It is the main source of energy for electricity generation, and according to the Department of Energy, 77 % of energy demands in South Africa are met by coal [18]. Statistics indicate that 95 % of the electricity that is consumed in the country is generated by Eskom, and from this percentage, 90 % of the generated electricity is produced by Eskom's coal-fired power stations [17,18]. Not only is coal a primary source of electrical energy in South Africa, but it is also feedstock energy for the nation's liquid fuel production, which contributes to about 36 % of Sasol's liquid fuel consumption [19]. Coal has a major role in South Africa's economy and in providing jobs for the country's citizens.

When viewing the contribution of coal to South Africa's economy, it has played an important role, generating a revenue of about R51 billion in 2013 [17]. In the mining industry, coal mining has had a revenue output of 35 % of South Africa's GDP, and employed about 93,000 coal mining employees in 2021 [20]. About 80 % of coal mining activities in the coal sector occur in Mpumalanga Province, and mining is the largest contributor to the province's economy [1]. In 2015, about 77,000 people were employed in coal mining [2]. The overall mining industry employed about 457,000 individuals in 2016 out of a workforce of 15,8 million people, therefore, roughly 0.5 % of the nation's workforce is employed in the coal industry [1,2]. On a regional scale, coal mining employs about 7 % of Mpumalanga's workforce [16]. Despite its vital contribution to South Africa's economy and the energy industry, coal has been an issue for the environment and human health due to the carbon intense emissions, as well as other air pollutants that are associated with its use.

2.2. Decarbonization and the just energy transition

To reduce the increased global emission of greenhouse gases, like other countries, South Africa became part of the Paris Agreement which aims to help countries transition to a low-carbon emitting economy [1]. This, however, requires South Africa to phase out its use of coal by decommissioning its coal-fired power stations and investing in a low carbon-emitting economy by transitioning to renewable energy technologies. There are several reasons why the decommissioning of coal-fired power stations is a necessary starting point for the energy transition in South Africa, those are that coal causes enormous environmental damage, particularly in Mpumalanga, and that burning coal creates air pollution, therefore damaging human health and biological diversity [50]. Air quality surrounding the coal power stations in Mpumalanga is ranked as some of the worst in the world and it is also estimated to cause over 2200 deaths annually [21]. In addition to the health impacts, the use of coal has a large carbon footprint, hence the transition is necessary.

To prepare for COP26, a United Nations climate change conference that was held in Glasgow, South Africa submitted its revised Nationally Determined Contribution (NDC), which entailed reducing its carbon dioxide emissions to approximately 420 and 350 carbon dioxide equivalence, by 2030 [22]. These emission reduction targets were in response to the goal of the Paris Agreement of reducing global warming levels. At the COP26 conference, which was held in 2021, South Africa entered a partnership with the United States, the United Kingdom, Germany, France and the European Union, called the Just Energy Transition Partnership (JETP) [23]. The partners in the JETP pledged a contribution of R131 billion to help South Africa with its transitioning process of reducing the carbon intensity in the energy sector, as well as the employment of renewable energy technologies [22]. In response to South Africa's carbon emission reduction target, Eskom, which is the country's largest electricity provider, plans to decommission 5400 Megawatt (MW) of electricity from coal generation by the year 2022, as well as 10,500 MW by 2030, and lastly, 35,000 MW by 2050 [24]. The plans for coal phase-out are set to begin in Mpumalanga, with the decommissioning of 10.7 GW of existing coal-fired power stations such as Komati, Camden and Grootvlei by 2030, with only Medupi and Kusile expected to remain operational by 2040 [24]. However, unlike as proposed initially, there are plans of decommissioning the Komati power in 2022 instead of 2030 [25].

2.3. The need for a just energy transition

A just energy transition is important an important process in ensuring that energy transition does not cause significant or irreversible impacts on the workers, society and communities that are supported by the coal-fired power stations, in this case, the Komati power station. As such to determine whether the transition process is just, it is crucial that the social impacts, as well as the environmental impacts that can arise from the energy transition, are addressed, relative to compliance with the just energy transition guidelines. Also, it is imperative to examine the role that the community plays during the transition process, to evaluate if the process has been inclusive. According to the International Labour Organization, a just transition refers to "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" [26]. To be just, a transition must provide an atmosphere that encourages businesses, employees, investors, and consumers to support and drive the transition to ecologically sustainable and inclusive economies and societies [27,28]. Given this background, it is necessary to examine the impacts of energy transition in Komati, to assess if the process has been a just energy transition.

2.4. Societal aspects of the Just Energy Transition

It is a well-known fact that the transition can have social impacts such as changes in employment or lower incomes. But on the contrary, the energy transition directly destroys or creates jobs and spreads through supply chains and income changes affecting the whole economy. İn addition to this, more ecological goods and services in the energy transition may lead to higher prices, leaving less income available for other goods and services [29]. Social impact refers to the consequences brought by public or private behaviors that change people's way of living, working and leisure, as well as the changes in customs, values and beliefs that guide and regulate social cognition [30]. The energy transition poses greater challenges for developing countries,

especially in terms of their dependence on traditional biomass and fossil fuels. This dependence makes developing countries vulnerable and makes them fall into a poverty trap, where countries without access to modern energy services have to pay more for the energy they use [31]. Due to this many questions and concerns have been raised by the public regarding the environmental degradation and socioeconomic issues surrounding just energy transition [32].

2.5. Research problem

The operation of the Komati power station is beneficial to Mpumalanga as it provides jobs and ensures electricity provision. Data indicates that the province is faced with high rates of unemployment [2]. In 2016, the unemployment rate in Mpumalanga was approximately 31 % and was above the average national unemployment rate of 26.5 % [1]. Throughout its operation, the Komati power station has employed about 753 semi-skilled and skilled workers, reducing the unemployment rate of the local municipality [33], under which Komati Village falls. According to an economic impact assessment conducted he KPMG [33], the Steve Tshwete local municipality had an unemployment rate of 13.9 % in 2015, which was far less than Mpumalanga's unemployment rate. Regarding electricity supply, of the 30,066 MW installed capacity, the Komati power station produces 1000 MW of generating capacity, helping to ensure energy security [2,33]. As such the decommissioning of the power station will have adverse impacts on the workers and communities that are supported by the power station.

Studies from countries that have undergone the energy transition process, by decommissioning their power stations, indicate that energy transition processes can give rise to impacts such as job loss, changes in livelihood, effects on well-being and distrust in the government [34–36]. Other studies indicate that the energy transition process can help improve the environment by improving air quality, reducing emissions as well as introducing renewable energy technologies [4,8,37]. However, during the transition process, the environment can be degraded by the lack of rehabilitation strategies and actions for the effects associated with coal ash emissions and dams [38]. The construction of renewable energy facilities or power plants can also have negative implications for the environment [39,40]. Existing studies have mainly focused on labor issues and the distributional consequences of the transition [32]. In general, the literature on the social impacts of a just energy transition has focused mostly on developed countries [32]. There is less research on the evaluation of the social impacts of a just energy transition As the decommissioning of the Komati is a recent pilot project for the energy transition in South Africa, very limited research has been conducted on the impact of the energy transition and even less on the socio-environmental impacts associated with the decommissioning of coal-fired power stations.

