Assessing coal mine closures and mining community profiles for the 'just transition' in South Africa

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Synopsis

Growing global concern over the impacts of climate change, attributable largely to fossil fuel energy sources, has led to the widely shared goal for a 'just transition' to cleaner energy and reduced dependence on carbon-based fuels. As the world's 14th biggest CO_2 emitter and being particularly vulnerable to the impacts of climate change, South Africa must embark on a just transition pathway. This paper reviews expected coal mine closures and associated community vulnerabilities and local governance challenges in South Africa. Decommissioning schedules for all coal-fired power stations and operating coal mines are plotted, and 69 mining host communities and 21 municipalities are mapped, classified, and described. Community socio-economic profiles are measured using a set of SDG indicators and census data and municipalities assessed through financial audits. Our research shows that five coal-fired power plants (8.9 GW) and 15 coal mines (29.5 Mt/a) will probably close by 2030, and a further four plants (14 GW) and 23 mines (106 Mt/a) by 2040. Thus, the shift to cleaner energy will likely occur without the premature closures implied by the just transition. The impact of mine closure on the 2.5 million residents of host communities will be significant, particularly as levels of income, employment, and education are already very low and many municipalities are in financial distress. The South African approach to the just transition needs to take local realities into account and the narrative must support an effective transition that does not undermine energy security and economic growth.

Keywords

just transition, South Africa, coal mining, mining communities, energy, mine closure.

Introduction: What is the just transition?

Growing concern over the impacts of climate change on livelihood across the world has led to the widely shared goal of a 'just transition' to cleaner energy sources and reduced dependence on coal (World Bank Group, 2018). Internationally, the transition away from coal mining and coal-based energy generation is intensifying, particularly in Europe, despite the intermediate resort to coal for energy security due to the Russia/Ukraine war and resulting withdrawals of Russian gas and sanctions on Russian coal. Furthermore, some countries have growing domestic demand for coal, such as China and India, and expanding coal exports, such as Australia and Indonesia (Ruppert Bulmer *et al.*, 2021). At the same time, global renewable energy jobs have been growing rapidly, with 12 million jobs (temporary and permanent) in 2020, 39% of them in China, covering the whole renewable energy production value chain (IRENA, 2022). At least 36 governments and 54 companies have committed to phasing out thermal coal from the power sector by 2030, and governments have instituted 'just transition' task forces, coal transition commissions, and stakeholder consultation platforms to explore options for the end of coal use (Ruppert Bulmer *et al.*, 2021).

Many different definitions are used for the 'just transition', but a key feature is that no-one is left behind when making necessary changes to energy and economic systems. That involves sharing the costs and benefits of the changes fairly, supporting workers with new jobs or retraining, and supporting communities through broader economic changes. The International Renewable Energy Agency (IRENA and ILO, 2021) has identified four key concerns that require policy intervention:

- Temporal misalignments, where job losses precede job gains
- Spatial misalignments, where new jobs emerge in other communities or regions
- Educational misalignments, where skills levels or the occupations required under the energy transition have not been developed or needed under the previous energy system
- Sectoral misalignments, where changing value chains and supply chains affect job count and location.

The South African context

The coal mining industry has been an important part of the South African economy since the late 1800s when it supported the growth of the gold and diamond mining industries (Cole and Broadhurst, 2020).

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Today, South Africa is the seventh biggest coal producer in the world with 3.2% of global coal production (BP, 2022) and about 20% of production is exported (Minerals Council South Africa, 2022). In 2022 the industry directly employed 90 977 people who earned R31.7 billion, had total sales of R252.3 billion, and paid R1.97 billion in royalties (Minerals Council South Africa, 2023). In 2021 the coal industry spent R61 billion procuring goods and services (Minerals Council South Africa, 2022). The median wage of mineworkers is double that of other formal sector workers in South Africa (Pai *et al.*, 2021). There are an estimated 170 000 indirect jobs linked to the coal mining industry (Chamber of Mines of South Africa, 2018).

The major users of coal in South Africa are national utility Eskom's coal-fired power stations (53% of total production), Sasol's coal-to-liquid (CTL) fuel plant (33%), and aluminium and ferro-alloys producers (12%) such as ArcelorMittal (Eskom, 2021). The power grid and economy are heavily reliant on fossil fuels, with 80.1% of electricity produced in 2022 using coal and 1.6% from diesel; while hydropower (6.4%), other renewables (7.3%), and nuclear (4.6%) produce the balance (Pierce and le Roux, 2023). The country's dependence on coal for electricity is the highest in the world (IEA, 2021) and its total energy consumption (oil, gas, and coal) resulted in 438.9 Mt of CO_2 emissions in 2021 (BP, 2022). Mining operations require baseload electricity and are highly dependent on Eskom's coal-fired power stations and affected by electricity tariffs, which have increased by over 500% in the past decade (Minerals Council South Africa, 2023).

South Africa is the world's 17th biggest greenhouse gas (GHG) emitter, with 1.13% of global emissions in 2020 (Climate Watch, 2023), despite being the 39th biggest economy (IMF, 2023), and therefore faces international pressure to reduce its emissions. It also faces domestic pressure as the country will experience greater temperature increases than the global average – with 5-8°oC possible by 2100 causing, amongst other problems, heatwaves, floods, and droughts (DEA, 2013). South Africa's Low-Emission Development Strategy (SA-LEDS), submitted to the UNFCCC in 2020, has an aspirational net zero CO_2 emissions target for 2050. The vision is that '*South Africa follows a low-carbon growth trajectory while making a fair contribution to the global effort to limit the average temperature increase, while ensuring a just transition and building of the country's resilience to climate change*' (Republic of South Africa, 2020). South Africa's updated Nationally Determined Contribution (NDC) under the 2016 UNFCCC Paris Agreement includes mitigation targets based on an assessment of the country's 'fair share' of global emissions and likely outcome of current policies, including the Integrated Resource Plan (IRP) 2019 (DMRE, 2019), draft post-2015 National Energy Efficiency Strategy, Green Transport Strategy, and the carbon tax (Marquard *et al.*, 2021). The climate mitigation targets in the 2021 NDC commit to absolute GHG emissions reduction of 350-420 Mt CO_2e, including land use, by 2030 (Republic of South Africa, 2021). This would be 18-32% below 2010 levels and is almost sufficient, against modelled domestic pathways, for meeting the 1.5°C global temperature goal (Climate Action Tracker, 2022). Although the country plans to add over 20 GW of renewable energy capacity over the next decade, coal will remain an important energy resource for the forseeable future.

This vision for a low-carbon economy requires significant funding. At the UNFCCC COP26 climate negotiations in Glasgow in 2021, the World Bank announced the world's first 'Just Energy Transition Partnership', a new funding mechanism for the just transition in coal-producing emerging economies, to support South Africa with a US$8.5 billion loan (Kramer, 2022). South Africa's Just Energy Transition Investment Plan (JET IP) for the period 2023-2027, published in November 2022, lays out priority required investments in the electricity, new energy vehicles, and green hydrogen sectors totalling US$98 billion, highlighting the breadth of interventions required (The Presidency Republic of South Africa, 2022). This builds on the South African Just Transition Framework published in 2022, with seven pillars and four at-risk value chains identified – coal, auto, agriculture, and tourism (Presidential Climate Commission, 2022). This framework is broad and the definition for the just transition in South Africa includes mitigation, resilience, decent work, social inclusion, and poverty alleviation (*ibid.*).

