Energy and Development: An assessment of South Africa's Progress towards Achieving SDG 7

By

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Declaration Of Originality

I, Oratilwe Teisho, declare that this dissertation is my original work. As per departmental requirements, acknowledgement was given, and reference was made where someone else's work was used. I understand what plagiarism entails and am aware of the University's policy in this regard.

Signature: …….

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Abstract

Electricity is the most important source of energy for most households and businesses in South Africa. This dissertation explores the contribution of electricity to sustainable development in South Africa by assessing the extent to which the country is achieving the Sustainable Development Goal (SDG) 7 - "Ensure access to affordable, reliable, sustainable and modern energy for all." SDG 7 serves as a proxy (Framework) for assessing progress in achieving the type of energy supply needed for sustainable development. This research takes into consideration the tension between the cost-reflective tariffs of Eskom and affordability for the customer, as well as the social tensions and environmental factors involved in the transition to an energy-efficient low-carbon economy.

My findings are that by 2030, South Africa: will provide access to electricity for all citizens although it will not be affordable for many and the quality of access is not ensured. There will be a substantial increase in the share of renewable energy in total energy generation and there is potential to improve in energy efficiency. I find that the development finance pledge by international partners for the just transition provides an opportunity for South Africa to expand infrastructure, upgrade technology, if it can be implemented, for supplying modern and sustainable energy services for all in a just and equitable manner.

Addressing these broad matters can assist in providing possible solutions to achieving sustainable development and further contribute to the understanding of the complexities surrounding access, affordability and reliability of electricity, upscaling renewable energy and practising energy efficiency.

Keywords: Sustainable Development, Electricity, Energy, Renewable Energy, Energy efficiency, Infrastructure, Eskom, NDCs, IPPs, SDG Goal 7, SDG 7.1, SDG 7.2, SDG 7.3, SDG 7. B, Solar, Wind, Coal, Nuclear, South Africa, just transition

List of Abbreviations

BSS	Battery Storage System
COVID-19	Coronavirus disease caused by the SARS-CoV-2 virus
COSATU	Congress of South African Trade Unions
DFFE	Department of Forestry, Fisheries, and the Environment
DMRE	Department of Mineral Resources and Energy
DOE	Department of Energy
ERA	National Energy Regulator Act
FDI	Foreign Direct Investment
GoSA	Government of South Africa
GW	Gigawatt
IMF	International Monetary Fund
IPPO	Independent Power Producers Office
IPPs	Independent Power Producers
IRP	Integrated Resource Plan
KwH	Kilowatt per Hour
LPG	Liquefied Petroleum Gas
Mwh	Megawatts per Hour
MYPD	Multi-Year Price Determination
NDC	National Determined Contributions
NDP	National Development Plan
NEES	National Energy Efficiency Strategy
NERSA	National Electricity Regulator of South Africa
NT	National Treasury of South Africa

NUM	National Union of Mineworkers
NUMSA	National Union of Metalworkers of South Africa
PPAs	Power Purchasing Agreements
Presidency	Department in The Presidency (including the President & office of the President)
REIPPP	Renewable Energy Independent Power Procurement Programme
RMIPPP	Risk Mitigation Independent Power Producer Programme
SA	South Africa
SALGA	South African Local Government Association
SANEDI	South African National Energy Development Institute
SAPP	Southern Africa Power Pool
SASSA	South African Social Security Agency
SDGs	Sustainable Development Goals
SEA	Sustainable Energy Africa
SOE	State Owned Enterprise
Stats SA	Statistics South Africa
UN	United Nations
W	Watts
WB	World Bank

Glossary

Apartheid	The race based policy of the National Party Government that came to power in 1948. It governed relations between South Africa's white minority and non-white majority for much of the latter half of the 20th century, enforcing racial segregation and political and economic discrimination against black people. Although the legislation that formed the foundation of apartheid had been repealed by the early 1990s, the social and economic repercussions of the discriminatory policy persist into the 21st century.
Energy Poverty	The lack of adequate, affordable, reliable, quality, safe and environmentally modern energy services. . .
Eskom	A South African electricity public utility in terms of the Electricity Act. It was established in 1923 as the Electricity Supply Commission and is also known by its Afrikaans name Elektrisiteitsvoorsieningskommissie. With effect from 1 July 2002, Eskom was converted from a statutory body into a public company as Eskom Holdings Limited, in terms of the Eskom Conversion Act, 13 of 2001. The two-tier governance structure of the Electricity Council and the Management Board was replaced by a Board of Directors.
Informal Settlements	Informal settlements are housing areas that are often illegally built on municipal land and locations that often do not have access to basic services such as water andsanitation as well as electricity. In South Africa, these settlements are found in a variety of areas and are home to a large percentage of the country's impoverished population.
Integrated Resource Plan	refers to the coordinated schedule developed and updated by the Department of Mineral Resources and Energy for generation expansion and demand-side intervention programmes, taking into consideration multiple criteria to meet electricity demand.
Just Transition	Just transition is a framework to encompass a range of social interventions needed to secure workers' rights and livelihoods when economies are shifting to sustainable production, primarily combating climate change and protecting biodiversity.

Medium-term	two to ten years period.
National Development Plan	The NDP was drafted in August 2012 by the National Planning Commission, a special ministerial body first constituted in 2009 by President Jacob Zuma. The NDP aims to eliminate poverty and reduce inequality by 2030. According to the plan, South Africa can realize these goals by drawing on the energies of its people, growing an inclusive economy, building capabilities, enhancing the capacity of the state, and promoting leadership and partnerships throughout society.
Nationally Determined Contributions	NDCs are non-binding national plans highlighting climate actions, including related climate-related targets for greenhouse gas emission reductions, policies and measures governments aim to implement in response to climate change and as a contribution to achieve the global targets set out in the Paris Agreement.
Photovoltaic (PV)	Photovoltaics is the direct conversion of light into electric power using semiconducting materials such as silicon.
Sustainable Development Goals	The Sustainable Development Goals are a call for action by all countries – poor, rich, and middle-income – to promote prosperity while protecting the planet. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection. 17 Sustainable Development Goals (SDGs) and 169 targets was adopted on 25 September 2015 by Heads of State and Government at a special United Nations summit. The Agenda is a commitment to eradicate poverty and achieve sustainable development by 2030 world-wide, ensuring that no one is left behind.
The Paris Agreement	The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015, and entered into force on 4 November 2016.

1. Introduction

Electricity is the most critical energy source for most households and businesses in South Africa (SA). Eskom, a state-owned utility, dominates this sector. It is responsible for most of the country's electricity generation, transmission and distribution. In recent years, Eskom has not been able to meet the country's electricity demand and therefore has introduced load-shedding, potentially resulting from mismanagement, power plant maintenance failures and insufficient investment. This failure to meet the country's electricity needs has impacted households and the economy, as businesses cannot operate without electricity, and domestic consumers cannot carry out essential household functions. These developments have highlighted the importance of giving more attention to this sector that influences SA's development.

Sustainable Development Goal 7 (SDG 7) positions energy as central to sustainable development and sets out an agreed goal, specified targets and indicators against which progress can be measured. This study aims to identify progress and challenges in delivering affordable and reliable electricity supplies, because it is the most important energy source, to bolster sustainable development based on available data. It is essential that access to electricity, cost of electricity supply, job creation and environmental commitments all be balanced in SA's transition to affordable, reliable and clean electricity. Achieving SDG 7 and balancing these different needs is an important debate to address energy policies and programmes to optimally shape sustainable development. The research is not only limited to how citizens and businesses experience the provision of electricity, but also to the extent the fiscus is negatively impacted by mismanagement at Eskom.

The structure of this Dissertation will begin with the background on Electricity in SA, moving to the Conceptional Framework of SDG 7, then research objectives and questions. It then presents the research methodology, literature review, and critical findings, thereafter, before ending with the recommendations and conclusions.

My research findings and conclusions aim to identify progress and challenges in the delivery of affordable and reliable electricity supplies to bolster sustainable socio-economic and economic development based on available data.

2. Background: Electricity in South Africa

The purpose of this chapter is to provide an overview of the management and sustainability of electricity supply in SA. It will provide ~~a~~ background on the importance of electricity for households and the economy, and further consider SA's energy policies, associated environmental, economic and sustainability factors.

Government policy

SA has committed to the full and integrated implementation of the United Nations Sustainable Development Goals (SDGs) by 2030. Achieving the SDGs, particularly SDG 7, can assist SA in addressing unemployment, inequality, and poverty. It further impacts on the overall quality of public services – including health and education services – and the quality of life (WB, 2012). The National Development Plan (NDP) identifies the need for SA to invest in a strong network of economic infrastructure that is designed to support the country's economic and social objectives (NPC, 2012). NDP goals are aligned to the SDGs and have been integrated into the GoSA's planning systems and processes at national, provincial and local levels (VNR, 2019). The NDP prioritises SA's transition to a low-carbon economy as one of the most urgent actions to address climate change, while ensuring access to sustainable energy. Additionally, the provision of a clean and reliable supply of renewable energy, to address climate change, is further prioritised by SDG 7 as an important enabler of this transition.

The NDP states that SA will have an energy sector that promotes economic growth and development through adequate investment in energy infrastructure. The sector should provide reliable and efficient energy at competitive rates while supporting economic growth through job creation. Furthermore, it is essential that the sector ensures Social Equity through expanded access to energy at affordable tariffs and through targeted, sustainable subsidies for needy households, as well as Environmental sustainability through efforts to reduce pollution and mitigate the effects of climate change (NPC, 2012).

The following NDP targets are related to those of SDG 7 (StatsSA, 2019):

- Contracting at least 20 GW of renewable energy by 2030;

- Decommissioning 11 GW of ageing coal-fired power stations and stepping up investments in energy efficiency;
- Providing grid electricity to at least 90% of South Africans by 2030 and the remaining to utilise alternative off-grid solutions; and
- Improving energy efficiency by 15% in the mining sector.

SA is further implementing the Integrated Resource Plan (IRP) 2010-30 (DOE, 2011a), which is an electricity infrastructure development plan that was based on the least cost supply and demand balance. The IRP was updated in 2019 to outline several steps the GoSA will undertake to improve SA's unreliable and deteriorating energy sector. These steps focus on the greater use of natural gas, maintaining the nuclear sector, while increasing the focus on social inclusion and a "just transition plan" to more renewable energy (DOE, 2019a).

The GoSA has identified reforms that are required from the electricity supply system, including the restructuring of Eskom to ensure a reliable, competitive, and transparent system. In late 2019, the GoSA released the updated IRP (IRP 2019) and the Roadmap for Eskom in a Reformed Electricity Supply Industry (Roadmap for Eskom) (DPE, 2019).

The Roadmap for Eskom steps to reform are as follows (DPE, 2019):

- Outlines actions to overcome the current crisis at Eskom and sets it onto a new path of sustainability that will benefit all South African citizens for generations to come;
- Defines the key steps in transforming the electricity supply system that are required, including the energy sources proposed by the 2019 IRP).
- Addresses steps to restore Eskom's finances including government support;
- Identifies measures to reduce the cost structure of Eskom to enable provision of affordable electricity; and
- Details the process through which the restructuring of Eskom will take place, including the process through which a new transmission entity will be established by Eskom and the Department of Public Enterprise (DPE, 2019).