Given these reasons, the study has addressed the social and environmental impacts of the energy transition in Komati, Mpumalanga Province, South Africa, it has also investigated the involvement of the community in the transition process. The study area was selected based on the energy transition pilot project of decommissioning the Komati power station, which is taking place in Komati, it was also selected because scientific studies investigating the social and environmental impacts of the energy transition are limited in South Africa and none have been conducted in Komati to investigate the energy transition impacts of the decommissioning of the Komati power station.

The following objectives were addressed to achieve the research aim of assessing the social and environmental impacts of the energy transition in Komati.

- Evaluate key social impacts associated with the closure of the Komati power station
- Investigate environmental impacts associated with the closure of the Komati power station.
- Investigate the participation community in the power station closure process.

3. Methodology

3.1. Study area

The study was conducted in Komati, Mpumalanga Province, South Africa. It falls within the Steve Tshwete Local Municipality and Nkangala District Municipality [22]. Its coordinates are 26.093395°S, 29,46,378°E [22]. This area was chosen as it houses the Komati power station, which is the pilot project for just energy transition in the country. Below are the maps indicating Komati (Figs. 1 and 2). The most recent statistical information available on Komati is from the 2011 census (STATSSA 2011). According to the census Komatipoort had a population of 393,030 people with a population density of 82/ km^2. Females made up the largest part of the population (55 %) and the majority of inhabitants are black African (97,7 %), 1,6 % are white, with other population groups making up the remaining 0,4 %. More than a third (34,2 %) of the 110,469 economically active (employed or unemployed but looking for work) population in the municipality is unemployed. Among the 64,497 economically active youth (15–34 years) in the area, 42,3 % are unemployed (STATSSA 2011).

3.2. Research design and justification

In the study, qualitative and quantitative research methods were used, this is referred to as a mixed research technique. The quantitative research method that was employed in the study was the use of questionnaires. This method was appropriate as it can help to examine social and environmental impacts that may be caused by energy transition with regards to the closure of the Komati power station, based on the perspective of the society, as well as evaluating the involvement of the community in the energy transition project [51]. By employing this method, the quantitative data obtained from the residents in Komati, regarding the social and environmental impacts of the energy transition,

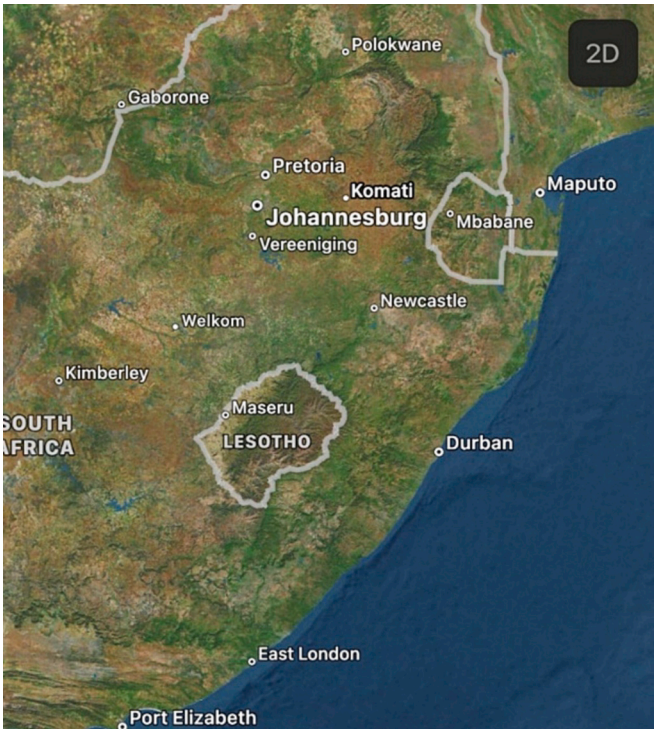

Fig. 1. Map of South Africa, showing the location of Komati.

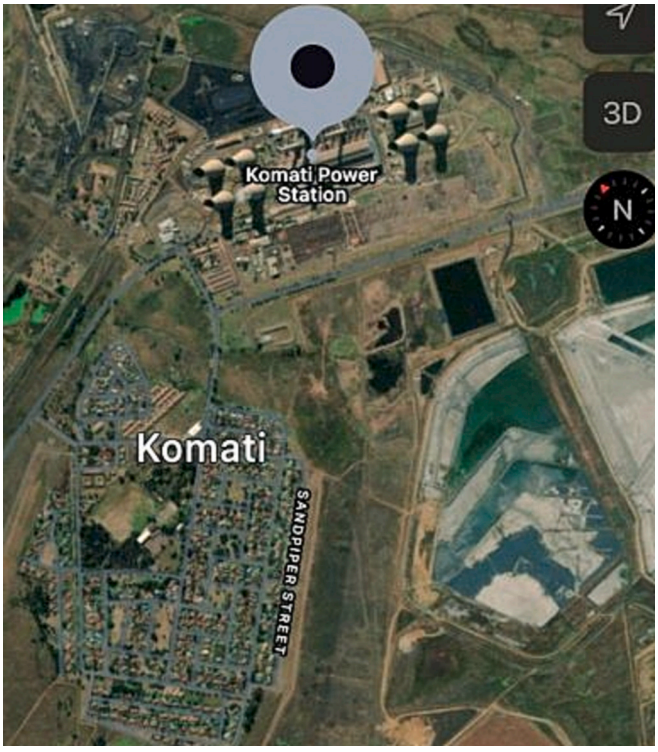

Fig. 2. Location of Komati, relative to the Komati power station.

can be measured and evaluated to highlight the key issues of the transition, hence the method is fitting for this study.

The qualitative method was appropriate for exploring the opinions and views of environmental experts regarding the energy transition in Komati, backing up the data provided by the Komati residents on the questionnaire. Qualitative research was conducted in the form of in-depth interviews with environmental experts to obtain data regarding the environmental impacts that are associated with energy transition. The semi-structured interview questions were sent to environmental experts using emails, from which four responses were sent back. Table 1 indicates the types of research techniques which were to provide data for the research objectives.

Table 1
Demographic characteristics of respondents.