The global literature on the just transition has focused on OECD countries and the national level, despite the regional and local implications (Pai *et al.*, 2021). This paper seeks to contribute to the relatively new and strategic debate on South Africa's just transition by providing an in-depth and comprehensive spatial and temporal analysis of the coal mining industry and its host communities, particularly looking at expected coal mine closures and current community vulnerability. The followin sections describe the methodology employed, the results for coal-fired power stations, coal mines, coal mining host communities, and local municipalities, and provide a discussion on the local, national, and regional implications of the data and the just transition imperatives.

Methodology

There are four parts to the paper that involved data collection and analysis. Firstly, all coal-fired power stations (coal plants) were identified and data on location, unit capacity, start dates, and planned decommissioning was collected from the Global Energy Monitor's Coal Plant Tracker (Global Energy Monitor, 2022a). The plants were mapped in ArcGIS and a closure schedule plotted from 2023 to 2071.

Secondly, all operating coal mines were identified and data on location, start date, owner and operator, mining method, customers, employment, production, life of mine, resources and reserves, and extension projects were collated from the lead author's previously published work on all South African mines and mining host communities (Cole and Broadhurst, 2021, 2022), the Global Energy Monitor Coal Mine Tracker (Global Energy Monitor, 2022b), and mining company annual reports (Integrated Reports, ESG Reports and Mineral Resources and Reserves Reports), websites, and Social and Labour Plans (SLPs). The mines were mapped in ArcGIS and a production and mine closure schedule plotted for the next 55 years.

Thirdly, all coal mining communities were identified and mapped based on the lead author's previously published work on all South African mines and mining host communities (Cole and Broadhurst, 2021, 2022) and additional research using Google Earth, the national census 2011 geographical files demarcating 'main places' and 'sub places' (Frith, 2019), and data published by Statistics South Africa (StatsSA) and provided by the University of Cape Town's DataFirst (StatsSA, 2016). The communities were categorized and analysed as cities, towns, townships, rural villages, mine villages, and informal settlements on mine land, based on population, demographics, location, levels of informal housing, and visual assessment of satellite images in Google Earth.

Demographic and socio-economic indicators were selected based on the South African Index of Multiple Deprivation (SAIMD) (Wright and Noble, 2009) and Sustainable Development Goals (SDGs) indicators that can be comprehensively measured at the town/village level. These indicators are found in seven SDGs,

namely SDG 1 (poverty), SDG 4 (education), SDG 6 (water and sanitation), SDG 7 (energy), SDG 8 (decent work), SDG 11 (sustainable cities and communities), and SDG 17 (partnerships). These indicators were measured using the Census 2011 main place and sub place data collected from SuperCross (StatsSA, 2016) and aggregated or disaggregated to fit each individual community. Although the census data used for the community analysis is now relatively old, it is valuable as it provides a comparison between the different types of communities and will allow for a useful assessment of changes over time when the 2022 census data is released.

Fourthly, all coal mining local municipalities were identified and mapped and the most recent financial data sourced from the Auditor-General of South Africa (AGSA) reports (Auditor-General South Africa, 2022) and National Treasury's Municipal Money Data website (National Treasury, 2022), while data on local government election results was sourced from the Independent Electoral Commission (IEC) website (Independent Electoral Commission, 2023).

Results

Coal plants

South Africa has 16 operational coal plants located in Mpumalanga, KwaZulu-Natal, Gauteng, and Limpopo provinces and one coal-to-liquid (CTL) fuel plant owned and operated by Sasol located in Secunda in Mpumalanga (see Table I and Figure 1). The coal plants have a total capacity of 43 GW and employ over 12 000 people. Most of the Eskom power stations are more than 30 years old and four are more than 50 years old. The current schedule involves decommissioning the oldest three power stations (3.6 GW) by 2025 and retiring a further four (12 GW) by 2035, as shown in Table I and Figure 2. The NDC notes that flexible retirement allows the option of these plants retiring early if their annual utilization drops below 40%. Komati power station (the oldest in the country at 61 years) was decommissioned in October 2022 and is now a 'just transition' pilot site for repurposing to renewable energy (solar PV, wind, and battery storage) with R9 billion in concessional loans and grants secured from the World Bank (Eskom, 2022). Grootvlei power station will be one of the next plants to close (along with Hendrina and Camden) and Eskom has secured a grant from the German development bank, KfW, to set up a renewable training facility at the Grootvlei site (Bega, 2022).

Despite the abundance of coal, South Africa is experiencing a national electricity crisis due to the poor performance of Eskom's new coal-fired power stations (Medupi and Kusile), escalating maintenance and breakdowns of ageing plants, and slow roll-out of the national Renewable Independent Power Producer Programme (REIPPP) due to political and governance factors (Kruger and Alao, 2022). This has resulted in increasing load-shedding since 2018 (Pierce and Ferreira, 2022). In 2021, the country experienced load-shedding 13% of the time (*ibid.*) and this increased to 43% of the time (3773 hours) in 2022, with mostly stage 4 load-shedding occurring (Pierce and le Roux, 2023). To partly address the electricity crisis, in June 2021 the President announced an increase in the threshold for generation license exemptions for embedded generation projects connected to the grid from 1 MW to 100 MW, and this cap has since been removed. The mining industry has led the way in taking advantage of this change in legislation and now has a pipeline of 89 self-generation projects of 6.5 GW (95% solar) at 29 mining companies with a project value exceeding R100 billion (Minerals Council South Africa, 2023).

More than the climate crisis, the electricity crisis is driving the renewable energy sector, which is fundamentally shifting the transmission grid from concentration near coal mines in the east, to decentralization to accommodate solar and wind farms spread

Table I

Summary of coal plants in South Africa, listed by retirement date

Name	Owner	Province	Units	Operating capacity (MW)	First unit start	Last unit retirement	Combined capacity to be retired (MW)
Grootvlei	Eskom	Mpumalanga	6	600	1969	2025	8 952 MW by 2030
Hendrina	Eskom	Mpumalanga	10	1 400	1970	2025	
Camden	Eskom	Mpumalanga	8	1 600	1967	2025	
Arnot	Eskom	Mpumalanga	6	2 352	1971	2029	
Kriel	Eskom	Mpumalanga	6	3 000	1976	2029	
Matla	Eskom	Mpumalanga	6	3 600	1979	2034	6 600 MW by 2035
Duvha	Eskom	Mpumalanga	6	3 000	1980	2034	
Tutuka	Eskom	Mpumalanga	6	3 654	1985	2040	7 362 MW by 2040
Lethabo	Eskom	Mpumalanga	6	3 708	1985	2040	
Matimba	Eskom	Limpopo	6	3 990	1987	2041	8 106 MW by 2045
Kendal	Eskom	Mpumalanga	6	4 116	1988	2043	
Majuba	Eskom	Mpumalanga	6	4 143	1996	2051	
Medupi	Eskom	Limpopo	6	4 800	2015	2071	
Kusile	Eskom	Mpumalanga	6	3 200	2017	2071	
Eskom Total			90	44 763			
Kelvin	Anergi	Gauteng	6	180	1957	2026	
Richards Bay Mill	Mondi	KwaZulu-Natal	2	72	1984		
Grand Total			98	45 015			