The roadmap plan provides necessary interventions needed for SA's energy path for the next 10 years. The key steps suggested by DPE to transform the energy sector include (DPE, 2019: 4):

- The transition from the existing dependence on fossil fuels to the mix of electricity energy sources reflected in the IRP 2019;
- The restructuring of Eskom into Eskom Holdings with three new subsidiaries: Generation, Transmission and Distribution;
- An intensive focus on radically improving the current operations and eliminating inefficiencies in generation;
- A more significant requirement for transparency in the governance of both Eskom Holdings and the subsidiaries;
- A rigorous approach to cutting wasteful costs, optimising revenue and resolving the debt burden; and
- A just transition involving all stakeholders to ensure sustainable livelihoods for workers and communities.

In the wake of the COVID-19 pandemic, President Cyril Ramaphosa tabled the South African Economic Reconstruction and Recovery Plan in parliament in October 2020. The plan consists of high-impact interventions to kickstart the economy and lay the foundation for a sustainable recovery. Efforts will be strengthened to attract private sector investment in the delivery of infrastructure as part of building broad-based Public, Private Partnerships (PPP) (Presidency, 2020).

The economic recovery plan (Presidency, 2020) further included specific interventions worth highlighting in the energy sector:

- Connection of an additional 128 MW of IPP capacity;
- Connection of Bid Window 4 IPP capacity, 1338 MW between January and June 2021 and 279 MW by March 2022;
- Preparation for the nuclear programme at a pace and rate that is affordable;
- Enabling generation for private use.

Some of the interventions set to secure SA's energy future include separating and unbundling Eskom, improving efficiency, monitoring the Eskom build programme and

reliability of energy supply, and reviewing progress with the minimisation of load-shedding trends (Presidency, 2020). Furthermore, implementing the IRP 2019 will ensure the diversification of SA's energy sources which also embraces new entrants and capacity into the energy space. The plan aims to achieve sufficient, secure and reliable energy supply by improving Eskom's performance and rapidly expanding generation capacity through a diverse energy mix. The process to implement bid window 5 of the renewable energy programme has begun, expanding renewable energy sources through the REIPPP. DMRE has called for proposals from IPPs to develop new generation capacity of 2 600 MW which includes 1 600 MW from onshore wind energy and 1 000 MW from Solar Photovoltaic (Solar PV) power plants, in line with the GoSA's intention to increase generation capacity and ensures the security of energy supply (DMRE, 2021a).

SA intends to limit GHG emissions to 398-510 Metric tons of carbon dioxide equivalent (MtCO2e) by 2025 and to 350-420 MtCO2e by 2030, which are significantly lower than the mitigation targets communicated in 2016, which are in line with the recommendations proposed by the Presidential Climate Commission (PCC) (PCC, 2021). "The PCC is a multi-stakeholder body established by the President to advise on the country's climate change response and pathways to a just transition" (PCC, 2021: 2). The President tasked the PCC to make recommendations on SA's updated Nationally Determined Contribution (NDC) draft paper (PCC, 2021).

Moreover, the PCC followed a public engagement process and drew on the diversity of views and inputs received from business, labour, civil society and academia. In formulating its recommendations, the commission found that there is scope for greater emission reductions by accelerating energy efficiency measures, thus allowing for earlier decommissioning and repurposing of coal-fired power stations as they reach the end of the life cycle, while filling the gap with additional low-carbon generation capacity (PCC, 2021) as one example.

The PCC recommended that the NDC should implement the following but not limited to (PCC, 2021: 12-29):

- prioritising specific sectors - health, water, biodiversity, agriculture, human settlements, and infrastructure - and actions within them to ensure greater resilience to climate shocks;
- supporting the effective consideration and incorporation of gender impacts in adaptation projects as part of the NDC's broader commitment to ensuring the climate change response addresses the needs of vulnerable groups;
- supporting the implementation of the National Framework for Climate Services to assist in improving climate information and forecasting services;
- stressing the importance of building capacity at the sub-national level in the design, planning and financing of adaptation programmes and projects;
- being compatible with SA's 'fair share' of emission reductions, considering common but differentiated responsibilities and respective capabilities;
- reaffirming SA's commitment to reaching 'net-zero' carbon emissions by 2050;
- lowering SA's emissions target range to at least 350 – 420 Mt CO2-eq by 2030. This will be consistent with SA's fair share contribution to a 2°C global target;
- indicating the measures to upscale climate finance in SA's intention to develop a climate finance strategy, supporting an accelerated climate transition.

The recommendations put forward were intended to support and urge the country to accelerate its climate change response, by matching a higher level of evidence-based ambition with the imperativeness of social and economic justice. The implementation process requires a long-term strategy for accessing and mobilising national and international support (PCC, 2021: 30).

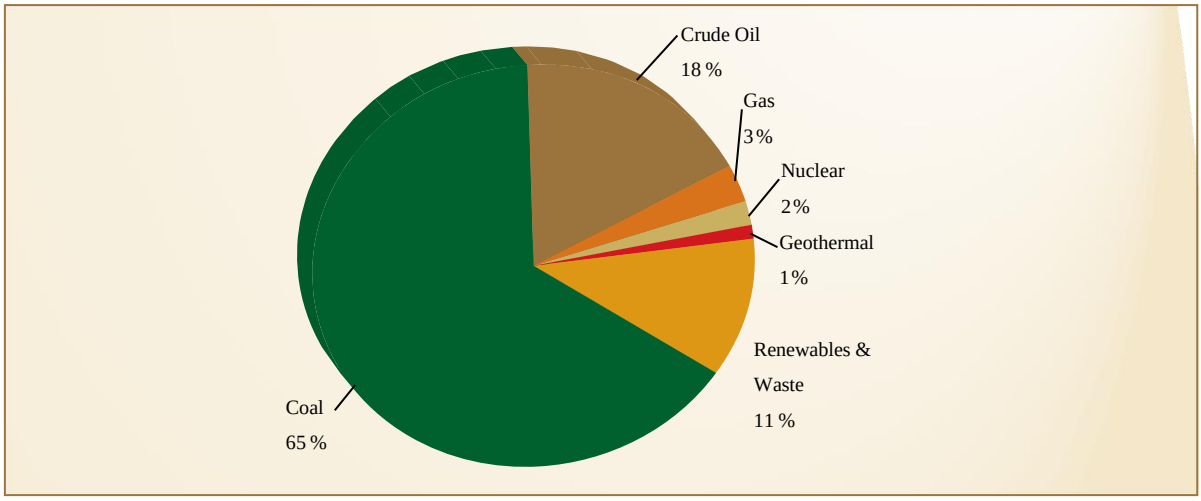
The Framework Agreement for a Social Compact on Supporting Eskom for Inclusive Economic Growth is also a critical component for ensuring security of energy supply as well as the operational and financial stabilisation of Eskom (NEDLAC, 2021). The social compact sets out steps that each social partner will take to stabilise Eskom to result in efficient, reliable, and affordable supply of energy, which will enable sustainable job creation and inclusive economic growth. It includes the social partners working together to identify and support innovative and reasonable funding mechanisms that aim to reduce Eskom's debt, access fresh capital where required and preserve the integrity of the financial system.

At the end of 2019, social partners at NEDLAC started negotiating the social compact, recognizing that the resolution of the energy challenges was instrumental in ensuring the economic recovery of the country (NEDLAC, 2021). On 08 December 2020, The Minister of Public Enterprises Pravin Gordhan, signed on behalf of GoSA, the Framework Agreement for the Social Compact on supporting Eskom for Inclusive Economic Growth (NEDLAC, 2021).

South Africa's Energy Supply

Eskom, the primary electricity supplier, generates approximately 90% of the nation's electricity (DOE, 2019c). Their electricity generation is dominated by coal-fired power stations which constituted 65% of the primary energy supply in 2018, followed by crude oil with 18% and renewables with 11%. Additionally, natural gas contributed 3% while nuclear contributed 2% to the total primary supply (Figure 1) (DOE, 2019c).

Figure 1: Total primary energy supply (Source: DoE Energy Balances, 2018)



SA has recently made progress in its energy mix and environmental sustainability. On 26 March 2009, NERSA approved the country's first renewable energy feed-in tariff (REFIT) scheme (IEA, 2013). The REFIT places an obligation on Eskom to purchase the output from qualifying renewable energy generators at predetermined prices based on the levelized cost of electricity (IEA, 2013). Eskom's Single Buyer Office has been appointed as the Renewable Energy Purchasing Agency (REPA) and is obliged to purchase power from licensed renewable energy generators (IEA, 2013).

In 2011, the DOE revised its renewable energy strategy, switching from the REFIT remuneration system to a procurement process based on price competition. the introduction of the REIPPP (IEA, 2013) was aimed at bringing additional megawatts onto the country's electricity system through private sector investment in wind, biomass and small hydro, among others (IEA, 2013).

Instead of enacting a downward adjustment of the 2009 tariff schemes as scheduled for June 2011, NERSA validated the change to a competitive bidding process (IEA, 2013). From July 2011, 1 000 MW of new renewable energy generation capacity from onshore wind, solar thermal, solar PV, biomass, biogas, landfill gas, or small hydro have been issued for tender. Since the tender process will go on without predetermined reference tariffs, the 2009 REFIT levels will be maintained, acting as a ceiling price against which potential developers and investors could tender (IEA, 2013).

The implementation of the procurement programme for renewable energy (REIPPP) will enable the private sector to generate electricity, contributing both financial and technical capacity to the country’s energy needs. In June 2018, the REIPPP for utility-scale transactions signed 27 power purchase agreements (DOE, 2018b). While coal may be the dominant source now, its share of total capacity is likely to decrease as more renewable generation comes online in the coming years.

In 2019, SA commissioned renewable energy power plants that have contributed to a decrease in the frequency of load-shedding (DOE, 2019c) which include Biotherm Energy developed Aggeneys Solar - 40 MW solar PV power plant in partnership with Power Africa (US Agency for International Development) (USAID, 2019). Power Africa provided financial and legal advisory support to the SA’s Independent Power Producer Office (IPPO) related to the project guarantee as well as potential funding options (USAID, 2019).

In the same year, the Kathu Solar Park was operationalized (USAID, 2019). The 100 MW greenfield Concentrated Solar Power (CSP) project with parabolic technology produces power through a molten salt storage system that allows 4.5 hours of thermal energy storage (USAID, 2019). The CSP park is situated in the Northern Cape and the shareholders consist of Engie a partner of Power Africa, the Government

Employees Pension Fund (PIC), SIOC Community Development Trust, Development Bank of Southern Africa Limited, Investec Bank Limited, Lereko Metier and the Kathu Trust (KathuSolarPark, 2019).

In 2020, BioTherm Energy operationally launched the Excelsior Wind farm, a 31.9 MW wind plant in the Western Cape, as a part of the GoSA's Renewable Energy Independent Power Producer Procurement Programme (REIPP) (USAID, 2019). In 2021, the Garob wind farm situated in the Northern Cape was successfully commissioned (USAID, 2019; Enel Green Power, 2021). The 135.9 MW wind project was financed partly by Nedbank, a partner of Power Africa (USAID, 2019).