Demographic characteristics	Response Category	Frequency	Percentage %
Age group	18–28	10	12.3
	29–39	15	18.5
	40–50	35	43.2
	Fifty-one and over	21	25.9
Highest level of education	Primary school	8	9.9
	High school	41	50.6
	College	24	29.6
	University	8	9.9
Time residing in Komati	1–6 years	11	13.6
	7–12 years	18	22.2
	13–19 years	19	23.5
	20 years and over	33	40.7
Household size	Three members or less	19	23.5
	4–7 members	35	43.2
	8–11 members	22	27.2
	Twelve members or more	5	6.2
Number of household persons employed	None	3	3.7
	Three members of less	71	87.7
	4–7 members	7	8.6

3.3. Data collection

To collect data for this study, two research tools were used, which are the use of a questionnaire survey and in-depth interviews. A questionnaire survey was employed to cover a large population and to provide vast information. To conduct the study, questionnaires were printed out and then handed to residents in Komati, by research assistants. Whereas interview questions were emailed to environmental experts to obtain qualitative data. Purposive sampling was used to distribute the questionnaires to the residents. This method is a non-probability sampling method.

The questionnaire contained a standardized set of questions and answers which were fixed for each recorded response from the respondents. According to Roopa and Rani (2012), the use of questionnaires for fixed variables is fitting as data can be gathered from many respondents while also being time efficient. The fixed structure of questionnaires also helps ensure the data's accuracy as it eliminates bias when interacting with the respondents [52].

The interviews were semi-structured and had open-ended questions to allow interviewees to thoroughly record their responses. This allows flexibility, while also having a predetermined thematic framework to identify patterns and differences from the responses of the interviewees [53]. Additionally, the open-ended nature of semi-structured interviews increases the richness and detail of the data [54]. To save time, and due to location differences, interview questions were emailed to environmental experts.

The questionnaire had three sections, one covering the demographic data of the respondents, the other section covering the social impacts associated with the first closure of the Komati power station, and lastly, the third section covered the social and environmental impacts which may arise from the proposed closure of the Komati power station. In both the second and the third sections, the involvement of the community, regarding the power station closures, was investigated to provide information on their involvement in the energy transition project.

The interview questions were eleven in total and were not divided into sections. They addressed the awareness and roles of the interviewees in the closure of the Komati power station. They also addressed the knowledge of the interviewees regarding environmental impacts that are associated with the energy transition, as well as their severity and remediation. To conclude, interviewees were asked about their views on just energy transition and its implication on the environment, with regards to the decommission of the Komati power station.

One hundred questionnaires were conducted face-to-face, with residents in Komati. The decision on sample size was based on the 10 % proportion of population statistics of Komati. Statistics indicate that there are about 1500 households in Komati [33]. In the case of language barriers, isiZulu and Ndebele languages were used by research assistants to translate the questionnaire for those that did not understand English. Overall, a total of eighty-one questionnaires were returned.

Interview questions were sent to experts in the environmental field via email, from which they snow-balled. According to Handcock and Gile [55], the snowball sampling technique enables the researcher to reach populations that are difficult to cover when using other sampling techniques. Therefore, the snowball sampling technique was essential as the researcher did not have access to influential and credible environmental experts, more so, those that were knowledgeable about the just energy transition concept. As such, with the help of the supervisor, interview questions were emailed to accredited environmental experts, from which they were sent to their respectable colleagues. A total of four interview responses were sent back to the researcher.

3.4. Data analysis

The data was collected from the distribution of questionnaire surveys

and was re-entered on Google forms to obtain a spreadsheet. The spreadsheet was then edited via Microsoft Excel, which entailed data sorting and coding. The coded data were then analyzed using statistical version 26 of the Statistical Package for Social Sciences (SPSS).

Descriptive statistics were used to analyze the data, about the objectives. The type of descriptive statistics used was data frequencies. In the study, frequencies were used to indicate the concentration of data from the respondents, regarding the key social and environmental impacts associated with the energy transition in Komati, as well as the involvement of the community in the transition process.

The data that was collected from in-depth interviews, was analyzed with the use of the thematic analysis technique. Several themes were created from the interview responses. Those themes were arranged according to the responses of the interviewees. Interview questions were used to sort out the provided responses regarding 'awareness' and 'roles of the interviewees in the closure of the Komati power station.' They also addressed the 'knowledge about energy transition-associated environmental impacts, as well as their 'severity.' Lastly, interviewees were asked about their 'views on just energy transition and its implication on the environment, in relation to the decommissioning of the Komati power station. The identified themes represented the key facts in the data, which were relevant to the second objective, which was to identify environmental impacts associated with the energy transition, concerning the closure of the Komati power station. As such, they gave a complete picture of what the study aimed to achieve.

Ethical clearance was given to the researcher by the ethical committee from the University of Johannesburg, to allow the researcher to conduct the study. Fairness was maintained when the study was conducted, and there was no form of exploitation or abuse during the administering of the questionnaires and the interviews.

4. Results

Data collected from eighty-one questionnaires was re-entered in Google forms and then captured into the Statistical Package for Social Sciences (SPSS) software. This data was then analyzed using descriptive frequencies. Table 3 represents the profile of respondents as per their age group, level of educated, time residing in Komati, household size, and the number of persons employed.

4.1. Social impacts of energy transition

In this study, the questionnaire had two sections that address the social impacts associated with the energy transition, concerning the just transition. The first section evaluates the impacts associated with the first closure of the Komati power station during the 1990s mothball, whilst the second evaluates the social impacts associated with the decommissioning of the Komati power station, as a proposed pilot project of just energy transition.

4.1.1. Social impacts of the 1990s closure of the Komati power station

When asked about their presence during the first closure of the Komati power station in 1990, 34.6 % of the respondents were present in Komati (see Table 4). Most of that percentage were those that resided in Komati for 20 years and over. During the mothballing process, the majority of the respondents who resided in Komati (19.8 %), were not informed of the closure, while 14.8 % of them were. In addition to not being informed of the closure, most of the respondents (25.9 %) were not aware of any discussions or social dialogues that took place regarding the closure, and only a few (8.6 %) were aware of the discussions. Before its closure, the operation of the power station supported 24.7 % of the respondents, through community development (25 %), and labour (75 %), with formal labour accounting for 65 % and informal labour accounting for 10 % (see Table 4) (Table 2).

The findings in this study indicate that the closure of the power station affected 25.9 % of the respondents. When asked about the

Table 2
Residents who lived in Komati during the 1990s and the support they received from the power station operation.

Question aspect	Response category	Frequency	Percentage (%)
Residing in Komati in 1990 during the closure of the Komati power station	Yes	28	34.6
	No	53	65.4
Supported by the operation of the power station (if yes)	Yes	20	24.7
	No	7	8.6
Form of support (if yes)	Community development	5	25
	Formal labour	13	65
	Informal labour	2	10

Table 3
Residents who were affected by the closure of the power station in the 1990s and the form of impact.

Question aspect	Response category	Frequency	Percentage (%)
Affected by closure	Yes	21	25.9
	No	7	8.6
Form of impact (if yes)	Job loss	14	17.5
	Financial stress	15	18.5
	Inadequate affordability of basic needs	7	8.6
	Changes in standard of living	8	9.9
	Poverty	14	17.3
	Mental health impacts	12	14.8

Table 4
Reasons for supporting or not supporting the proposed closure of the Komati power station.