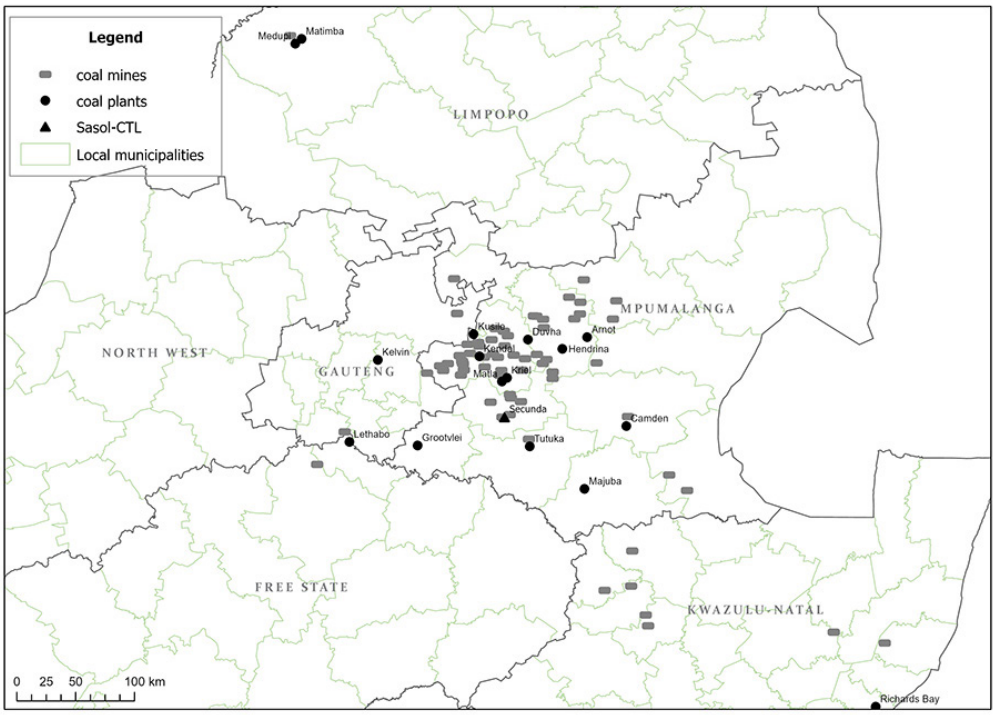

Figure 1—Coal mines and coal plants in South Africa (labels refer to coal plants)

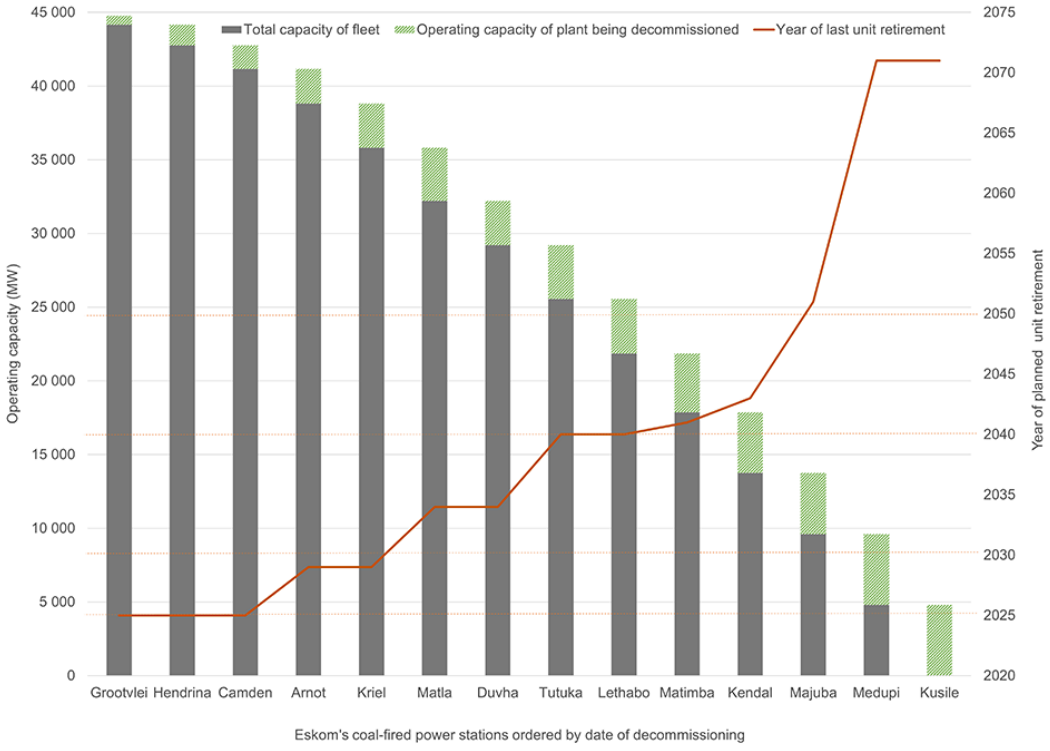

Figure 2—Planned reduction in total operating capacity of Eskom's coal fleet (grey) as individual coal-fired power stations (green) are retired from 2025 to 2071, simplified to include all currently operating units in each bar

across the western half of the country (Kruger and Alao, 2022). The country is moving to a multi-market model where municipalities and consumers can buy directly from independent power producers (IPPs) and Eskom could unbundle the transmission sector to promote the development of the renewable energy sector (*ibid.*). The International Renewable Energy Agency (IRENA) found that South Africa could 'realistically, and cost-effectively … supply 49% of its electricity mix from renewables by 2030' (IRENA, 2020).

Coal mining

There are 66 operating coal mines in South Africa, largely in Mpumalanga Province (see Figure 1), owned by 32 private mining companies (Table II), most of which are locally owned. Five companies produce 77% of all coal; Seriti is the biggest producer (62 Mt/a) followed by Sasol (42 Mt/a), Exxaro Resources (26 Mt/a), Thungela (25 Mt/a), and Glencore (22 Mt/a). There are many junior or emerging mining companies operating relatively short-life mines. Altogether they produced 231 Mt of thermal and metallurgical coal in 2022, generating earnings of R28 billion and employing 90 977 people. In 2021 just over 79% of coal production was sold locally, although it has averaged 72% since 1998 (see Figure 3). Despite high coal prices in 2021 and 2022, exports were constrained by road and port infrastructure and operations, resulting in lost export revenues of R22.7 billion (Minerals Council South Africa, 2022). Coal mining employment steadily increased from 2003 to 2019, except for a drop in 2015, though it has decreased slightly in the past three years, as shown in Figure 4. Figure 4 also shows the significant drop in coal mining employment during the 1980s and 1990s as many mines in KwaZulu-Natal closed.

Life of mine (LOM) data is available for 82% of the mines, and if not extended through brownfield or greenfield exploration, production will steadily decline from 2023 to 2057 as shown in Figure 5. According to this data, four mines will close by 2025 (6.5 Mt), 11 will close in 2026 to 2030 (23 Mt), 12 in 2031 to 2035 (62 Mt), 11 in 2035 to 2040 (44 Mt), nine in 2041 to 2050 (23 Mt), and seven mines will close after 2050 (53.5 Mt). There are 11 mines with an unknown life of mine (32 Mt). If the planned operation of coal plants continued until 2071, there would be a 14-year gap in supply from the last coal mine closure based on available data.