However, the utility is still instituting daily rolling blackouts (load-shedding) across the country as a last resort to protect the power system from total collapse (Gosai, 2019). In the case that Eskom struggles to generate enough capacity to keep the lights on countrywide, the utility rations the country by 1000 MW of power per hour in stages to avoid a total countrywide blackout (Eskom, 2019c). Therefore, load-shedding is scheduled to be implemented in the following stages (Eskom, 2019c):

- Stage 1: allows for up to 1 000 MW of the national load to be shed.
- Stage 2: allows for up to 2 000 MW of the national load to be shed.
- Stage 3: allows for up to 3 000 MW of the national load to be shed.
- Stage 4: allows for up to 4 000 MW of the national load to be shed.
- Stages 5: allows for up to 5 000 MW of the national load to be shed.
- Stage 6: allows for up to 5 000 MW of the national load to be shed.
- Stage 7: allows for up to 7 000 MW of the national load to be shed.
- Stage 8: allows for up to 8 000 MW of the national load to be shed.

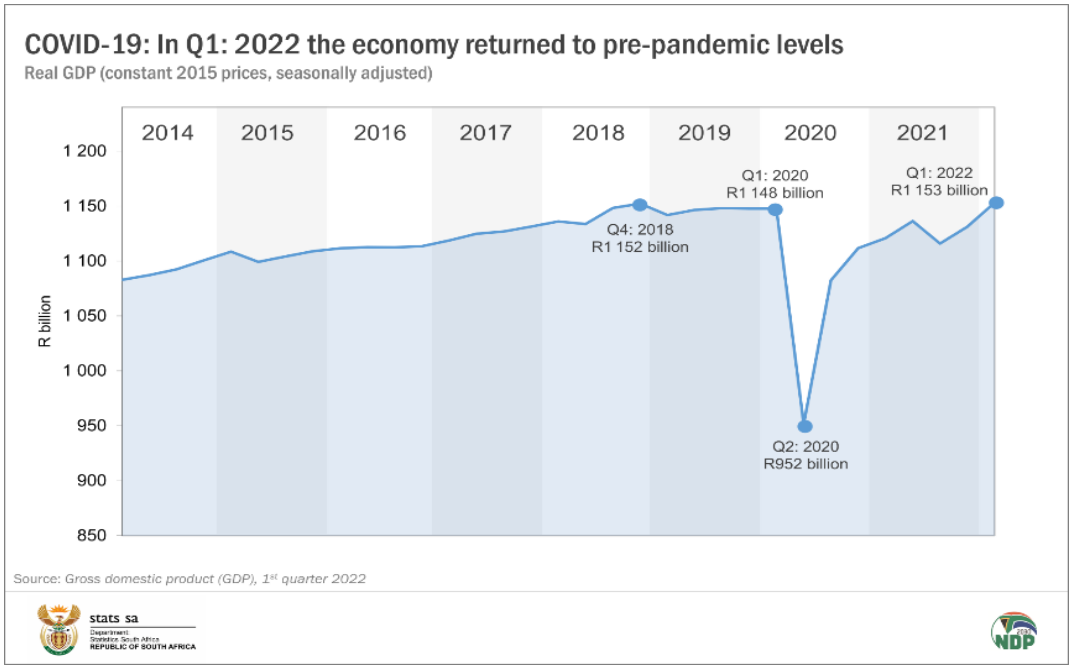
The resurgence of extensive load-shedding in the second half of 2019 contributed to the economy's technical recession, as the mining and manufacturing sectors were negatively affected by Eskom's energy supply disruptions, compounded by weak private investment and rising government debt (WB, 2020b; IMF, 2020). In 2020, 2021 and 2022, load-shedding continues to affect SA's economy.

In the first quarter of 2020, the South African economy recorded its third consecutive quarter of economic decline, plummeting by 2%. This was before the impact of COVID-19 and followed contractions of -1,4% and -0,8% in the third and fourth quarters of 2019 (StatsSA, 2020a). SA's economy suffered further contractions between April and June 2020 when the country operated under widespread lockdown restrictions aimed at containing the spread of COVID-19 (StatsSA, 2020c). The COVID-19 pandemic impacts on unemployment and poverty were devastating, which resulted in increased poverty, inequality and social instability (Francis et al., 2020).

In the fourth quarter of 2021, the South African economy recorded growth, as the real gross domestic product (GDP), grew by 1,2%, with personal services, trade, manufacturing and agriculture being the key drivers of growth as a result of a decline in global and local COVID-19 restrictions (StatsSA, 2021a).

As displayed in Figure 2, the South African economy expanded by 1,9% in the first quarter of 2022, representing a second consecutive quarter of upward growth due to higher commodity prices of exports (StatsSA, 2022b). The size of the economy is now at pre-pandemic levels with the real GDP slightly higher than what it was before the COVID-19 pandemic, however, unreliable electricity supply remains a serious constraint on this much needed domestic growth (StatsSA, 2022b). A severe decline in electricity supply can result in a significant reduction in economic activity.

Figure 2: SA GDP returns to pre-pandemic levels



Reliable electricity supply is a positive contributor to investment growth and productivity in the economy, the frequent disruption of electricity distribution discourages investment and weakens productivity. In 2021, the rolling power cuts across the country negatively impacted SA's economic recovery prospects and job creation (Engineering News, 2021).

SA's total domestic electricity generation capacity is 58095 MW (USAID, 2021). In 2022, Eskom predicted between 37 to 101 days of load-shedding heading into the winter season (Polity, 2022). According to Eskom, it must contain unplanned breakdowns of below 13 000 MW for summer 2022 to avoid load-shedding entirely (Eskom, 2022i). Planned maintenance has taken out not more than 4 000 MW of capacity (Eskom, 2022a). However, unplanned losses above 15 600 MW have led to the implementation of load-shedding to manage demand and to avoid a total blackout in the year 2022.

SA's electricity infrastructure capacity has been degrading for the past 10 years, with both scheduled and unscheduled power cuts on the increase due to lack of investment in electricity infrastructure (Khonjelwayo and Nthakheni, 2020). The unsatisfactory performance of Eskom Generation is caused by a faster deterioration in generation units that have not yet enjoyed reliable maintenance (Eskom, 2021c). The concerns

of the generation performance have persisted, that in January 2022, Unit 2 of the Koeberg Nuclear Power Station was shut off for the steam generator replacement (SGR), regular refuelling and maintenance (Eskom, 2022a). The SGR will enable the extension of Koeberg power station life span to operate for a further 20 years beyond 2024 (Eskom, 2022a). Koeberg was expected to return to service by the end of June 2022, to boost Eskom's efforts to reduce load-shedding and to further meet the high winter demand. However, the SGR on this unit has been postponed for the outage next year (Eskom, 2022a).

IPP-owned renewable energy generation has gained traction and has provided available capacity to the power grid, although this progress has not been easy. The National Union of Mineworkers (NUM), the National Union of Metalworkers of South Africa (NUMSA) and the union Solidarity, which represents about 85% of the Eskom workforce, have all opposed Eskom's plans to bring on board IPPs to supply renewable energy to the grid (M&G, 2019). NUMSA has consistently stated that the main causes of the crisis are: 1) IPPs; 2) Inflated Coal Costs; 3) A bloated top executive structure; and 4) Tender corruption and cost overruns at Medupi and Kusile power stations. The Eskom Board, the Minister of Public Enterprises and the Minister of Energy are yet to respond to these accusations (NUMSA, 2019a).

Both NUM and NUMSA have stated that they will protest the privatisation of energy in SA through IPPs. In December 2019, the two labour unions vowed to unite against the move towards privatising Eskom (SABC, 2019). They claim that the resumption of load-shedding is an intentional effort to sabotage Eskom (SABC, 2019) and that alternative employment opportunities from private renewable energy production might not arise. The NUM berated the senior managers represented by Solidarity for their demand of a 4.7% salary hike in 2019. NUM expressed that Eskom had already bloated the management wage bill which would add to the power utility's financial woes (M&G 2019).

In March 2020, the Congress of South African Trade Unions (COSATU) had proposed the use of government employees' retirement funds to reduce Eskom's debt, to safeguard jobs at the power utility and to prevent Eskom from being privatised (Business Day, 2020). The unions representing Eskom staff believe that the power utility is buying expensive power from IPPs only to sell to consumers at a loss and are

therefore demanding for labour to be involved in decision-making processes within the power utility (IndustriALL, 2020).

With reference to wage increases, labour unions NUMSA and NUM rejected Eskom's 1.5% wage increase for its workers in early 2021 (EWN, 2021). They demanded a 15% salary increase, while the union Solidarity wants a 9.5% wage increase (EWN, 2021). Eskom has been in wage increase negotiations with the three labour unions since May 2021. In June 2021, Eskom implemented a conditional 1.5% basic wage increase offer, and its decision was because its employees have additional benefits to take advantage of (EWN, 2021). Unions continue to blame the cost of IPPs for Eskom's shortfall and threatened industrial action (Financial Mail, 2021).

The KI 1 stressed that unions mandated by their members to revise the offer and to continue to mobilize for legal pickets and memorandums' handover in all workplaces. The unions risked defying the law and called on Public Enterprises Minister Pravin Gordhan, shareholder representative of government for Eskom and Deputy President David Mabuza, chair of the Political Task Team on Eskom, to intervene (Financial Mail, 2021). Unions first negotiated with Eskom's management and then in last round of talks, Minister Gordhan stepped in after Eskom's initial position was a wage freeze, but it was resolved that labour will receive 7% wage increase pending approval from NT in 2022, further denting Eskom's financial position (Financial Mail, 2021).

Unfortunately, the power utility has been plagued by mismanagement and maladministration over the years, which has contributed to its serious financial woes (Eskom, 2018). Eskom's financial challenges have further been aggravated by many South Africans refusing or unable to pay for their electricity usage. Municipalities often have outstanding payments, and some individual consumers steal electricity through illegal connections. Ioannis Kessides (2020: 4) articulates these problems faced by Eskom by highlighting that "in recent years, there has also been an alarming deterioration in the condition of SA's municipal distribution assets. High levels of non-payment for electricity, the municipalities' traditional dependence on electricity revenue to fund other public services, and a lack of appropriate technical resources and governance failure at the municipal level have been important contributing factors".

Meanwhile, to ensure continuous supply of electricity, Eskom warned the public against infrastructure and electricity theft, that includes illegal electricity connections (Eskom, 2021a), as they are also identified as the leading cause of unplanned power outages due to the network overloads and trips. Moreover, consumers who are not paying for electricity tend to be wasteful in their usage (ESI Africa, 2018).

Eskom has embarked on a strong communications drive to educate the public about illegal connections and other issues impacting the national power grid, such as infrastructure theft, bypassing and meter tampering. Despite Eskom's education through Operation Khanyisa - a national campaign aimed at promoting the legal, safe and efficient use of electricity have been implemented over the years - illegal connections and unlawful entry to electrical installations still occur (ESI Africa, 2016.). Eskom has taken the position that it will only restore supply to legal and paying customers, on condition that each community allows safe access to Eskom staff to conduct audits and remove illegal connections (Eskom, 2019b). According to Eskom, in some areas, technicians have not been allowed to conduct these audits which result in repeated failures of equipment, making power restoration a wasteful exercise (Eskom, 2019b).