Question aspect	Response category	Frequency	Percentage
Reasons for supporting the closure	Human/environmental impacts	4	4.9
	Reduced air quality	3	3.7
	Need for clean energy	1	1.2
Reasons for not supporting the closure	Employment	51	60.3
	Electricity provision	38	46.9
	Community development	49	60.5

Table 5
Possible social impacts from the proposed closure of the Komati power station.

Question aspect	Response category	Frequency	Percentage
Likely to be affected by the closure	Yes	70	86.4
	No	11	13.6
Form of impact (if yes)	Job loss	47	58
	Changes in livelihood	49	60.5
	The decline of community development	53	65.4

Table 6
Environmental impacts associated with the possible closure of the power station.

Question aspect	Response category	Frequency	Percentage (%)
Environmental impacts associated with power station closure.	Lack of rehabilitation for water pollution	35	43.2
	Lack of remediation of soil pollution	25	30.9
	Dust emissions of coal ash	39	48.1
	Landscape changes	38	46.9
	Noise disruption	22	27.2

impacts associated with the closure (see Table 5), respondents were allowed to select multiple answers. Most of the respondents were faced with job loss (17.3 %) as well as financial stress (18.5 %), 8.6 % of the respondents had inadequate affordability of basic needs and services, 9.9 % were faced with changes in standard of living, while 17.3 % were struck by poverty. Lastly, 14.8 % of the respondents were faced with mental health impacts such as anxiety, depression, stress, and fear, which affected their well-being. The findings of this study, regarding the impact of power station closure on mental health, support that of the Latrobe Valley case study in the literature [56], which indicates that job loss arising from restructuring can cause mental health impacts, more so on workers that are employed by the facility facing the restructuring process.

4.1.2. Social impacts of the present proposed closure of the Komati power station

The Komati power station was scheduled for permanent closure in 2022, as part of the just energy transition, Eskom plans to repurpose the coal-fired power plant into a renewable energy training facility [25]. As such the second section of the questionnaire addressed the possible impacts that may arise from the transition process. Respondents were asked if they were aware of the plans to permanently shut down the Komati power station in response to Eskom's energy transition plans. A substantial proportion of the respondents (59.3 %) were not aware of the closure plans, whereas 40.7 % of them were aware. Those that were aware were informed through the local newspaper (3.7 %), radio (1.2 %), social dialogues (12.3 %), and lastly, power station employees (23.5 %).

The respondents were asked if they support the closure of the power station, and the findings indicate that a considerable proportion of the respondents (95.1 %) did not support the closure plans, whilst a few (4.9 %) supported the closure. When asked about their reasons for supporting or not supporting Eskom's closure plans for the Komati power station, respondents were allowed to choose more than one response (see Table 6). The respondents that supported the closure were concerned with human and environmental impacts associated with the operation of the coal-fired power station (4.9 %), reduced air quality (3.7 %), and lastly, the need for clean and renewable energy sources (1.2 %). Despite the impacts that the operation of the Komati power station can have on humans and the environment, most of the respondents did not support the closure of the power station (see Table 6), due to the implications of the closure on employment (63 %), electricity provision (46.9 %), and community development (60.5 %).

According to Gürtler et al. [60], the decommissioning process does not have an equal impact on members of the community where the restructuring is taking place. As such, following the question about the support for the power station closure, respondents were asked if they would be affected by the planned permanent closure. A sizable proportion (86.4 %) of the respondents answered that they were more likely to be affected, whereas the remaining 13.6 % answered that they would not. When asked about the possible impacts, respondents were allowed to choose more than one response. Those that were likely to be affected responded that the impacts they would face include job loss (58 %), changes in livelihood (60.5 %), and a decline in community development (65.4 %). The findings of the study indicate that among the 58 % of respondents that are likely to face a job loss, 49.4 % of the respondents are power station employees, who work as pipefitters, plumbers, welders, and boilermakers. Others (8.6 %) work through sub-contracts as coal transporters, coal miners, security guards, and cleaners. This indicates that the closure of the power station threatens the job security, livelihoods, and development of the society in Komati, as such the transition may not be just.

Regarding the possible decline in community development, respondents addressed that the closure of the Komati power station may affect the operation of Lakama Accommodation, which is the only guest house in the area. The Lakama Accommodation provides housing for power station workers, as well as employment for the residents.

4.1.3. Environmental impacts of energy transition

In the study, environmental impacts associated with the closure of the power station and energy transition were addressed in the questionnaire as well as through interviews with environmental experts. Those from the interviews are addressed under the thematic analysis.

In the questionnaire, respondents were asked if they were aware of any environmental problems that may be associated with the decommissioning of the power station. By analyzing the responses, most of the respondents (67.9 %) were aware of the problems that may arise from the closure and repurposing of the power station, while a few (32.1 %) were not. Those that were aware were asked about the problems they were concerned with and were allowed to choose more than one response. Most of the respondents were concerned that the closure of the power station may give reasons for power station owners and managers to neglect their environmental management responsibilities giving rise to problems such as the lack of rehabilitation of water pollution (43.2 %) and the lack of remediation of soil pollution (30.9 %).

Another problem that most respondents (48.1 %) were concerned about regarding the closure of the power station was the dust emission of residual ash from the power plant into the atmosphere. The respondents were equally concerned with landscape changes (46.9 %), and noise disruption (27.2 %) that may be associated with the construction of the new projects, which may involve the removal of vegetation or land infrastructures. Overall, the findings of this study indicate that most of the residents in Komati are aware of the impacts that may result from the transition process that is initiated by the closure of the Komati power station.

4.2. Thematic analysis

Interview questions were sent to various experts within the environmental management field. The questions addressed the environmental impacts associated with the energy transition, following the closure of the Komati power station in response to the just energy transition project. A total of four interview responses were submitted and analyzed. To gather the expert opinion regarding the transition, the interviewees were asked about their take on the Just Energy Transition project and its implication on the environment. The interviewees indicated that the just energy transition project is beneficial as it will give rise to opportunities such as emission reductions and air quality improvement. However, one of the respondents expressed that the project may have an impact on biodiversity in terms of land management and that the employment of renewable energy technologies could increase unintended impacts on the environment. All the respondents expressed their concerns regarding the impact of energy transitions on humans as they are part of the environment. Their concerns were that the transition may affect their livelihoods due to job losses or displacements.

The interviewees were asked if they were aware of any discussions regarding the decommissioning of the Komati power station. One of the three respondents was aware of the closure discussions, while the others were not. When asked about their roles in the restructuring process, two of the respondents indicated that they are public participants, whereas the others have no role. As experts in the environmental field, interviewees were asked if they were aware of any environmental impacts that may arise from the closure of the power plant, in response to the Just Energy Transition. All the interviewees were aware of both the positive and negative impacts. When asked to identify these impacts, the positive impacts that were commonly identified by all the interviewees were that the energy transition will promote clean energy technologies, a cleaner atmosphere, low greenhouse gas emissions, and reduce the impacts made by the operation of the Komati power station. However, there was more concern regarding the negative impacts that may arise from the transition. As mentioned above, respondents were concerned

about the impact of the transition on the livelihoods of power station workers. One of the respondents raised a concern about cumulative impacts that may be associated with job loss or displacement, those include the introduction of communicable diseases and crime, these impacts are of concern because they can degrade the safety of the environment.