It is expected that some of the mines will extend their lives. There are three existing planned mine expansions that are not incorporated into the published LOM (at Aviemore, Khwezela, and Kangala) and 18 new coal projects with LOMs ranging from five to 39 years, which would add over 30 Mt/a if they all proceed to production (see Table III). For example, Mbuyelo Coal has four mines planned in Mpumalanga with a total mineral resource of 68.8 Mt and LOM ranging from 5 to 15 years (Mbuyelo Coal, 2022). Thungela's Dalyshope project east of Lephalale would be the second large mine in the Waterberg and would produce 10 Mt.a for 30 years (Global Energy Monitor, 2022a). MC Mining has five projects in the unmined Soutpansberg Coalfield in northeast Limpopo Province which would produce 17.5 Mt/a for at least 38 years (MC Mining, 2023). If South Africa's coal production were to expand significantly, it would be focused on the Waterberg Coalfield in

Table II

Summary of operating coal mines in South Africa

Province	Coal fields	Number of mines	Number of mining companies	Total annual production (Mt)	Maximum life of mine (years)
Free State	Vereeniging-Sasolburg	2	2	16.3	17
Gauteng	Witbank	3	2	5.9	37
KwaZulu-Natal	Utrecht, Vryheid, Nongoma	7	6	4.5	28
Limpopo	Waterberg	1	1	17.0	55
Mpumalanga	Witbank, Highveld, Eastern Transvaal	53	26	201.3	50
Total		66	32	231	55

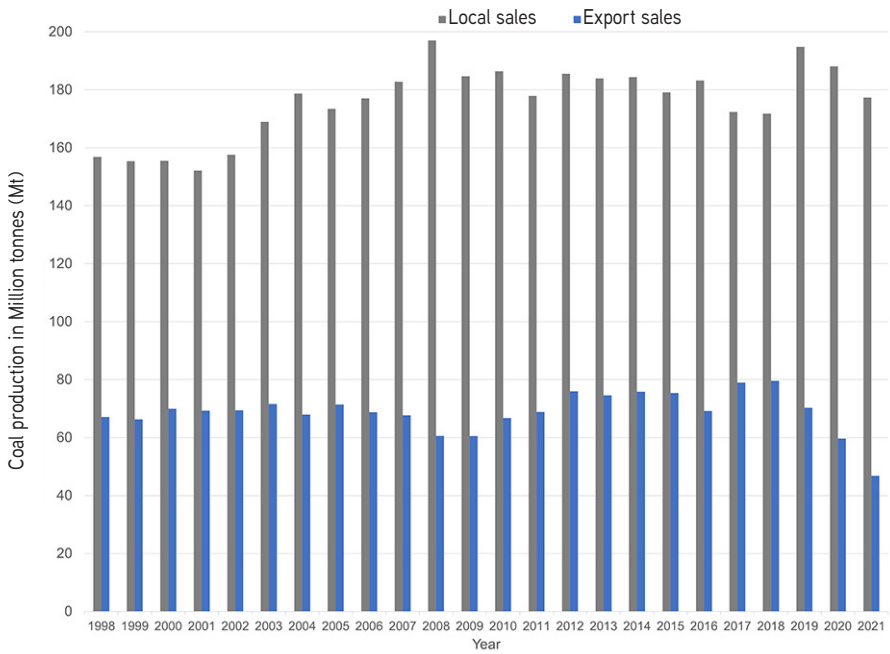

Figure 3—Coal production for local sales and export. Data sources: DMR (2020), Minerals Council South Africa (2022)

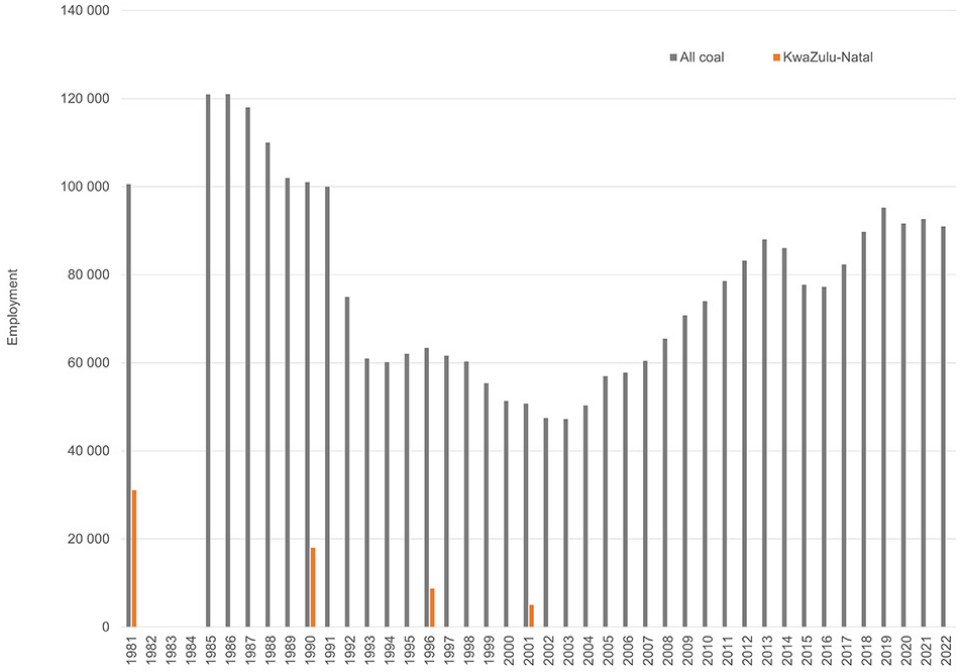

Figure 4—Coal mine employment in South Africa from 1981 to 2022, with the main reduction in jobs being due to mine closure in KwaZulu-Natal in the 1980s. Data sources: Binns and Nel (2003), Minerals Council South Africa (2022)