Eskom has recorded an exponentially high number of failed mini-substations due to the network overloading caused by illegal connections, meter bypasses and tampering, unauthorised operations on the electricity network, vandalism, and theft of electrical equipment (Eskom, 2021a). Eskom is faced with high demands for equipment that require repairs or replacement, making it difficult to meet the country's Electricity demand. This further includes assessing the severity of the damage on the network, removing illegal connections, disconnecting and issuing fines to customers with contraventions. One can deduce that the country is still expected to experience hours of planned or unplanned power cuts in 2023.

Energy and poverty

Energy poverty is commonly referred to as "a lack of access to adequate, reliable, affordable and clean energy carriers and technologies for meeting energy service needs for cooking and those activities enabled by electricity to support economic and human development" (Pauchari and Rao, 2013: 205). Energy poverty has serious

public health implications related to indoor air pollution, physical injury during fuelwood collection and lack of refrigeration (Sovacool, 2012). Energy poverty is usually defined as a lack of access to electricity and dependence of the household energy needs on burning wood and waste in an inefficient and pollutant manner (Akbari et al, 2022).

The unemployment rate among the black African population group is at 38.2% and remains higher than the national average and in comparison to other population groups (Stats SA, 2021). Furthermore, the impact of Covid-19, load-shedding and the underperformance of the economy on employment, has led to the unemployment rate climbing to a record 34.5%, from 28.9% in 2019 (StatsSA, 2022b). Youth unemployment has reached an all-time high at 63,9% for those aged 15-24 and 42,1% for those aged 25-34 (StatsSA, 2022b). Poverty is consistently soaring, especially among black South Africans, the less educated, the unemployed, female-headed households, large families, as well as children (Stats SA, 2020). Moreover, the number of unemployed persons increased by 278 000 to 7,9 million in the fourth quarter of 2021 (Stats SA, 2022c).

As the number of low-income households increases, it is likely that further energy poverty will arise as such households will no longer be able to afford electricity. That lack of or limited access to modern energy results in the use of fuels such as wood, coal, candles and paraffin, all of which pose severe health and safety risks (SEA, 2017a). Furthermore, energy poverty affects economic activity of adults and the educational opportunities available for children (Sovacool, 2012).

Energy poverty can also be understood in terms of dwelling types, as follows (SEA, 2017a):

1. Formalised low-cost housing – energy poverty is a result of unaffordability, yet it further includes times when grid quality is low because of an over-burdened system, which is due to illegal connections.
2. Backyard dwellings – these are informal dwellings located in the backyards of formal properties. Backyard dwellers typically rely on their landlords, who tend to resell electricity illegally, usually at exorbitant prices, making it unaffordable. Furthermore, backyard-dwellers are unable to access the pro-poor subsidies such as the Free Basic Electricity (FBE) subsidy, and subsidised tariffs.

3. Informal dwellings – typically do not have access to electricity unless they connect illegally.

The GoSA has acted with intent since the end of apartheid in 1994, to electrify all South African households, to ensure that everyone's basic energy needs are met, and to further ensure economic growth and social development in the country under the Government's Reconstruction and Development Programme (RDP) initiative (SEA, 2017; DOE, 2011b). At the beginning of the 1990s, only about one-third of all households were connected to the electricity grid (DOE, 2011b). The first democratically elected government then implemented the National Electrification Programme that connected more than 3,4 million new households between 1994 and 2001 (Winkler et al., 2011). In 2003, the government in conjunction with Eskom and municipalities, launched Free Basic Electricity (FBE) to support indigent households with the allocation of 50 kWh of free electricity per household per month to help meet their basic energy household needs (Eskom, 2016).

In 2007, the government recognised that FBE and electrification will not reach all households timeously and introduced the Free Basic Alternative Energy (FBAE) policy in 2007 to support indigent households, by providing them with the equivalent of R56,29 per month of alternative energy sources, such as paraffin and Liquefied Petroleum Gas (LPG) (SALGA, 2014). However, there are significant challenges for municipalities to roll out FBAE as it is very difficult to administer and monitor, although a small number of households do receive it (SALGA, 2014).

Over 86 500 indigent households (2,5% of the 3,5 million indigent households nation-wide) benefit from free paraffin in 20 municipalities. These municipalities are clustered within the Eastern Cape and Northern Cape, with two municipalities in the North West province (StatsSA, 2018). Seven municipalities provide candles as an off-grid source to almost 13 700 indigent households, comprising 0,4% of indigent households nation-wide (Stats SA, 2018a). Fire gel is used as a source of free off-grid energy in 10 municipalities in the Eastern Cape and KwaZulu-Natal, benefitting just over 19 600 households (0,6% of all indigent households (StatsSA, 2018). According to StatsSA (2018a), there were 22 municipalities providing free solar electricity systems. About 113 200 households (3,2% of the 3,5 million indigent households nation-wide) benefitted from this service.

Maintaining access to electricity and subsidising the poor was a challenging task for local authorities, as municipalities were not adequately run to generate revenue to finance the subsidy and maintain electrical infrastructure (PMG, 2012). Furthermore, from 2012, Eskom's energy supply capacity was tight, given that Eskom's generating capacity had not increased after the roll out of the electrification programme. Therefore, Eskom struggled to maintain a balance between supplying electricity and carrying out maintenance (PMG, 2012).

The South African Parliamentary committee on energy outlined the following implementation challenges associated with FBE (PMG, 2012):

- Inconsistency of application amongst municipalities and Eskom.
- The lack of local government capacity remained a big obstacle.
- Within municipalities, confusion seemed to exist as to whose responsibility it was to administer FBE.
- In some municipalities, there were no structures to roll out FBE.
- Communities were often unaware of the availability of FBE, due to local authorities and Eskom not providing sufficient information about the technologies. As such, there was inadequate communication and education on the technology as well as service options available for communities.

Due to weak economic activity, the unreliability of electricity supply and the inefficiency of the free electricity programme, mostly poor and low-income households increasingly make use of alternative energy sources to meet their energy and heating demands (Pretorius, Piketh & Burger, 2015). Domestic burning of wood, coal and paraffin is practiced by many South Africans living in informal settlements (Pretorius, Piketh & Burger, 2015).

In 2011, the number of households in informal settlements amounted to 1,25 million, of which 57% of these households did not have access to electricity (Pretorius, Piketh & Burger, 2015). Of the 43% of households that did have access to electricity, many households opted to still make use of domestic burning for their cooking and heating needs (Pretorius, Piketh & Burger, 2015: 7). This could be considered as an indication that the unreliability and high cost of electricity has propelled consumers to utilize alternative energy sources.

On the other hand, higher-income households are more fortunate to be able to make use of diesel-fuelled back-up generators and electricity-efficient technologies during load-shedding (Schoeman & Saunders, 2018). However, there is still large number of households that remain vulnerable to rising electricity tariffs, due to their limited ability to invest in technologies that significantly reduce the demand on the electricity grid (Goliger & Cassim, 2018). Higher-income households have invested in rooftop PV installations, solar geysers and gas appliances (Goliger and Cassim, 2018).

According to the UN National Voluntary Review Report of South Africa (2019: 13), the country is making significant strides towards the realisation of SDG 7, although there are challenges that still need to be addressed, such as the non-availability of data on the affordability of electricity. Moreover, the UN noted with concern the unaffordability of electricity for many South Africans, especially considering that not every household can have access to energy subsidies such as FBE and FBAE (UN, 2019: 61). Additionally, the poor uptake of off-grid solar systems is a concern, with less than 1% of the country's population utilising off-grid solar energy technologies to meet basic household needs from 2014 to 2017 (UN, 2019).

There have been efforts by the GoSA to alleviate these pressures on South Africans that have been struggling to afford electricity. At local government level for instance, the City of Johannesburg (CoJ) has urged those who can afford to pay for services should register for the city's Extended Social Package (ESP) (CoJ, 2020). According to the CoJ (2020), to qualify for the ESP package, individuals must be a South African citizen; reside within CoJ Boundaries; and have a monthly income between R0 and R6 086.37.

Moreover, the ESP targets vulnerable residents in the city such as: the unemployed, the youth, persons with disabilities, displaced persons, senior citizens, women and children. South African citizens will qualify for different levels of subsidy according to different levels of need, which are measured according to the city`s measure of poverty (CoJ, 2022). Individuals do not need to be account holders or homeowners to apply or qualify for the metered services. The benefits of the package include Water Subsidy and Electricity Subsidy (CoJ, 2020).

Due to infrastructural constraints, the CoJ has acknowledged that there are instances where the city might not be able to service all indigent households that have successfully registered because of technical errors and inadequate infrastructure (CoJ, 2020). In such cases, the city will strive to find alternative remedies to better the circumstances of the applicants, to give qualifying citizens in the city access to Free Basic Services (FBS) on their municipal services such as Rates, Refuse, Sewer, Water and Electricity (COJ, 2020). Furthermore, The CoJ and Eskom have signed an agreement ensuring that the electricity bought in bulk from Eskom allows the city's electricity distributor, City Power, distribution of electricity to the residents of Johannesburg that have not been compliant (Soweto, Alexander and Tembisa). The city has launched an energy mix Energy Sustainability Strategy for the municipality in a bid to accelerate security of reliable power supply for residents and businesses (CoJ, 2021b).

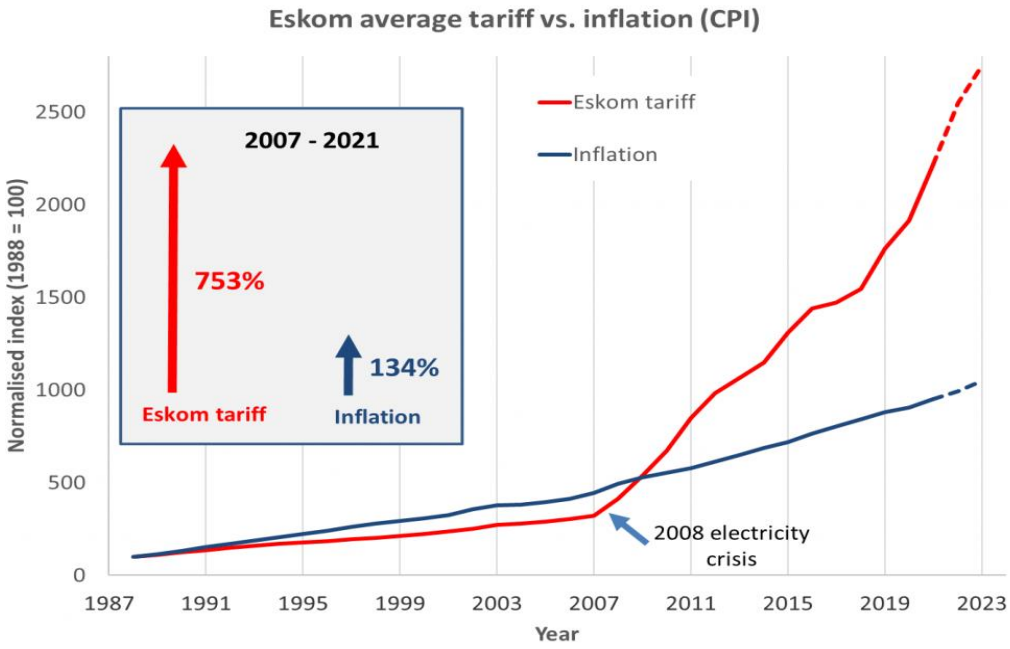
Citizens are required to pay for services rendered and the city is further working towards sourcing more energy to provide affordable electricity. The former CoJ's Executive mayor, Cllr Mpho Moerane, signed a new power purchase agreement with the privately-owned Kelvin Power Station on Friday, 08 October 2021 (CoJ, 2021a). The new agreement will see an additional power supply of 100 MW over and above the existing 80 MW to Johannesburg households and businesses, bringing the total to 180 MW. The CoJ aims to take over the supply of electricity from Eskom to supply Soweto, Diepsloot, Ivory Park, Orange Farm, Finetown and Sandton (CoJ, 2021b). Tackling energy poverty in SA is a complex issue and requires a range of solutions to meet the differing needs of those living in low-cost housing, backyard dwellings and informal settlements (SEA, 2017a). In the informal sector, where energy poverty is particularly prevalent, solutions beyond electrification are required. Due to the fast pace of urbanisation, the spur of informal households will ensure continued energy poverty if electrification is the only objective. While electrification has allowed low-income households access to electricity, the electrification programme itself has not alleviated energy poverty substantially in SA (SEA, 2017b).