Regarding the physical environment, two interviewees were concerned about the residual effects caused by ash dumps from the power station, which may be significant to water resources by causing contamination of surface and groundwater. In addition to the residual risks, two interviewees highlighted the probable lack of rehabilitation of soil quality and vegetation by the power station operators. Of the two respondents that were concerned about the residual effects, one mentioned that the power station may fail to rehabilitate the reduced soil quality and erosion that was caused during its operation, which as a result, can cause the soil to take longer periods to recover, thus affecting vegetation growth. Outside of the residual effect associated with the closure of the power station, one interviewee raised a concern about the possible construction of renewable energy technologies and facilities in Komati. The concern that was raised was that if the installation of renewable technologies or facilities takes place, water resources can be exploited, activities of land clearing can occur, and there can be an unlawful use of land. This indicates that, although the transition can be beneficial to the environment in Komati, there can be residual or recurring impacts which can negatively affect the environment.

To conclude the interview, respondents were asked if they think the energy transition in Komati will be just on the environment. Two interviewees indicated that the energy transition will be just, however, one added that it will be if only the negative impacts associated with the transition are adequate. The remaining two respondents argued that it will not, as it will have significant impacts on the environment due to possible recurring impacts and the possible impacts that may be related to the construction of renewable energy stations or facilities. In addition, they also emphasized the impacts felt by humans. The findings from the interviews support those obtained from the questionnaire surveys.

5. Discussion

Globally, the recognition of the need for a just transition has grown in recent years, however there are still too many initiatives which narrowly prioritize carbon reduction or efficiency without adequately integrating justice and rights [41]. International conventions emphasize that transition plans must consider and address the broader social consequences and impacts of mitigation actions, including on race, gender and intergenerational equity [42]. There are three distinct social spaces of the energy transition, namely mining affected communities (MACs); environmental justice organisations; and labour unions. There is a need for deeper connections between these three social spaces to develop a coherent vision of a just transition, which is fully aligned to narrowing inequalities. This particular study looked at mining communities in and around the Komati powerstation, the demographic characteristics of respondents showed that the majority of participants were middle-aged between the ages of 40–50 (43.2 %), have completed high school and have lived in the area for more than 10 years (50.6 %) and have lived in the area for over 20 years (40.7 %). A significant amount of the respondents live in households with 4–7 members where 3 or less of these members are working. The Oxfam study showed that Marginalized social groups in both low-and high-income countries – whether low-income, women, Black or Indigenous – are also often disproportionately affected due to their physical exposure, lack of resources and/or their dependence on agriculture. Low-income countries, marginalized communities and households are often unable to share the benefits of clean energy policies and programmes because they cannot afford the investment costs (e.g., in solar PV). South Africa as a country also has additional woes in this regard due to its unique legacies of apartheid, social unrest, poverty, unemployment, and structural crisis in the energy sector, which dictate much of its political landscape [43,44].

During The first closure of the Komati power station in 1990, 34.6 % of the respondents were present in Komati as most of that percentage were those that resided in Komati for 20 years and over. During the mothballing process, the majority of the respondents who resided in Komati (19.8 %), were not informed of the closure and most of the respondents (25.9 %) were not aware of any discussions or social dialogues that took place regarding the closure. An effective Just Transition process requires social dialogue between governments, employers, and unions to develop the measures that build trust and guarantee secure income support for affected workers, skills training and redeployment services (ITUC 2017). Most of the respondents were faced with job loss as well as financial stress, inadequate affordability of basic needs and services, changes in standard of living, while 17.3 % were struck by poverty. Lastly, 14.8 % of the respondents were faced with mental health impacts such as anxiety, depression, stress, and fear, which affect-ed their well-being. The findings of this study, regarding the impact of power station closure on mental health, support that of the Latrobe Valley case study in the literature [56], which indicates that job loss arising from restructuring can cause mental health impacts, more so on workers that are employed by the facility facing the restructuring process.

For the second proposed closure Respondents were asked if they were aware of the plans to permanently shut down the Komati power station in response to Eskom's energy transition plans 59.3 % of the respondents (were not aware of the closure plans, and 40.7 % of them were aware. This indicates that a sizable proportion of residents in Komati are not aware of the plans to shut down the power station, as many were not informed through media outlets such as the local newspaper or the radio. The findings also indicate that most of the people that were aware of the closure plans were the power station employees, however, the lack of community awareness indicates that the plans were internalized and that no formal issue of the closure had been released to the public. According to Paul [57], community participation in projects that affect society can influence project planning and implementation by encouraging fair, equitable and sustainable outcomes.

The respondents were asked if they support the closure of the power station, and the findings indicate that 95.1 % of the respondents did not support the closure plans. The few that supported the closure cited concerns with human and environmental impacts associated with the operation of the coal-fired power station, reduced air quality and the need for clean and renewable energy sources. Respondents who did not support the closure of the power station cited implications of the closure on employment, electricity provision, and community development. This indicates that the energy transition plans of permanently closing and repurposing the Komati power station are not widely accepted by the community, regardless of the positive benefits they may bring forth, as such the project may not be just.

The paper by examining resistance to coal mining that is emerging from three different social spaces: MACs, environmental justice organisations, and the labour movement highlighted the fact that the just transition should adhere to an inclusive, participatory process, which is part of a national conversation on the transformation of our society [45].

Environmental impacts - Environmental and socio-economic risks are strongly interconnected, There is also a failure to compensate for damage to communities and the environment. Similarly, workers affected by the exit from fossil fuels are not being given an adequate say, social protection, or support such as job-related training to participate in the emerging new green economy [41]. In this study, most of the respondents were concerned that the closure of the power station may give reasons for power station owners and managers to neglect their environmental management responsibilities giving rise to problems such as the lack of rehabilitation of water pollution (43.2 %) and the lack of remediation of soil pollution (30.9 %). Concerns regarding the lack of rehabilitation of contaminated water sources are valid. Data from

hydrological assessment indicates that the quality of water in the Komati Spruit tributary has been contaminated by 646 mg per litre (mg/l) of sulphur dioxide, exceeding the acceptable emission levels of 244 mg/l [58]. This indicates that indeed water resources in Komati have been polluted by the power plant, the lack of implementation of rehabilitation strategies by the power station is a concern, and it can also prevent the energy transition process from being just. Another concern was the dust emission of residual ash from the power plant into the atmosphere. An environmental impact assessment conducted by environmental consultants indicates that the Komati power station produces about twenty-one million tons of ash, which is stored at the ash dam that is owned by the power plant [59]. This justifies the concerns of the respondents regarding dust emissions of ash from the power station. Moreover, the lack of implementation of ash waste management strategies by the power station operators can increase the risk of ash being dispersed into the atmosphere and on the nearby water resources. This can prevent the energy transition from being just. Lastly, the just energy transition plans include the repurposing of the Komati power station into renewable energy training facilities [25]. As such, the respondents were concerned with the environmental impacts that may arise during the transition process. The respondents were also concerned with landscape changes and noise disruption that may be associated with the construction of the new projects, which may involve the removal of vegetation or land infrastructures. Overall, the findings of this study indicate that most of the residents in Komati are aware of the impacts that may result from the transition process that is initiated by the closure of the Komati power station.