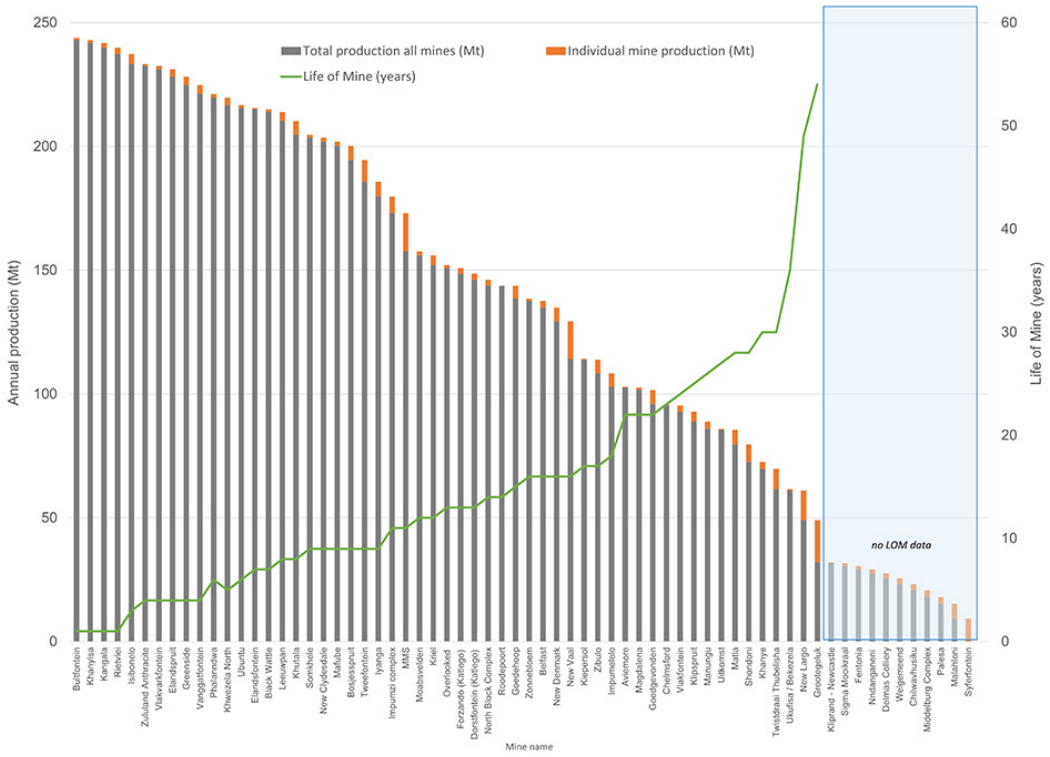

Figure 5—Predicted reduction in total annual coal production in South Africa from the year 2023 to 2057, based on current life of mine (LOM) of all operating coal mines. Mines with no publicly available LOM data are shown in the blue box

Limpopo Province near Lephalale and two coal plants – Matimba and Medupi. The Waterberg Coalfield contains an estimated 75 Gt of coal resources and is underexploited due to deeper orebodies and transport and water constraints (DMR, 2009; DOE, 2016). Given the climate change mitigation requirements, clean coal technologies would be essential for this expansion to be viable.

Coal mining communities

Coal mines are located in two metropolitan municipalities and 19 local municipalities (see Figures 6 and 7), home to over 10 million people. More specifically, there are 69 mining host communities (settlements located close to a coal mine) which are home to about 2.5 million people. These communities are classified as cities,

Table III

Summary of planned coal mine expansions and projects in South Africa

Province	Mines	Mining companies	Total annual production (Mt/a)	Maximum life of mine (years)
Gauteng	Bekezela, Sukuma	Canyon Coal	1.2	36
KwaZulu-Natal	Aviemore	Buffalo Coal	0.4	15
Limpopo	Makhado, Soutpansberg Coal Project, Dalyshope	MbeYashu, MC Mining, Thungela	27.5	38
Mpumalanga	Clydesdale, Eloff, Roodepoort, Maboko, Rirhandzhu, Boschpoort, Ukwenama, Umzila, Sukuma, Gugulethu, Gila, Thuso, Springboklaagte, Alexander, Elders, Sterkfontein	Mbuyelo Coal, Canyon Coal, Glencore, Sasol, Thungela, Salunguno Group, TerraCom, Ndalamo Resources	>4.82	39

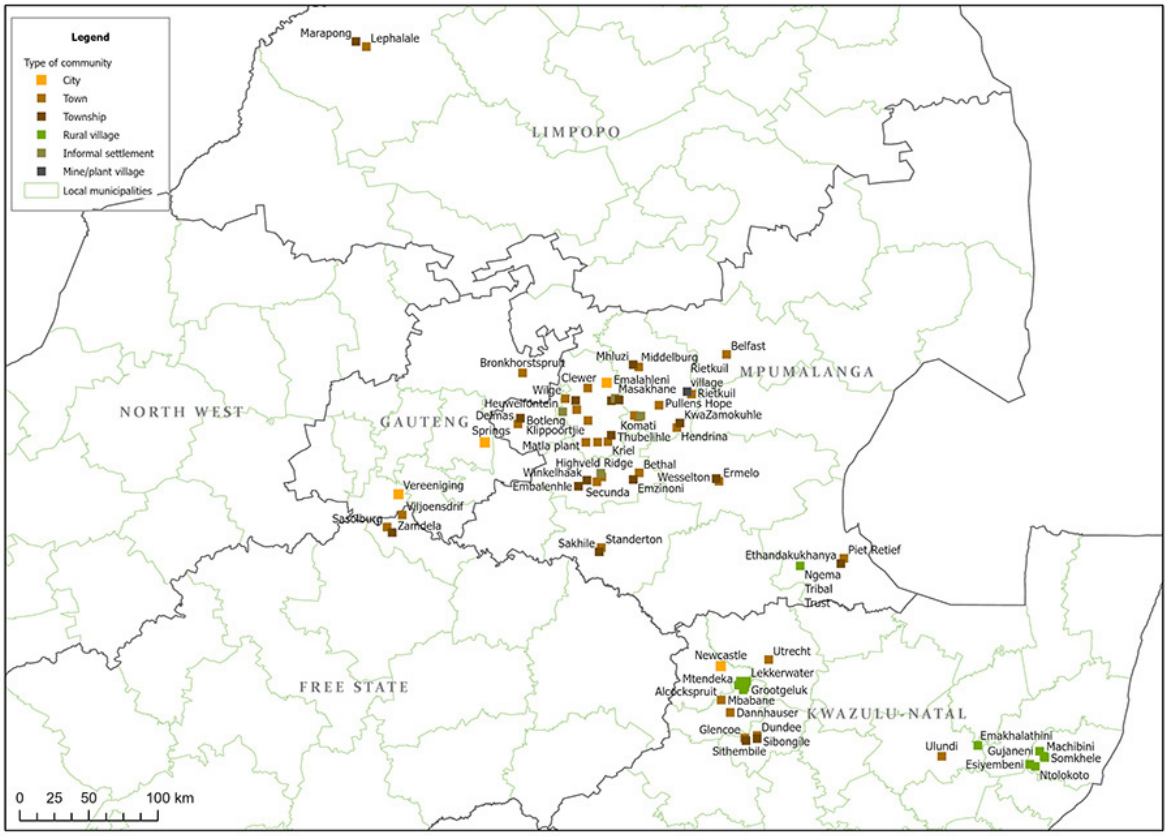

Figure 6—Coal mining communities and local municipalities in South Africa

towns, townships, rural villages, mine/plant villages, and informal settlements on mine land, based on population size, demographics, location, and history. In the past, thousands of mineworkers lived in mine accommodation (mostly single quarters). However, the majority of the mine villages have been removed and, in a few places, informal settlements have developed.

More than half of the people live in four cities (eMalahleni, Newcastle, Vereeniging, Springs), a quarter live in 16 townships, a fifth live in 26 towns, and the remaining 2% live in rural villages, mine/plant villages, and on mined out-land (see Table IV). These towns comprise both pre-existing towns (16 towns) like Middelburg and Bronkhorstspruit and those established to support mining and power generation (10 towns) like Dundee and Glencoe. Figure 4 shows that these communities are concentrated in the western part of Mpumalanga (particularly eMalahleni Local Municipality and Steve Tshwete Local Municipality) and the northwestern part of KwaZulu-Natal.