Price of Electricity

The pricing of electricity in SA has dramatically outpaced inflation over the past decade (2007-2017). Figure 3 below depicts increases in Eskom tariffs from 1988 to 2021,

plotted against the CPI (Consumer Price Index) or inflation over the same period. It also shows projections up to 2023, based on expert forecasts and inflation projections (Moolman, 2021).

Figure 3: Eskom tariff increases vs inflation since 1988 (with projections to 2023) (Source: Moolman – Power Optimal, 2021)



Note: The graph depicts overall average increases – actual increases will be different according to the types of consumers (residential, commercial and industrial) and will vary between municipalities.

Looking at the graph above (Figure 3), there is a clear and sharp inflation point for electricity tariffs in SA. After closely tracking and staying below inflation rates from 2007 to 2021, electricity tariffs increased by 753%, while inflation over this period was 134%. Thus, electricity tariffs increased in real terms more than five-fold in 14 years (Moolman, 2021). It is likely that South African consumers can expect a continuance of much higher than inflation electricity price increases over the next two years, which is a serious problem given the high levels of inequality and poverty in the country.

Eskom has implemented the Multi-Year Price Determination (MYPD) methodology that entails applying to the National Energy Regulator of South Africa (NERSA) for approval of a tariff rate, which will create cost-reflective revenue to cover efficient and prudent costs, as well as a return on assets corresponding to the weighted average cost of capital (NERSA, 2021a). A cost-reflective tariff allows Eskom to recover its

efficient and prudently incurred costs and to earn a reasonable return (NERSA, 2021a). The mandate of NERSA is to regulate electricity, piped gas and petroleum industries and to collect levies from people and companies holding title to gas and petroleum (NERSA, 2021e). In performing its duties to review regulatory framework, set tariffs and evaluate Eskom's application, NERSA is guided by the Electricity Regulation Act, 2006 (Act No. 4 of 2006) (ERA, 2006).

According to the ERA (2006: 2), NERSA is the custodian and enforcer of the national electricity regulatory framework; and regulates through licensing and registration for generation, transmission, distribution, trading and the import and export of electricity. Furthermore, NERSA's (2021e) regulatory framework requires the achievement of several objectives, which include:

- safeguarding the needs of customers;
- achieving the efficient, effective and sustainable development of electricity supply infrastructure;
- facilitating investment;
- promoting universal access;
- promoting competitiveness, customer and end user choice, and
- facilitating a fair balance between the interests of customers and end users, licensees, investors in the electricity supply industry and the public.

The MYPD methodology was developed for the regulation of Eskom's required revenues for business activities, namely generation, transmission and distribution. It forms the basis on which the Energy Regulator evaluates the price adjustment applications received from Eskom (NERSA, 2021d). The MYPD runs concurrently with Eskom's financial year(s) on a three-year price determination and submits its revenue (tariff determined) application to NERSA on an annual basis (Eskom, 2018). NERSA is required to ensure that the interests and needs of present and future electricity customers and end-users are safeguarded and met, having regard to the governance, efficiency, effectiveness and long-term sustainability of the electricity supply. The Regulator is also required to be fair and balanced in taking into consideration Eskom's applications for cost-of-service-based methodology (basically the calculation of tariffs), the interests of customers, end users, licensees, investors in the electricity supply industry and the public (NERSA, 2021d).

On 28 July 2020, Eskom won a court case against NERSA, allowing the power utility to recover historical losses or under-recoveries (SAFLII, 2020). In early 2020, NERSA had already approved Eskom's allowable revenue from standard tariff customers to be 8,76%, which was implemented on 1 April 2020 for Eskom's direct customers and 6,90% for municipalities, which was implemented on 1 July 2020 (Eskom, 2020). The recent court verdict will force NERSA to give Eskom the green light to add a sum of R23 billion allowable revenue collection for Eskom in respect of the 2022/23 and 2023/24 financial years over a 3-year period (SAFLII, 2020).

Undoubtedly, the hike in prices will have a huge negative impact predominately on households that will not be able to afford to pay for the services. Households are increasingly under strain due to electricity price increases, high inflation, high unemployment and eroded household disposable income (Goliger & Cassim, 2018). In the wake of the Covid-19 pandemic, the GoSA restricted most economic activity and regulated movement to protect South Africans and to prevent the public health system from collapsing, which further exacerbated the fragility of households (NT, 2020). These factors may cause households to default on electricity payments or to reduce electricity consumption and to further reduce other expenditure (Goliger & Cassim, 2018).

The overall industrial sector accounts for more than 41% of electricity demand (DOE, 2019c). Small and medium businesses that rely on the national grid and cannot afford to generate electricity privately have less customers and consequently make less income due to power outages. To cope with the impact of power outages, businesses must mobilise resources to have backup power available such as diesel/petrol generators, adding to the operational costs of the business (Akpeji et al., 2020; Schoeman and Saunders, 2018).

SA's mining and manufacturing sectors that are heavily energy-intensive have their productivity is limited by rising electricity prices and supply interruptions (Montmasson-Clair & Ryan, 2014). Disruptions to mining operations caused by higher and frequent electricity load-shedding stages will have an increasingly severe impact on mining production over the coming years (Davids, 2021). When load-shedding occurs, miners cannot go underground and operations cease, causing major supply disruptions

(Davids, 2021). The unreliability of electric power in SA remains a high risk for the mining sector.

Smelters and refineries take hours to restart after a break in power supply, outages in traffic management systems and traffic lights cause considerable congestion and a drop-in productivity and supply (van der Nest, 2015). Public offices reliant on internet services and technology have no option but to cease operations. Hospitals have come under increased pressure and governments administration services such as home affairs, simply close because of load-shedding (van der Nest, 2015).

Businesses in the CoJ have indicated that they have less customers and that they make less income during days with power outages (Schoeman & Saunders, 2018). On the other hand, restaurants experience increases in income in periods of power outages than on usual days as more people eat out or purchase take-aways during power outages. (Schoeman & Saunders, 2018).

Therefore, coping with power outages adds to the cost of running a business. In shopping centres that provide back-up power measures, small businesses' monthly rent and levies increase for this service (Schoeman & Saunders, 2018). If such a service is not provided, the business will be responsible to invest in a back-up power source thus spending more money on running and maintaining such back-up power generation (Schoeman & Saunders, 2018). Further indirect costs to a business may result from equipment damage due to power surges and stock may require replacement (Schoeman & Saunders, 2018).

Unfortunately, Eskom requires financial resources to fully comply with existing legislation on emissions (Reuters, 2019). Emissions from large power stations have increased due to lessened maintenance and deterioration of the stations (Pretorius, Piketh, & Burger, 2015). Both Medupi and Kusile have failed to resolve the energy shortage and have experienced project delays as well as cost overruns that have left Eskom reliant on a three-year, R128 billion government bailout to remain solvent, which has caused severe damage to economic activity, energy reliability and a lack of compliance with the country's prescribed SO2 limits (Watermeyer & Phillips, 2020). The cost of negative health effects and environmental impacts of coal-fired power generation to society should be considered as well.

A revised estimate of the levelized cost of electricity (LCOE) of Medupi and Kusile's coal-fired power plants is long overdue and is particularly relevant now, considering the massive increase in the estimated costs (Yelland, 2016). The levelized cost of electricity (LCOE) from a generation plant is the net present-day monetary cost per present day kWh unit of electricity delivered which, when adjusted for inflation each year over the lifetime of the plant, will recover its full costs including the initial investment, cost of capital (including dividends and interest), fuel and all other fixed and variable operating and maintenance costs (Yelland, 2021).

Eskom and the Special Investigating Unit (SIU) are reviewing contractual claims and potential overpayments to several contractors involved in the construction of Medupi and Kusile Power Stations, particularly where it is suspected that there may have been collusion between Eskom employees and contractors (Eskom, 2021c).

The major defects at both Medupi and Kusile are (Eskom, 2021c):

- Pulse jet fabric filter plant (PJFF) poor performance due to inadequate pulsing system and flue gas flow entry,
- Gas air heater mechanical performance, erosion and operational performance in terms of ash carry over and outlet temperature stratification,
- Furnace exit gas temperature resulting in excessive reheater spray water flow,
- Milling plant defects,
- Air and flue gas ducting erosion.

According to Eskom's Annual Integrated Report (2021: 91), in April 2019, the total cost for fixing the major plant defects at Medupi and Kusile will range between R5,6 billion and R7,2 billion. The forecast for the completion of the major defects' correction of the Medupi and Kusile units with the contractor is 2023 (Eskom, 2021c). The Medupi coal-powered station was supposed to be commercially operational by July 2021 and Kusile is expected to be commercially operational in May 2024. However, the completion dates of the Medupi and Kusile projects were revised by the Board and their new completion dates are now in the 2022 and 2025 financial years respectively (Eskom, 2021c).

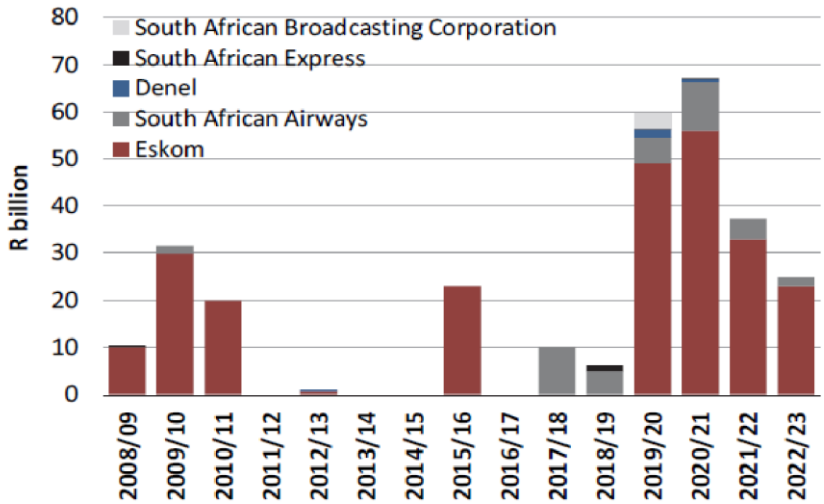
According to the National Treasury (NT) of South Africa (2019: 1), Eskom remains a major risk to the economy and to public finances. The GoSA allocated R49 billion of fiscal support to Eskom for the financial year 2019/20 and has committed R112 billion in the medium-term (NT, 2019) as displayed in Figure 4. Due to many years of massive failure of strategic and financial management, the utility is burdened with huge debt (Semple, 2020). NT has acknowledged that Eskom is plagued by operational inefficiencies, has suffered cash losses from municipalities and other entities that have not yet paid their bills, and has received tariff determinations from NERSA that do not allow the power utility to recover its costs (NT, 2019: 62).