6. Limitations, recommendations and conclusions

6.1. Limitations

The study aimed to address the social and environmental impacts of energy transition in Komati, following the proposed closure of the Komati power station as a pilot project for just energy transition. As such, the study dealt with residents in Komati who are likely to be affected by the closure, as well as those that were affected by the previous closure of the power station. The role or involvement of the community was assessed in both closures to examine if the transition was/is just. It was difficult to recruit residents who work at the Komati power station as there were strikes at the power station during the intended period of the study, therefore the study was delayed, and the events may have had an impact on the outcomes of the study, regarding participation. Additionally, some of the employees at the power station feared taking part in the study as they were concerned with their identity, this may have affected the snowball sampling procedure.

The recruitment process of the interviewees was a challenge, as the researcher did not have access to credible environmental experts, who were also knowledgeable on the just energy transition project. The researcher did not have access to environmental experts or consultants in Komati, who can provide expert and more knowledgeable information regarding the environmental impacts that may be associated with the closure of the Komati power station, as well as the implication of a just transition in Komati. Since there were four interview responses, the sample size was small, therefore the results of the interviewees regarding the environmental impacts of energy transition about the closure of the Komati power station may not be generalized to all expert opinions.

6.2. Recommendations

Findings in this research highlighted the importance of evaluating the social and environmental impacts of the energy transition to ensure that a just transition is achieved, more so, with the community involved in the transition process. According to the knowledge of the Researchers, there are no previous studies that have been conducted to evaluate the socio-environmental impacts of energy transition in Komati, relative to the closure of the Komati power station, thus indicating the need for further assessment studies. As the study has indicated, energy transitions can affect the power station workers, the community as well as the environment, as such, the following recommendations are made:

- During energy transition processes, the community should be informed about the restructuring and be involved, more so, those who are likely to be affected, just as indicated by the Just Transition Centre, the International Labour Organization and South Africa's Presidential Climate Commission, that vulnerable groups and marginalized communities should be prioritized when undergoing industrial transitions.
- All the workers at the Komati power station, semi-skilled and skilled should be treated fairly regarding job security and placements, similar to the mission of Scotland's Just Transition Commission, of ensuring that the transition from coal promotes socially sustainable occupations, while also addressing inequalities in the energy sector.
- Rehabilitation strategies should be effectively implemented and monitored to ensure that the residual impacts that can arise from the existing polluted water and soil surfaces, as indicated on the impact assessment conducted by the GHT Consulting Scientists, are rectified, and prevented from recurring, to avoid situations such as those faced by Australia's Victorian Government of having no rehabilitation plans in place before the closure of the Hazelwood power station.
- Lastly should new developments take place (i.e., the construction of renewable energy facilities), the plans should be addressed with all stakeholders, including the community, to ensure that all concerns are assessed and that there are sustainable alternative options in place, similar to Germany's Coal Exit Commission plans which ensured a proactive collaboration between the government and other stakeholders.

7. Conclusion

The energy transition can help South Africa to move away from its intense use of coal to the use of non-renewable energy technologies. This transition will not only reduce the impacts placed by coal use on human and environmental health, but it will also help South Africa to reach its carbon emission reduction targets that are set on its Nationally Determined Contribution of helping to reduce the level of global warming as indicated in the Paris Agreement. This decarbonisation will also improve South Africa's environmental health as required in the country's legislation. However, as indicated in the literature and the study findings the energy transition will have impacts that are not just on the workers, the community and to an extent, the environment. Recognition is 'post-distributive' in the sense that inequalities need to be understood in relation to their social impacts [46], which can be achieved by identifying which parts of society are impacted by energy injustices and reflecting on who qualifies as a legitimate 'energy victim' [47].

The closure of the Komati power station will affect society by threatening their employment at the power station, livelihoods, well-being, and community development, as well as increasing the risk of being energy insecure, due to the loss of energy provision. Regarding the environment, the closure of the Komati power station will affect the environment if there are no strategies and plans that are deployed by the Komati power station operators, or Eskom, to rehabilitate the impacts caused by the operation of the power station on the environment. The lack of rehabilitation actions associated with the emission of air pollutants and coal ash will increase the risk of recurring environmental impacts such as water and soil contamination, which will continue to affect water quality and soil quality, when not treated, preventing the energy transition from being just.

İt is of utmost importance that when restructuring takes place in each area, the community must be involved, more so if the restructuring or

transition may affect their lives. The energy transition process in Komati has failed to include the community. As the findings of the study indicate, most of the community is not aware of the plans and discussions to close the Komati power station. This may indicate a pattern, as they were also not involved in the mothballing process that took place during the 1990s. This lack of community inclusion will deter the energy transition process from being just, as the needs of the community are not prioritized and proactively addressed. For a just energy transition to take place in Komati, the social and environmental impacts of the energy transition, relative to the closure of the Komati power station, and the involvement of the community during the transition process, need to be addressed in the energy transition strategies and plans, only then can a just energy transition be achieved.

CRediT authorship contribution statement

Bonolo Tladi: Writing – original draft, Methodology, Formal analysis, Data curation. **Njabulo Kambule:** Supervision, Resources. **Lee-Ann Modley:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The Authors hereby confirm that neither of them have any conflict of interest to declare.

Data availability

Data will be made available on request.

Acknowledgments

The authors would like to thank NRF Thuthuka (grant number TTK200410512236) for funding this research and all activities related thereto.