Census 2011 data shows that many people in these communities have low levels of income, employment, and education which could hinder the just transition (Table V). Overall, 37% are living below the poverty line of R19 600 annual household income (SDG 1), only 46% of adults have a Grade 12 or NQF4 qualification or higher (SDG 4), and 36% of the labour force is unemployed (SDG 8). In terms of basic services, 9% lack access to piped water in their

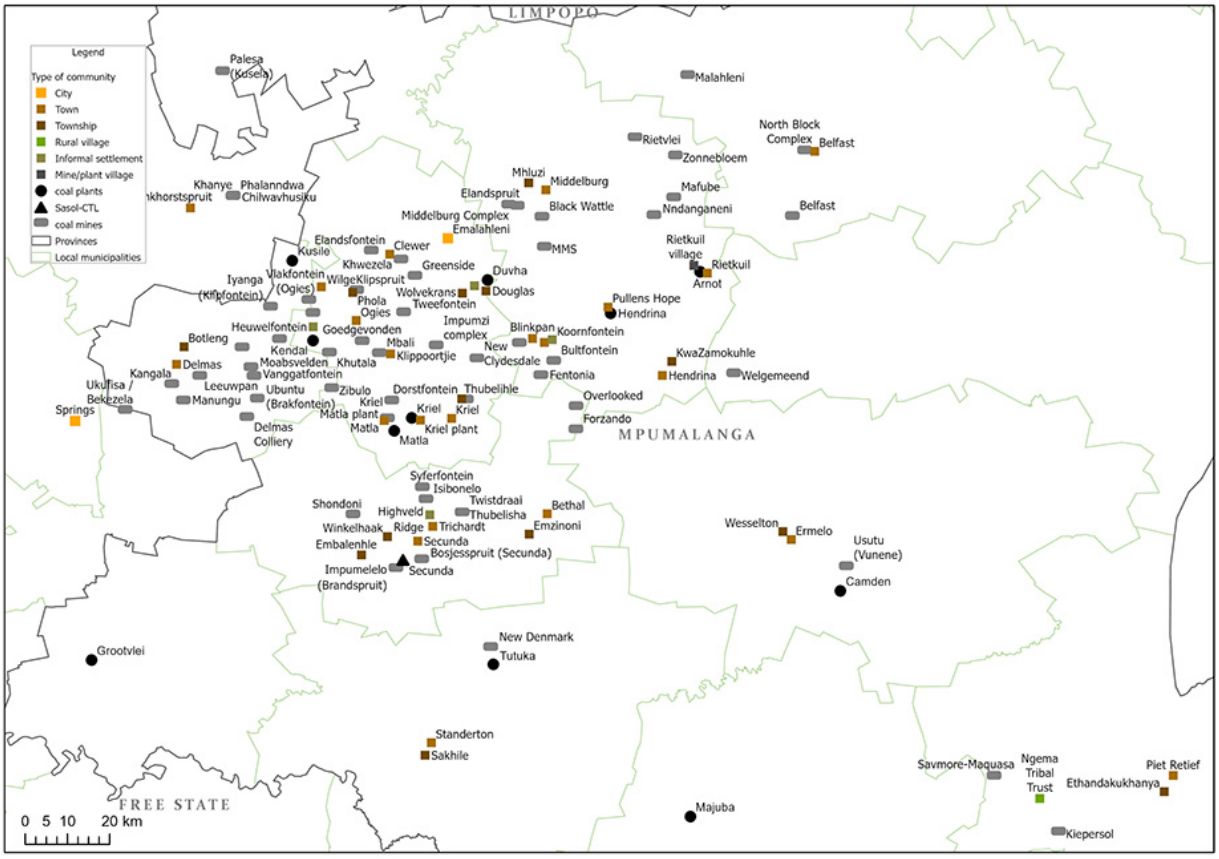

Figure 7—Coal mining communities, coal mines and coal plants in Mpumalanga

Table IV

Summary of demographic data for all coal mining communities in 2011. Data source: Census 2011 SuperCross database (StatsSA, 2014)

Community type	Number of communities	Area (km²)	Population	Households	Household size	Gender (% female)	Race (% non-white)
Cities	4	1,014	1,326,979	377,798	3.5	50.4	89.3
Towns	26	1,185	496,035	145,260	3.4	48.7	67.8
Townships	16	272	626,264	179,278	3.5	49.0	99.8
Rural villages	13	362	43,388	7,399	5.9	53.9	100.0
Mine and power plant villages*	5	98	4,413	1,743	2.5	35.6	80.0
Mine land with informal settlements	5	92	6,177	2,543	2.4	38.1	92.0
Total	69	2,929	2,515,082	718,055	3.5	49.7	87.8

*Excludes 9,132 people in mine villages that have since been removed

dwelling or yard (SDG 6), 15% lack formal housing, 15% lack refuse removal (SDG 11), and 10% do not use electricity as their main source for lighting (SDG 7).

These averages hide the significant inequality between communities, visually shown by the SDG barometers in Figure 8. The living conditions and level of basic services are much higher in towns and cities and much lower in rural villages, which are underserviced, have 57% of households below the poverty line, and 54% female residents (see Table V). Active mining areas also host a few male-dominated villages that are relatively well off, while inactive mining areas host a few informal settlements that are the worst off out of all types of communities (see Table V). The data shows the impact of mine closure that has already taken place, giving an indication of what may ensue in the coming decades as more mines close. The results also show that it is going to be very difficult to achieve the SDGs and South Africa's National Development Plan goals in these communities by 2030 without a significant collaborative effort on the part of the government, mining companies, civil society, and the communities themselves.

Coal mining local municipalities

Coal mines in South Africa are spread across five provinces, ten district municipalities, two metropolitan municipalities, and 19 local municipalities (see Table VI). Of the local municipalities, five are categorized in the South African Municipal Infrastructure Investment Framework (MIIF) as B1, as they have a 'secondary city', three are categorized as B2, with a large town, seven are B3 municipalities home to several small towns, and four are B4 (rural) municipalities. The AGSA findings for municipalities in 2021 (see Table VI) show that:

- Only two host municipalities had a clean audit, six had an unqualified audit with findings (the municipality produced quality financial statements, but struggled to produce quality performance reports and/or to comply with all key legislati)
- Ten had a qualified audit with findings (financial statements contained material misstatements and the municipality had challenges with the quality of the performance report and/or compliance with key legislation)
- One (Emakhazeni) had an adverse audit (financial statements contained so many material misstatements that the AGSA disagreed with virtually all the amounts and disclosures)
- One (Lekwa) had a disclaimed audit (the municipality could not provide evidence for most of the amounts and disclosures in the financial statements).

National Treasury's municipal financial data (see Table VI) shows that there was almost R7 billion (US$376 million) of 'unauthorized, irregular, fruitless, and wasteful expenditure' (UIFW) in 2021 in these host municipalities. Thus, most local municipalities hosting coal mining do not have adequate financial and performance management in place. Local politics affects the governance of the municipality, and the recent 2021 local elections saw a major shift away from single party dominance to coalitions and minority governments (see Table VI). It is too early to tell whether this will improve or hinder good governance and potential improvement in the provision of basic services.

Discussion

Local implications and considerations

The poverty and poor living conditions of thousands of people in coal mining host communities is distressing and is not being adequately addressed by the government. A major concern is the high unemployment rate of 39%, which is much higher than in other developing-country coal economies like India (7.7%) and Indonesia (3.8%) (World Bank, 2023), although the South African population is much smaller. This poses a threat to the social licence to operate for coal mining companies, which in turn is an energy security risk and economic risk for the country. Stakeholder engagement with communities is essential but, despite good efforts from some companies, is often overlooked by others (Hallowes and Munnik, 2019). Many of these communities have experienced mine closures and do not have the skills and opportunities to take advantage of the inevitable transition, let alone the transition to clean energy. The majority of renewable energy development has taken place in the Northern Cape, far from those living in the coalfields, although eMalahleni has been identified as a Renewable Energy Development Zone (REDZ) based on its solar PV potential and proximity to transmission infrastructure (DEA and CSIR, 2019).