Figure 4: Summary of Recapitalization and bailouts to State Owned entities (Source: National Treasury, 2020 Budget Review)

R billion	Eskom	South African Airways	Denel	South African Express	South African Broadcasting Corporation	Total
2008/09	10.0	–	–	0.4	–	10.4
2009/10	30.0	1.5	–	–	–	31.5
2010/11	20.0	–	–	–	–	20.0
2011/12	–	–	–	–	–	–
2012/13	0.7	–	0.4	–	–	1.1
2013/14	–	–	–	–	–	–
2014/15	–	–	–	–	–	–
2015/16	23.0	–	–	–	–	23.0
2016/17	–	–	–	–	–	–
2017/18	–	10.0	–	–	–	10.0
2018/19	–	5.0	–	1.2	–	6.2
2019/20	49.0	5.5	1.8	0.3	3.2	59.8
2008/09-2019/20 (history)	**132.7**	**22.0**	**2.2**	**1.9**	**3.2**	**162.0**
2020/21	56.0	10.3	0.6	0.2	–	67.1
2021/22	33.0	4.3	–	–	–	37.3
2022/23	23.0	1.8	–	–	–	24.8
2020/21-2022/23 (MTEF)	**112.0**	**16.4**	**0.6**	**0.2**	**–**	**129.2**
Total	**244.7**	**38.4**	**2.8**	**2.1**	**3.2**	**291.2**

Electricity shortages have put the economy under great strain and demands from Eskom and other financially distressed state-owned companies are draining public resources. Over the past 12 years, the government has allocated R162 billion to the financially distressed state-owned companies shown in Figure 5 below, and of the total allocations, Eskom accounts for 82% of NT's bailouts for SOEs (NT, 2020).

Figure 5: Financial support provided for state-owned companies (Source: National Treasury, 2020 Budget Review)



South Africa Climate change obligations

Regarding environmental obligations in the energy sector, SA is a signatory of the Paris Agreement on Climate Change and has ratified the agreement (DEA, 2019). Additionally, SA has adopted the 2030 Agenda for Sustainable Development as a UN member in 2015 (UNDP, 2015). Such efforts underpin SA's commitment to address universal challenges that require prioritising job creation, the elimination of poverty, the reduction of inequality and in growing an inclusive economy (VNR, 2019).

Furthermore, under the Paris Agreement, all countries are required to submit their Nationally Determined Contributions (NDCs) every five years. This is a commitment in terms of the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement to contribute to the global climate change effort (DEFF, 2021).

The NDCs are at the centre of the Paris Agreement and the achievement of these long-term goals such as SDGs. NDCs exemplify efforts by each country to reduce national emissions and adapt to the impacts of climate change (UNFCCC, 2021). The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive NDCs that it intends to achieve, and Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions (UNFCCC, 2021).

Initially, SA deposited its first NDC with the UNFCCC in October 2015, committing to keeping national GHG emissions within a range from 389 Mt CO2-eq (Million Tonnes of carbon dioxide equivalent) for 2025 and 2050 (DEFF, 2021). The 2030 target range (398 - 440 Mt CO2-eq) is consistent with SA's fair share of omitting GHG emissions (DEFF, 2021).

SA's second NDC was published for comment on 30 March 2021 by the DEFF. A consultation process consisting of a number of virtual consultations with national and provincial environmental partners were held until the end of May 2021, and written inputs were requested to be submitted to the DEFF by 30 April 2021 (DEFF, 2021). The second NDC will be communicated to the UNFCCC in 2025 (DEFF, 2021) and the second draft NDC update is a proposed improvement on the current NDC of SA. According to DEFF (2021), SA's next NDC seeks to balance the three structural components of mitigation, adaptation and means of implementation/support requirements, and to further provide opportunities for accessing large-scale international climate finance to fund low carbon infrastructure, and to fund energy mix transition.

Various clean energy initiatives have been launched. For instance, in 2010, the GoSA introduced solar water heating (SWH) geysers as a possible affordable energy alternative technology in the Sol Plaatje and Naledi municipalities (Özdemir et al., 2012), as solar geysers have favourable effects on both the environment and household costs (Özdemir et al., 2012). It is estimated that households spend an average of 40% of their electricity on domestic water heating alone in SA (Eskom, 2011). Therefore, SHW systems enable households to reduce the amount of electrical energy used for water heating (Eskom, 2011).

On 29 November 2019, Eskom applied to the Department of Environment, Forestry and Fisheries (DEFF) for suspension and alternative limits of the Minimum Emissions Standards (MES) for Acacia and Port Rex Peaking gas power stations, as well as Grootvlei, Matimba and Medupi coal-fired power stations (Eskom, 2019a). According to the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), all of Eskom's coal and liquid fuel-fired power stations are required to meet the Minimum Emission Standards (MES), which have been implemented for the

prevention of pollution and further set standards for the regulation of air quality in the country (NEMA, 2004).

The above-mentioned regulations allow for a once-off postponement with the compliance of minimum emissions for a new plant for five years from the date of issue, noting that no once-off postponement will be valid beyond 31 March 2025; a once-off suspension for plants being decommissioned by 31 March 2030; and that the National Air Quality Officer may grant an alternate emission limit or emission load if certain conditions are met (Eskom, 2019a). The reduction of emissions by abatement technologies like flue-gas desulfurization (FGD) has decreased due to the increased pressure on the power grid and missed opportunity for maintenance (Pretorius, Piketh and Burger, 2015).

Coal-fired power plants are among the largest sources of pollutant emissions in SA (Belelie et al., 2019). Three of the most dangerous pollutants emitted from power plants are Sulphur Dioxide (SO2), nitrogen oxides (NOx), and mercury (Greenpeace, 2019). As such, these emissions cause reduced visibility, acidification of lakes and streams, degradation of forest ecosystems and an increase in risk of respiratory infections and heart disease for citizens living near the power plants (Greenpeace, 2019). Therefore, failure to comply with legislated emission standards has a very significant impact on the quality of air and health. Consequently, more than 2 200 people die of a lower respiratory tract and illnesses such as pneumonia, cancer, strokes and heart disease every year in SA (Environmental Justice Atlas, 2019). These are some of the noticeable social costs to Eskom's proposed non-compliance with SA's air emission standards.

According to Environmental Justice Atlas (2019), medical facilitates in Emalahleni, Mpumalanga, are overcrowded with mostly ill mothers and children plagued by coal pollution exposure symptoms such as burning eyes, inflamed sinuses, constant headaches, chronic lung diseases, diabetes, birth defects and premature deaths. They blame this on the proximity to the Kusile power plant that is only 40 kilometres away from Emalahleni (Environmental Justice Atlas, 2020). The GoSA promotes implementation of abatement technologies for power facilities to be more environmentally friendly, as compliance to minimize emissions is crucial for SA to uphold its international commitments. Unfortunately, Eskom is struggling to meet

these standards and further struggles to implement effective abatement technologies, such as FGD for power plants.

Coal-fired power stations are responsible for the release of the large quantities of SO2 emissions into the atmosphere that lead to detrimental health and welfare effects in communities within the proximity of coal-fired power generation plants (Strickroth et al., 2020). The SO2 abatement solution for the coal-fired power generation industry is wet flue gas desulphurization, which uses a limestone adsorbent and produces a gypsum by-product (WFGD L/G) to reduce SO2 emissions (Strickroth et al., 2020).

Medupi is a greenfield coal-fired power station that is currently being prioritized to be retrofitted with FGD technology, to reduce sulphur dioxide (SO2) emissions to meet the energy needs of SA in an environmentally sustainable manner (AfDB, 2018). According to Eskom (2021: 92), the newer stations namely Matimba, Kendal, Medupi and Kusile, are being commissioned with fabric filter plants to reduce particulates, as well as low NOx technology to reduce NOx emissions. Kusile is still in preparation to be commissioned with FGD technology to reduce SO2 and Medupi will be retrofitted with FGD technology (Eskom, 2021c).

Conclusion

The South Africa 2019 Voluntary National Review (VNR, 2019) report produced by the Presidency, articulates that the key challenges that are creating barriers to clean renewable energy in the country are the lack of capacity (skills), the marginalisation of renewable energy uptake due to the mineral-energy industrial complex as coal is by far the major energy source, corruption, environmental degradation, poor functioning energy innovation system, and the high cost of renewable energy technologies. As such, SA's attempt to transition to a low carbon economy remains a major challenge while a high degree of dependence on fossil fuels prevails (UN, 2019).

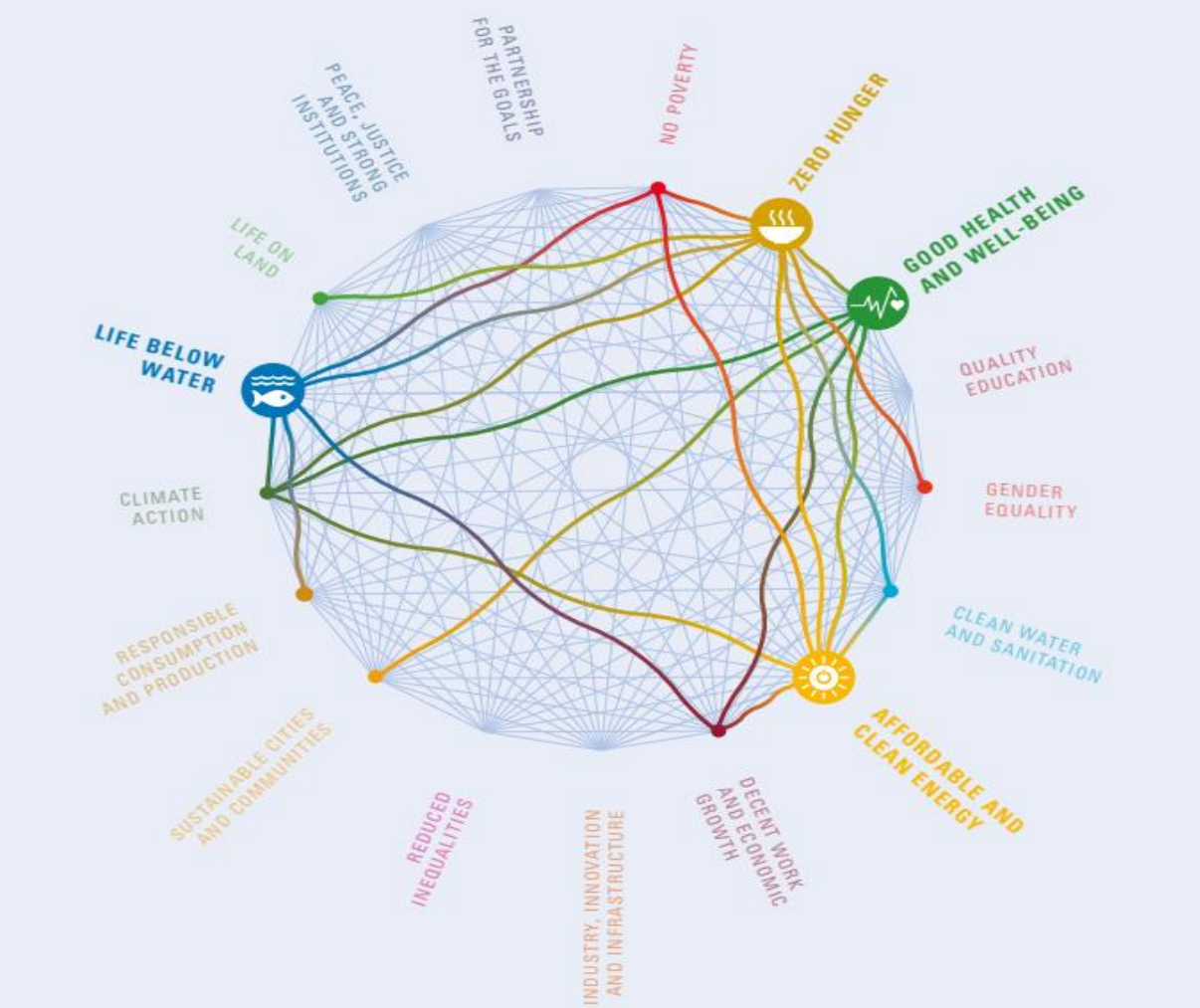
The current debates and challenges surrounding electricity in SA have created the need and the opportunity to discuss further affordable, decentralised and low-carbon energy options. Any reconfiguration of electricity supply faces significant political and economic challenges that are rooted in the country's socio-economic inequalities and its heavy dependence on coal-fired power. This complexity requires dialogue and