References

[1] N. Makgetla, The Just Transition in Coal, 2021, p. 30.
[2] J. Burton, Coal transitions in South Africa. Understanding the implications of a 2oC-compatible coal phase-out plan for South Africa 36, 2018.
[3] Z. Asif, Z. Chen, H. Wang, Y. Zhu, Update on air pollution control strategies for coal-fired power plants, Clean Techn. Environ. Policy 24 (2022) 2329–2347, https://doi.org/10.1007/s10098-022-02328-8.
[4] G. Evans, L. Phelan, Transition to a post-carbon society: linking environmental justice and just transition discourses, Energy Policy 99 (2016) 329–339, https://doi.org/10.1016/j.enpol.2016.05.003.
[5] E. Fosso-Kankeu, A. Manyatshe, F. Waanders, Mobility potential of metals in acid mine drainage occurring in the Highveld area of Mpumalanga Province in South Africa: implication of sediments and efflorescent crusts. Int. Biodeterior. Biodegrad, Environmental Biotechnologies for Sustainable Development (EBSuD) 119 (2017) 661–670, https://doi.org/10.1016/j.ibiod.2016.09.018.
[6] G. Goudarzi, S. Geravandi, E. Idani, S.A. Hosseini, M.M. Baneshi, A.R. Yari, M. Vosoughi, S. Dobaradaran, S. Shirali, M.B. Marzooni, A. Ghomeishi, N. Alavi, S. S. Alavi, M.J. Mohammadi, An evaluation of hospital admission respiratory disease attributed to sulfur dioxide ambient concentration in Ahvaz from 2011 through 2013, Environ. Sci. Pollut. Res. 23 (2016) 22001–22007, https://doi.org/10.1007/s11356-016-7447-x.
[7] I.P. Morosele, K.E. Langerman, The impacts of commissioning coal-fired power stations on air quality in South Africa: insights from ambient monitoring stations, Clean Air J. 30 (2020), https://doi.org/10.17159/caj/2020/30/2.8833.
[8] S. Carley, D.M. Konisky, The justice and equity implications of the clean energy transition, Nat. Energy 5 (2020) 569–577, https://doi.org/10.1038/s41560-020-0641-6.
[9] R.J. Brecha, G. Ganti, R.D. Lamboll, Z. Nicholls, B. Hare, J. Lewis, M. Meinshausen, M. Schaeffer, C.J. Smith, M.J. Gidden, Institutional decarbonization scenarios evaluated against the Paris agreement 1.5 °C goal, Nat. Commun. 13 (2022) 4304, https://doi.org/10.1038/s41467-022-31734-1.
[10] P.A.Y. Parra, G. Ganti, R. Brecha, B. Hare, M. Schaeffer, U. Fuentes, Global and regional coal phase out requirements of the Paris Agreement: Insights from the IPCC Special Report on 1.5°C 3, 2019.
[11] Intergovernmental Panel on Climate Change (IPCC), Global Warming of 1.5°C: Special Report. https://www.ipcc.ch/sr15/, 2018.
[12] UNFCCC, Just Transition of the Workforce, and the Creation of Decent Work and Quality Jobs, United Nations Framework Convention on Climate Change (UNFCCC), Bonn, 2016. https://unfccc.int/sites/default/files/resource/Just%20transition.pdf.
[13] J.A. Gordon, Mechanisms of Growth in Offshore Wind Power: Feasibility of 2030 Targets in the North Seas Energy Cooperation, Central European University, 2020, https://doi.org/10.13140/RG.2.2.33379.58404 (MSc Thesis).
[14] P.J. Loftus, A.M. Cohen, J.C.S. Long, J.D. Jenkins, A critical review of global decarbonization scenarios: what do they tell us about feasibility? WIREsClim. Chang. 6 (2015) 93–112.
[15] C. McEwan, Spatial processes and politics of renewable energy transition: land, zones and frictions in South Africa, Polit. Geogr. 56 (2017) 1–12.
[16] P.J. Hancox, A.E. Götz, South Africa's coalfields — a 2014 perspective, Int. J. Coal Geol. 132 (2014) 170–254, https://doi.org/10.1016/j.coal.2014.06.019.
[17] P. Dikgwatlhe, Coal as a Strategic Resource in South Africa, 2015, p. 8.
[18] Department of Energy, Energy Balance for South Africa, Government Printer, Pretoria, 2015.
[19] M. Stephenson, Chapter 4 - The Coming Industrial Revolution? Fossil Fuels and Developing Countries, in: M. Stephenson (Ed.), Energy and Climate Change, Elsevier, 2018, pp. 71–89, https://doi.org/10.1016/B978-0-12-812021-7.00004-X.
[20] M. Garside, South Africa: Coal Mining Employment 2011–2021 [WWW Document], Statista, 2022. URL, https://www.statista.com/statistics/1311307/south-africa-coal-mining-employment/ (accessed 10.25.22).
[21] GroundWork, Coal Kills. Research and Dialogue for a Just Transition. groundWork, Pietermaritzburg. https://www.groundwork.org.za/specialreports/Coal_Kills.pdf, 2018.
[22] Eskom, Just energy transition (JET) fact sheet #2. https://www.eskom.co.za/wp-content/uploads/2021/12/JET_FactSheet002.pdf, 2021.
[23] L.J. Houston, O.C. Ruppel, Just energy transitions in Progress? The partnership between South Africa and the EU, J. Eur. Environ. Plan. Law 19 (2022) 31–54, https://doi.org/10.1163/18760104-19010004.
[24] Department of Minerals Resources and Energy (DMRE), Final - Integrated Resource Plan, Department of Mineral Resources and Energy, Pretoria, 2019.
[25] J. Evans, Just transition project: shut down Komati Power Station first of its kind to be repurposed into renewable energy training facility, Daily Maverick, 2022. https://www.dailymaverick.co.za/article/2022-09-25-shut-down-komati-power-station-first-of-its-kind-to-be-repurposed-into-renewable-energy-training-facility/.
[26] ILO, Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All, International Labour Organisation (ILO), Geneva, 2015. Available from: https://www.ilo.org/wcmsp5/groups/public/—ed_emp/–emp_ent/documents/publication/wcms_432859.pdf.
[27] Just Transition Centre, Just Transition: A report for the OECD, Available from: https://www.oecd.org/environment/cc/g20-climate/collapsecontents/Just-Transition-Centre-report-just-transition.pdf, 2017.
[28] Presidential Climate Commission, A framework for a just transition in South Africa. https://pccommissionflow.imgix.net/uploads/images/A-Just-Transition-Framework-for-South-Africa-2022.pdf, 2022.
[29] P. García-García, Ó. Carpintero, L. Buendía, Just energy transitions to low carbon economies: a review of the concept and its effects on labour and income, Energy Res. 70 (2020) 101664, https://doi.org/10.1016/j.erss.2020.101664.
[30] F. Vanclay, Principles for social impact assessment: a critical comparison between the international and US documents, Environ. Impact Assess. Rev. 26 (2006) 3–14.
[31] M.M. Vanegas Cantarero, Of renewable energy, energy democracy, and sustainable development: a roadmap to accelerate the energy transition in developing countries, Energy Res. Soc. Sci. 70 (2020) 101716. Available at: https://doi.org/10.1016/j.erss.2020.101716.
[32] Z. Sun, F. Zhang, Y. Wang, Z. Shao, Literature review and analysis of the social impact of a just energy transition, Front. Sustain. Food Syst. 7 (2023) 1119877, https://doi.org/10.3389/fsufs.2023.1119877.
[33] KPMG, Economic Impact Assessment of Komati Power Station, KPMG Services (Pty), 2017. https://cer.org.za/wp-content/uploads/2018/02/Eskom-Komati-EIA-report_Final.pdf.
[34] B. Birrell, The Latrobe Valley, Victim of Industrial Restructuring. Centre for Population and Urban Research, Monash University, Clayton, 2001.
[35] B. Caldecott, O. Sartor, T. Spencer, Lessons from Previous 'Coal Transitions': High-Level Summary for Decision-Makers, Climate Strategies and IDDRI, Paris, 2017. https://www.iddri.org/en/publications-and-events/report/lessons-previous-coal-transitions.
[36] J. Wiseman, S. Campbell, F. Green, Prospects for a "just transition" away from coal-fired power generation in Australia: Learning from the closure of the Hazelwood Power Station, in: CCEP Working Paper, 1708, Crawford School of Public Policy, Centre for Climate Economics and Policy, Melbourne, 2017.
[37] D.P. Upham, P.B. Sovacool, D.B. Ghosh, Just transitions for industrial decarbonisation: a framework for innovation, participation, and justice, Renew. Sustain. Energy Rev. 167 (2022) 112699, https://doi.org/10.1016/j.rser.2022.112699.
[38] V.C. Pandey, N. Singh, Impact of fly ash incorporation in soil systems, Agric. Ecosyst. Environ. 136 (2010) 16–27, https://doi.org/10.1016/j.agee.2009.11.013.
[39] M.K.H. Rabaia, M.A. Abdelkareem, E.T. Sayed, K. Elsaid, K.-J. Chae, T. Wilberforce, A.G. Olabi, Environmental impacts of solar energy systems: a review, Sci. Total Environ. 754 (2021) 141989, https://doi.org/10.1016/j.scitotenv.2020.141989.
[40] Shifeng Wang, Sicong Wang, Impacts of wind energy on environment: a review, Renew. Sustain. Energy Rev. 49 (2015) 437–443, https://doi.org/10.1016/j.rser.2015.04.137.