Much of the focus of the 'just transition' is on supporting mineworkers. However, most of the coal mining communities are small towns and townships that are dependent on coal mining for the local economy. For example, 57% of businesses in Steve Tshwete local municipality offer services to either coal mines or coal plants (Semelane *et al*., 2021) and hundreds of small businesses rely on spending by direct and indirect coal workers (Pai *et al*., 2021). Globally, mining regions have generally struggled to cope with mine closure and the resulting economic loss, often leading to regional decline and effective town abandonment (Nel, Marais, and Mqotyana, 2023). Literature on regional resilience identifies key elements as strong local leadership, endogenous knowledge, innovation, willingness to change, experience from previous crises, access to funds, transferrable skills, and willingness to retrain, coupled with the availability of resources and market opportunities for a 'new' economy (*ibid*.). The just transition must take all these factors into account.

There are good reasons for mining communities being included in equity positions in mine site IPPs, leading to potential long-term financial flows into the communities. The significant financial resources being utilized by the mining industry for corporate social investment and social and labour plans (SLPs) could be more strategically spent to support the just transition. Mining companies have spent billions of rands over the past 15 years on SLPs but it is unclear how sustainable that spend has been and research in this area is required. The mining industry needs to rethink the model for mines benefiting host communities, as is being done in the Impact Catalyst initiative in Mpumalanga and Limpopo provinces (Impact Catalyst, 2023), and this could be facilitated by the just transition.

Municipal audits show that most of the local municipalities that host coal mines do not have adequate financial and performance management and misspent almost R7 billion in 2021. This is unacceptable given the poor living conditions of so many people in these communities, and the significant financial needs of ensuring that the energy transition is just. Local municipalities are very dependent on large businesses such as mines who are big users of water and electricity, which make up a significant part of the municipal operating budget (Ledger, 2021), about 40% on average in 2021 (StatsSA, 2022). The closure of coal mines could mean that the municipalities struggle to cope with the resultant loss of revenue and basic service delivery to the communities suffers.

National implications and considerations

South Africa's shift from fossil fuels to renewable energy is inevitable. Disastrous mega coal-fired power station projects have led to dramatic rises in electricity tariffs and damag to the economy (Kruger and Alao, 2022). Worldwide renewable energy investment has created twice as many jobs as investment in fossil fuels (UNIDO and GGGI, 2015), evident in over 50 000 renewable energy jobs created in 2020 (IRENA, 2022), and 12 planned coal-fired power plants have been cancelled in recent years (Global Energy Monitor, 2022). The cost of solar and wind energy has declined consistently over the past decade in South Africa (Evans, 2021) and renewable energy projects appear to have been generally delivered on time and on budget. Importantly, the projects are short-term with revenue being generated relatively soon after capital expenditure begins. The latest REIPP bid window (DMRE, 2023) asks for 4200 MW (similar in capacity to the new coal-fired plants, although with lower steady-state production), with power available on the grid in less than three years from closure of the bid window, compared to more than 12 years for the new Medupi and Kusile coal plants.

The main techno-economic argument in favour of coal power is that solar and wind cannot provide uninterrupted power and that energy storage is still expensive, despite solar and wind power being cheaper than coal at a levellized cost basis (Pai *et al*., 2021). In addition, the transmission grid does not extend to potential renewable energy sites, although Eskom is looking at ways to accelerate the rollout of new transmission lines. Current thinking is that coal power will be required during peak electricity usage times (evenings and mornings) when the sun does not shine, or wind may not blow, and for managing the grid throughout the day owing to the intermittency of renewables. However, rapid improvements in storage technologies are bringing down renewable energy storage

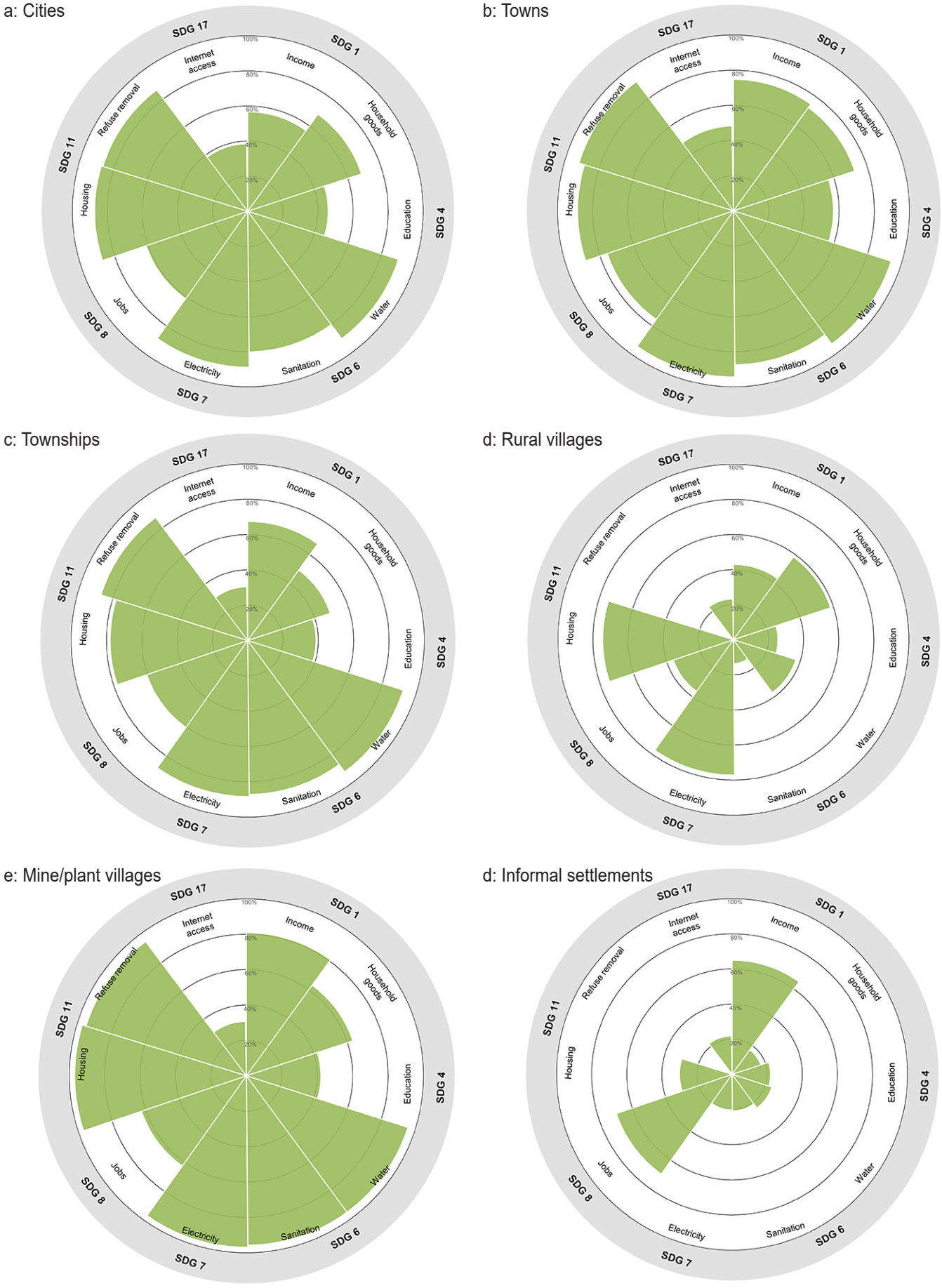

Figure 8—SDG barometers for coal mining communities in South Africa (green triangles show socio-economic indicator status in 2011)