active citizen engagement to find solutions. SA’s energy sector is at the centre of the economic and social development. The energy sector directly affects the economy by using labour and capital to produce energy. This role is particularly important for economic growth and job creation, which are such high priorities in the country. The country continues to grapple with energy poverty, which is a challenge that is being further amplified by the decline in investment and lack of sufficient electricity generation infrastructure.

3. Conceptual Framework

The SDGs are an established knowledge-based decision support system for policymakers and other relevant stakeholders such as constructors, researchers, private investors, and asset managers (Omar & Noguchi, 2020). SDGs are a conceptual framework based on a systematic and comprehensive literature review, coupled with critical content analysis (Omar & Noguchi, 2020). The research and data provided and recorded provides building materials that can contribute significantly to the achievement of 13 goals and 25 targets of SDGs. This includes SDG 7, which aims to ensure access to affordable, reliable, sustainable, and modern energy for all. This is a core element of achieving the other SDGs, which have been agreed upon by almost all the nations in the world (UN, 2020), as it interlinks with economic growth, climate change mitigation and adaptation (Figure 6).

Figure 6: UN SDGs linkages (Source: Alan Attkisson - With the SDGs, everything is connected**)**



SDG 7 has set targets for what must be done to ensure the goal is achieved by 2030 (UN, 2016). One can see how these targets attempt to balance the tension between the need for accessible energy, environmental and other sustainability, and development considerations. These are the following targets that are most applicable to this research report:

- 7.1 By 2030 to ensure universal access to affordable, reliable, and modern energy Services.
- 7.2 By 2030 to increase substantially the share of renewable energy.
- 7.3 By 2030 to double the global rate of improvement in energy efficiency.
- 7.B by 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries.

The rationale for the established SDG methodology of the “Target” and “Indicator” is to provide clear and comparable evidence of progress (UN, 2016: 2). The targets are the metrics by which the world aims to track whether the goals are achieved

First, the global indicator SDG 7.1.1 focuses specifically on electricity access being available to the total population. The target has a range of social and economic impacts that include facilitating development of household-based income generating activities and lightening the burden of household tasks. The World Bank is the responsible agency (custodian agency) for compiling statistics on electricity access, harvested from the full global body of household surveys (UN, 2016).

Secondly, indicator 7.2.1 aims at a substantial increase in the share of renewable energy in the global energy mix by 2030. This indicator focuses on the amount of renewable energy consumed rather than the capacity for renewable energy production, which cannot always be fully utilized. By focusing on consumption of the end user, it avoids the distortions caused by the fact that conventional energy sources are subject to significant energy losses along the production chain (UN, 2016: 10). The SDG 7.2.1 indicator is used to report the tracking of the renewable energy target. The methodology applied is the share of renewable energy in total final energy consumption which is expressed as a percentage (UN, 2021). It is duly acknowledged that renewable energy includes hydro, solid and liquid biofuels, biogases, wind, solar, geothermal, tide/wave/oceans and renewable municipal waste. However, modern

renewable energy equates to the total renewable energy consumption minus the traditional use of biomass (UN, 2022).

Thirdly, indicator 7.3.1 looks at energy intensity measured in terms of the relationship between primary energy production and GDP. Energy intensity is an indication of how much energy is used to produce one unit of economic output, thus showing the efficiency with which, an economy can use energy to produce economic output (UN, 2016: 13). The SDG 7.3.1 indicator is used to report the tracking of the efficiency target. The methodology applied is the energy intensity of the economy, computed as a ratio between total energy supply (in MJ) and the GDP, measured at purchasing power parity at constant 2017 US dollars (UN, 2022). The UN noted that energy intensity is an imperfect proxy for energy efficiency. It can be affected by a few factors such as climate, the structure of the economy, the nature of economic activities, etc, which are in essence not essentially linked to pure efficiency improvements (UN, 2022).

Lastly, indicator 7.B looks at expanding energy services through private and foreign direct investments in financial transfer for infrastructure and technology to sustainable development services in developing countries, least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support (Ritchie et al., 2018).

SDG 7 is an innovative framework that this study uses as a proxy for assessing SA's current electricity sector in relation to access, affordability, renewable energy, and energy efficiency. This can be a tool to inform analysis of challenges and required improvements in electricity provision for social, environmental, and economic sustainability.

This study has utilized the SDG 7 targets and indicators to show how efficient, reliable, and affordable electricity can contribute to sustainable development, and will further report on the capacity of electricity supply, the quality of service, affordability, uptake of renewable energy and execution of energy efficiency. This paper uses quantitative and qualitative data to indicate and evaluate if SA is on track to achieve SDG 7, under target 7.1, 7.2 and 7.3 by 2030.

According to SDG 7 as highlighted in Figure 6, ensuring access to modern, reliable, affordable, and sustainable energy is critical for the eradication of poverty through the improvements in health and wellbeing, food production, water supply, education, and climate change mitigation (UN, 2015).

The SDG Report (2019:255-258) on SA's attainment of SDG 7, highlighted the following challenges:

- Insufficient data on pro-poor electrification interventions
- Deceleration in the rate of off-grid electrification
- Inadequate electrification in informal settlements

Based on the indicators of SDG7, SA's population with access to clean fuels and technology for cooking is on a positive trend in comparison to SA's population with access to electricity from the national grid (Sachs et al., 2021). In relation to ensuring affordable and clean energy for all citizens, significant challenges remain while SA is moderately improving, however, the efforts and investments from the GoSA remain insufficient to attain all targets (Sachs et al., 2021). The key findings below will provide more information and impetus on how the GoSA has attempted to address these significant challenges that remain.

Considering the above, there is a research gap in terms of the lack of information from independent sources on energy supply, energy efficiency, electricity generation and distribution. Most of the data and the assessments of progress on achieving the SDGs and other targets are provided by state entities and do not adequately consider other needs and interests.

This paper will address these above-mentioned gaps and challenges by giving closer attention to the constraints in electricity supply and tensions in adaptation, as well as mitigation responses in SA's electricity sector. Addressing these broad problems can assist in providing possible solutions to achieving sustainable development and contribute to the understanding of the complexities in issues surrounding access, affordability and reliability of electricity, upscaling renewable energy and practising energy efficiency. SDG 7 provides a useful framework for such a study as it is a widely agreed effort at balancing these various interests.

4. Research Objective and Questions

Objective

The objective of this research is to identify ways in which SA can achieve SDG 7. The achievement of SDG 7 serves as a proxy for progress in achieving the type of energy supply needed for sustainability and progress. Achieving this objective requires assessing the data available and the progress and challenges encountered so far, taking into account the perspective of different interest groups.

Research Questions

The overarching research question is: How can SA ensure access to affordable, reliable, and sustainable electricity for all citizens by 2030, as committed to in the SDG 7, considering the current challenges of electricity affordability, generation, and distribution?

This dissertation will address the following sub-questions:

- What progress has SA made in achieving SDG 7 taking into consideration agenda deadline of 2030, and what gaps remain?
- What progress has been made, and what challenges have been encountered in increasing the deployment of renewable energy?
- What progress has been made and challenges encountered by South Africa in its efforts to produce cost-effective electricity without causing health and environmental harm?
- What else must be done to overcome South Africa's specific challenges in achieving SDG 7 and mobilising the electricity supply to support sustainable development?

5. Methodology

Introduction

This chapter will give an outline of research methods that were followed in the study. It provides information on the criteria of participants, description of the research design that was chosen for the purpose of this study and the reasons for this choice. Furthermore, the methodology that was used for data collection and analysis will be described. Lastly, this chapter entails the ethical considerations that were followed in the process.

The secondary research approach used is desktop research that involved re-analysing, interpreting, or reviewing existing data and sources (Kothari, 2004: 111). The primary research approach used research analysis and interviews to successfully carry out the primary data collection (Kothari, 2004: 96). The gathering and use of secondary sources and conducting semi-structured interviews is a common practice in data collection (Harrell & Bradley, 2009).

Secondary Sources

Secondary research is a research method that involves compiling existing data sourced from a variety of channels (Stewart and Kamins,1993).Researchers may use accessible and credible documents as a source of secondary data (Denscombe, 2017).This study is mainly based on the secondary approach of research, involving desktop study of relevant documentation in academic literature on energy and sustainable development; metadata documents on SDG 7; news or web-based articles on SA's electricity sector; documentation on Eskom price determinations; NERSA regulation directives; literature from environmental organizations; labour union positions statements on the energy sector; as well as GoSA energy policies, programmes and legislation through desktop research.

This research took a pragmatic approach that explored the links between data analysis and evidence, thereafter summarized and collated data to provide key findings and offer recommendations in this research. By doing so required this study to look for similarities or differences in policies, pledges and international agreements made by the GoSA, the governance of Eskom and shareholder responsibility of the GoSA on Eskom, and subsequently provide findings in themes and developing categories for

the SDG 7.1, 7.2, 7.3. 7.b, Eskom's performance, Organised Labour, and President Cyril Ramaphosa Energy Interventions.

Primary Sources

Primary data was directly collected by the researcher to source data from key informants through a semi-structured interviews. Interviews were conducted with seven key informants that have in depth knowledge and extensive experience in the electricity sector of SA.