[41] D. Dalabajan, R. Mayne, B. Bobson, H. Qazzaz, H. Ushie, J. Ocharan, J. Farr, J. Romero, K. Priego, L. Victoria Gomez Correa, L. Gomez Ortiz, L. Socci, M. Buenaventura Goldman, M.R. Felizco, N. Dabi, N. Chauke, O. Haq, P. M. Arellano, Enciso SPM, S.K. Ni'mah, V.F. Zano, Towards A Just Energy Transıtıon: Implications for Communities in Lower- and Middle-Income Countries. Oxfam reports, 2022.
[42] High Level Expert Group on Net Zero Emissions Commitments of Non-State Entities, Integrity Matters: Net zero commitments by businesses, financial institutions, cities and regions, UN. Retrieved 18 July 2023, from, https://www.un.org/sites/un2.un.org/files/high-level_expert_group_n7b.pdf, 2022.
[43] L. Baker, P. Newell, J. Phillips, The political economy of energy transitions: the case of South Africa, New Polit. Econ. 19 (2014) (2014) 791–818.
[44] J. Barnes, Divergent desires for the just transition in South Africa: an assemblage analysis, Polit. Geogr. (2022) 97.
[45] J. Cock, Resistance to coal inequalities and the possibilities of a just transition in South Africa, Dev. South. Afr. 36 (2019) 860–873.
[46] H. Bulkeley, G.A.S. Edwards, S. Fuller, Contesting climate justice in the city: examining politics and practice in urban climate change experiments, Glob. Environ. Chang. 25 (2014) 31–40.
[47] B.R. Jones, B.K. Sovacool, R. Sidortsov, v., Making the ethical and philosophical case for "energy justice", Environ. Ethics 37 (2015) (2015) 145–168.
[48] B.N. Shongwe, The Impact of Coal Mining on the Environment and Community Quality of Life: A Case Study Investigation of the Impacts and Conflicts Associated with Coal Mining in the Mpumalanga Province, South Africa, Thesis, University of Cape Town, Cape Town, South Africa, 2018, https://open.uct.ac.za/bitstream/handle/11427/28127/thesis_ebe_2018_shongwe_bonisile_nolwando.pdf?sequence=1&isAllowed=y.
[49] P. Mirzania, J.A. Gordon, N. Balta-Ozkan, et al., Barriers to powering past coal: implications for a just energy transition in South Africa, Energy Res. Soc. Sci. 101 (2023). July 2023, Article Number 103122.
[50] D. Hallowes, V. Munnik, Daily maverick newspaper. A just transition must transform our relationship to each other and to the Earth, accessed from, https://www.dailymaverick.co.za/article/2022-05-03-a-just-transition-must-transform-our-relationship-to-each-other-and-to-the-earth/, 2022. on 22 November 2023.
[51] A. Utasi, T. Yuzhakova, N.J. SebestyénV, B. Robu, Á. Rédey, J. Lakó, T. Fráter, I. Ráduly, L. Ráduly, G. Popita, Advanced quantitative environmental impact assessment method, Environ. Eng. Manag. J. 12 (2) (2013) 305–310.
[52] H. Taherdoost, Sampling methods in research methodology; how to choose a sampling technique for research, Int. J. Acad. Res. Manag. (IJARM) 5 (2016) 18–27, https://doi.org/10.2139/ssrn.3205035.
[53] A. Brown, P.A. Danaher, CHE Principles: facilitating authentic and dialogical semi-structured interviews in educational research, Int. J. Res. Method Educ. 42 (1) (2019) 76–90, https://doi.org/10.1080/1743727X.2017.1379987.
[54] K.E. Newcomer, H.P. Hatry, S. Joseph, Planning and designing useful evaluations, in: K.E. Newcomer, H.P. Hatry, S. Joseph (Eds.), WholeyBook, WholeyFirst, 2015, https://doi.org/10.1002/9781119171386.ch1 published: 10 August 2015.
[55] M.S. Handcock, K.J. Gile, Comment: on the concept of snowball sampling, Sociol. Methodol. 41 (1) (2011) 367–371, https://doi.org/10.1111/j.1467-9531.2011.01243.x.
[56] Voices of the Valley, Interview With Wendy Farmer, President of Voices of the Valley, 2019.
[57] S. Paul, Community participation in development projects: the World Bank experience, in: World Bank Discussion Papers, World Bank, Washington, D.C, 1987.
[58] GHT Consulting Scientists, Komati power station: hydrological & geohydrological baseline study. https://www.eskom.co.za/OurCompany/SustainableDevelopment/EnvironmentalImpactAssessments/Documents/Komati_Baseline_Report_-_2008.pdf, 2008.
[59] Synergistics Environmental Services, Construction and operation of ash dam extension 3 and the deviation of transmission and distribution lines at Komati Power Station, in: Mpumalanga: Final Environmental Impact Report, 2008.
[60] K. Gürtler, D. L̈ow Beer, J. Herberg, Scaling just transitions: legitimation strategies in coal phase-out commissions in Canada and Germany, Polit. Geogr. 88 (2021) 102406, https://doi.org/10.1016/j.polgeo.2021.102406.