Table V

Socio-economic indicators for all coal mining communities in 2011. Data source: Census 2011 SuperCross database (StatsSA, 2014)

SDG	Indicator	Cities	Towns	Townships	Rural villages	Mine /power plant villages	Mine land with informal settlements	TOTAL
SDG 1 No Poverty	Annual household income >R19,600 (%)	56.7	74.8	67.5	45.3	82.6	63.4	63.1
	Household ownership of a fridge (%)	68.2	72.5	49.2	58.3	62.6	20.0	64.0
SDG 4 Education	Adult education level NQF4/Grade 12 or higher (%)	45.9	56.8	38.7	25.4	40.5	20.4	45.8
SDG 6 Water and Sanitation	Persons with access to piped water in dwelling or yard (%)	90.1	94.0	92.4	37.4	95.2	16.2	90.3
	Persons with access to a toilet (%)	80.1	87.5	87.2	13.6	95.7	16.1	82.0
SDG 7 Energy	Persons with electricity as main source of lighting	88.8	94.4	88.4	77.2	97.0	14.4	89.3
SDG 8 Decent Work	Employed labour force (%)	61.1	75.7	60.3	36.1	65.5	68.4	63.1
SDG 11 Sustainable Cities and communities	Persons with formal housing	87.3	88.6	78.0	74.5	97.1	23.9	84.8
	Persons with municipal refuse removal	86.4	91.9	87.0	0.8	94.0	1.9	85.8
SDG 17 Partnerships	Household internet access (%)	38.5	48.3	30.5	23.3	32.0	20.9	38.2
Well-being Score		7.0	7.8	6.8	3.9	7.6	2.7	7.1

Table VI

Audit findings and political parties for municipalities that host coal mines

Province	District municipality	Local municipality	Type of municipality	Audit finding for 2020/21	UIFW* expenditure in 2020/21(R million)	Elected political parties in 2021	Number of coal mines
Mpumalanga	Nkangala	eMalahleni	B1	Qualified	644	ANC majority	19
		Steve Tshwete	B1	Clean	107	ANC majority	13
		Emakhazeni	B2	Adverse	23	ANC majority	2
		Victor Khanye	B3	Qualified	182	ANC majority	9
		Thembisile Hani	B4	Qualified	21	ANC majority	1
	Gert Sibande	Lekwa	B3	Disclaimed	286	LCF-EFF minority	1
		Govan Mbeki	B1	Qualified	980	ANC majority	7
		Msukaligwa	B2	Qualified	258	ANC majority	1
		Mkhondo	B3	Unqualified	180	Independent-EFF-ATM minority	2
Gauteng	Ekhuruleni		A	Clean	227	DA coalition	1
	City of Tshwane		A	Unqualified	3 490	DA coalition	2
Free State	Fezile Dabi	Metsimaholo	B2	Qualified	91	DA minority	2
KwaZulu-Natal	Amajuba	Emadlangeni	B3	Qualified	41	IFP coalition	1
		Dannhauser	B4	Qualified	22	IFP-EFF minority	1
		Newcastle	B1	Unqualified	36	IFP coalition	2
	Umzinyathi	Endumeni	B3	Qualified	44	IFP minority	2
	uThungula	uMlalazi	B4	Unqualified	36	IFP majority	1
		uMhlatuze	B1	Clean	12	IFP-DA-EFF coalition	2
	Zululand	Abaqulusi	B3	Qualified	218	IFP minority	1
		Ulundi	B4	Unqualified	44	IFP majority	1
Limpopo	Waterberg	Lephalale	B3	Unqualified	23	ANC majority	1

* Unauthorised, irregular, fruitless and wasteful expenditure

costs further, which will aid renewables to provide consistent and cheap power throughout the day (*ibid.*).

The country needs to prioritize energy security to support economic growth and job creation that will build the momentum for social progress. South Africa still has significant untapped mineral resources that are of strategic interest to the rest of the world, and mining and processing operations could expand if the policy and investment environment is right (MISTRA, 2018). Mining has been a catalyst of and major contributor to the national economy since the mid-1800s and this is likely to continue. This means that energy demand will increase, and coal plants and coal mining will be required for many years to come. Much can be done to improve the social impact and reduce the negative environmental impact of coal mining. The national government needs to partner with mining companies and communities to support the most effective means of maximizing benefit from the country's coal resources.

Regional implications and considerations

South Africa operates within the regional context of the Southern African Development Community (SADC), which is an electricity-poor region where only 50% of residents have access to electricity (SADC, 2023). In 1995, the Southern African Power Pool (SAPP) was set up as a cooperative venture between 13 national electricity companies to create a regional power grid and common electricity market to improve access to electricity in the SADC (SAPP, 2023). The SAPP allows for bilateral agreements between national utilities, and trading arrangements through SAPP where excess power is auctioned. Although South Africa is the biggest power producer by far (73% of operating capacity in the SAPP), it imports hydropower from Mozambique's Cahorra Bassa dam (SAPP, 2022). South Africa, can and sometimes does, export to Lesotho, Swaziland, Mozambique, Botswana, Zimbabwe, and Namibia, though they experience load reduction when Eskom implements load-shedding. Thus South Africa's management of national electricity generation and distribution has direct economic implications for SADC countries.

South Africa has an important role to play in supporting socio-economic development in the SADC region through electricity exports, and the country's coal-fired power could be exported to the SADC in the medium term to address the regional energy deficit and promote energy security. This could ensure that no new coal plants are built elsewhere in the SADC while also ensuring that the region does not end up with less energy in a bid to mitigate climate change. High interest rates, lack of capital, and limited electricity grids across Africa mean that investment in decentralized renewable energy is much more likely on the continent.

Conclusion

South Africa is dependent on coal mining for power generation and economic growth, but is planning to reduce this dependence as coal plants are decommissioned and renewable energy is rolled out. Despite the narrative that coal mines will close prematurely to meet climate mitigation commitments to the UNFCCC, data shows that coal mines will be closing regularly over the coming decades as resources are depleted and new projects will replace only a small part of total production. These mine closures will impact the 2.5 million people living in 69 communities who benefit directly and indirectly from coal mining. Although there are significant inequalities in standards of living and thus resilience to shocks, all these people will be affected to some degree. Addressing community needs requires significant efforts to improve local governance across municipalities, which will be critical to the success of a just transition to a lower carbon economy in South Africa. The just transition is possible through firstly, a dual energy generation strategy of coal and renewable energy with a net renewable energy outcome; secondly, regional collaboration in the SADC, where the comparative advantages of surrounding countries is applied; and thirdly, political will and integrity to enable the investment and development required for the just transition to manifest.

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CRediT statement

MC: conceptualisation, methodology, investigation, validation, formal analysis, writing – original draft, visualization; MM: conceptualisation, writing – reviewing and editing, AvZ: conceptualization, writing - reviewing and editing.

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