This research targeted informants to be interviewed, from the electricity sector such as relevant government departments; Academics in the related field of energy; organized labour within the sector; civil society and non-profit organizations. With the assistance of my supervisor, I was able to meet several key informants. I reached out to these informants via email, WhatsApp, and cell phone calls. Thereafter, I was able to successfully secure dates to interview them either in person or online using Zoom.

Some key informants assisted in sharing contacts with me of other stakeholders within the related industry and information such as documents as well as links with relevant information that have contributed to the research key findings.

Semi-structured interviews were conducted with the key informants that have knowledge and experience in the electricity sector of SA. The interviews involved:

- key informants with knowledge of the industry and energy policy making;
- those who work or previously worked in the electricity sector;
- researchers and senior academic with knowledge of the electricity sector;
- Eskom employees; and
- environmental non-profit organizations' representatives that are advocating for clean renewable energy use.

Semi-structured interviews are a common data collection method in qualitative research (Jamshed, 2014). The semi-structured interview guide (Annexure A) has questions that are standardized to direct the conversation towards the research topic during the interview, yet also allowing the space to focus on issues of particular interest that may arise during the interview (Humphrey & Lee, 2004). This is a method that

permits the researcher to collect open-ended data with a degree of flexibility and adaptability, and to further explore the participant's thoughts, views, and perspectives about a particular topic (Harrell & Bradley, 2009).

The semi-structured interviews were conducted in the following manner: the guide is developed with general questions (column "Questions") designed to open up conversation about the topic; In the column "Additional Questions", a set of possible follow-up questions is included in the case that an interviewee is not responsive about the topic or as the interviewer needs more clarity; and in the last column ("Rationale"), reasons for asking particular sets of questions is provided (Annexure A). Interviews conducted virtually were more convenient and considered safer, taking into consideration the COVID-19 safety protocols. Moreover, to have the interview data captured more effectively, recording of the interviews was considered an appropriate choice and was done, despite the risk that recording might prevent interviewees from disclosing some data. The advantage of recording interviews is that rather than simply relying on notes taken, the interviewer can review and replay the interview later and potentially identify key information that may have been missed during the interview (Sullivan, 2010). On the disadvantage, it is claimed that recording creates unease in the interview as recorders can make some interviewees nervous (Leko et al., 2020).

I asked research participants if they were comfortable with the recording of the meeting. The interviews were transcribed and included in the data analysis and may or may not be disclosed based on the research participant's decision.

Maintaining the anonymity of research participants, while presenting detailed accounts of key information, presents challenges that require the safeguarding of the identity of participants and care in sharing information to protect the identity and anonymity of the participants (Surmiak, 2018). To tackle the challenges that arose, I took the approach of not mentioning in this paper: 1) People's names; 2) Places; 3) Religious or cultural background; 4) Occupation 5) Family relationships; and 6) Other potentially identifying information (Saunders et al., 2015).

Key informant 1 (KI 1) is a former senior manager at Eskom. This was the only interview conducted face-to-face, the rest were done online. The topics of discussion were Eskom's weak financial position, declining revenue and governance failures

which threaten the sustainability of the company. In my engagements with the KI 1, I wanted to further understand the mounting operational challenges that contribute to load-shedding and how possible it is to map a way forward for the entity.

Key informant 2 (KI 2), who is from a non-profit organisation that drives the widespread adoption of economically viable green economy solutions. The KI 2 has supported the development of the green economy in the Southern African region by working with businesses, investors, academia, and governments to help unlock the investment and employment potential of green technologies and services, and to contribute to a transition to a resilient green economy.

Key informant 3 (KI 3) is involved in the Soweto Electricity Crisis Committee. The interview assisted my research to focus on the non-payment of Alexander and Soweto residents and investigate what are the governmental interventions that are being implemented to address the crisis and municipal debt caused by non-payment of residents.

Key informant 4 (KI 4) is an academic in the field of engineering with a focus on energy efficiency and demand management. This interview assisted my research in strengthening my literature on SA's energy sector. The KI 4 shared some literature that contributed to my secondary data collection.

Key informant 5 (KI 5) is an energy specialist with extensive experience in energy and economics. The interview focused on universal energy access, doubled energy efficiency, doubling the share of renewables and increased research and development (R&D), and the need for the GoSA to implement bold policies and take decisions based on their developmental impact.

Key informant 6 (KI 6) is active in civil society, through Co-operative and Policy Alternative Centre (COPAC) and has experience in the renewable energy sector. The interview assisted my research in focusing on the mining industry, policies and pledges made by the GoSA to combat climate change and sustainable infrastructure development.

Key informant 7 (KI 7) is from an independent environmental campaigning organisation. The interview assisted my research with sharing information proposals made to the GoSA to fast track a just transition to renewable energy and campaigns from 2019 to stop Eskom from obtaining postponements from complying with air pollution limits from the DFFE.

Although I did not get interviews with them, I contacted several government departments via email to source key and valuable information. Two Departments and responded via email to my interview questions.

In my outreach to contact unions that represent Eskom staff, I experienced difficulties in getting into contact with them or even receiving responses. Emailing the relevant persons on the 'contact us' page of both NUM and NUMSA go no response. I also reached out to members of NUM and NUMSA on social media platforms. Unfortunately, I was not able to secure an interview before I had to complete my research. Despite not being able to interview NUM and NUMSA I was able to utilize their written positions and public statements to ensure that their inputs or views be included in this study. The number of interviews were few, however, the quality of the informants ensured valuable information was gathered as they all had extensive knowledge, from different perspectives, due to having actively participated in the sector for many years.

Data Analysis

In this thesis, the aim is to analyse data to provide understanding of sustainable development and energy, to contribute to identifying opportunities to encourage further research on sustainable energy development and improve public policies as well as decision making in SA's electricity sector. It is important for research to provide an explicit account of the data analysis process to give insights into how conclusions are reached, while studies that explain themes anchored to data and theory produce the strong evidence (Green et al., 2007: 549).

My data analysis approach was to gather all perspectives and positions on the assessment of SA's progress in attaining SDG 7 by 2030. The purpose is to understand civil society, labour, business, and GoSA intentions under SDG 7. Through

understanding both differences and commonalities from these social forces, I was able to analyse and seek balance, and look for win-win scenarios to address the energy challenges in SA. In performing qualitative analysis on data or a subset of the data, the objective is to evaluate the measured evidence (Phillips & Stawarski, 2008). I bring together primary and secondary data to analyse similarities and contradictions to identify what needs to be considered in order find a way forward in the just transition.

Limitations of Study

As a public official and student engaging with colleagues and other departments, gathering information was a sensitive matter which presented challenges to my research. In reaching out to my counterparts from other departments and Eskom, there were no responses or acknowledgement from some potential research participants. Furthermore, due to restrictions and measures put in place to curb the spread of the coronavirus, I was not able to explore events, workshops, symposiums and meet as many sources as I would have liked to contribute to the research. COVID-19 has restricted in-person interviews and has sped up the adoption of digital technologies for interviews. The means of communication to contact key informants included email, WhatsApp, and phone calls.

Ethical Clearance

Through the submission of my research proposal, I was provided ethical clearance to carry out my research by the Faculty of Humanities, Research Ethics Committee (Annexure D). The University of Pretoria's (UP) Code of Ethics for Research (UP, 1999) served as an important guideline that inspired me to maintain high ethical standards in all research activities. The Code identifies key values characterising the ethos which the University pursues is to promote exceptional expertise as well as ethical responsibility in the quest for knowledge and the development, conservation, and transfer of such knowledge (UP,1999).

In the conduct of research, several key principles and actions were observed and preserved, which include freedom from harm, right to self-determination, right to privacy, and right to anonymity and confidentiality (Rogers, 1987: 456).

Ethics is fundamental to all research, as researchers are unconditionally responsible for the integrity of the research process (O'Leary, 2004). Therefore, the conduct of ethical research required that as the researcher, I had to be cognizant of the benefits and risks of the research, protect the rights of participants, and secure informed consent from key informants who have been asked to confirm consent by signing a consent form (Annexure B). Furthermore, research participants were provided with an information sheet (Annexure C) to explain the purpose of the research and how participants may partake in the study.

I ensured that my research, which would be largely desktop, does not fabricate any data or conduct anything that could mislead anyone. There are no COVID-19 related risks, as my research was largely based on secondary sources and interviews with key informants that were mostly conducted online in an effective, safe, and non-intrusive manner to avoid the risk of spreading COVID-19. I aimed to avoid bias in any aspect of my research including data analysis and interpretation Additionally, I have respected and followed the required guidelines on privacy, confidentiality and maintain the integrity of the interview data.

Research participants were kept anonymous, to ensure that when key informants' views were presented, that could not jeopardize their position of occupation. All participants agreed to be interviewed as key informants to my research and signed the consent form to confirm this. There was a clear undertaking that these interviews will form part of my primary research. As stipulated on the consent form, key informants understood their identity and contribution to this research will be kept anonymous.

I am aware of the sensitivities related to allegations of corruption and the politicisation of issues in the energy sector in SA. Thus, I was cautious about how I address these issues in my interviews and in my paper, to avoid being distracted by such issues or having these contribute to misunderstandings or politicisation of the study.

6. Literature Review

Introduction

A literature review provides the primary concepts and theories that frame a study as well as presents on how these ideas have evolved over time (Tracy,2019). The literature review also clearly defines key constructs to be examined and sums up what is currently known about a topic (Tracy, 2019). This literature review will share information from research by academics, as well as grey literature largely from NGOs and government, in order to address the complexity of the concept of energy and sustainable development, advocating for a broad conceptualisation of energy security, considering economic growth, poverty alleviation as well as environmental considerations.

Energy and Development

The OECD (2011: 5) articulates that high levels of resource productivity and the efficient use of energy can lead to more dynamic and competitive economies and is therefore a fundamental input to economic activity. Energy policies, through their effects on capital accumulation and productivity growth, determine the country's energy trends (Jorgenson, et al., 2013). Hence, good governance policies in the economy create a conducive environment to invest in the energy sector, which would increase competition and reduce inefficiencies in the production, transmission and distribution of electricity.

Energy policies impact on the regulation of the energy product markets to the influence of electricity consumption on economic growth (Bercu, Paraschiv, and Lupu, 2019). Governments have a responsibility to develop policies and strategies to manage their country's energy supply and consumption. Energy production, transmission and distribution of energy resources, and end products – heat, wind, coal-powered electricity – as well as the consumption of energy on both industrial and small scale, requires energy policies to ensure economic development (Aalto et al.,2021). Furthermore, solar PV panels or energy communities selling part of their power or heat production to the grid is a matter of policy, as the energy industry requires regulation (Aalto, 2021). How policy-makers intervene in the provision of energy is through (1) granting access to data on the Energy sector's activities which could help investors

shape their business expectations; (2) regulations entail the governing of the extraction, production, sale, access and use of energy; and (3) issuance of licenses to retailing activities of oil and gas products (Edomah et al., 2016).

According to Esen and Bayrak (2017: 78), there is a significant relationship between electricity production, consumption and economic development. When energy is scarce with deficiencies in the system, it poses a strong constraint on the growth of an economy (Stern, 2010; Bercu, Paraschiv & Lupu, 2019). Energy consumption contributes more to economic growth, hence reliability of electricity supply is important for economic growth (Stern et al., 2017). Energy policies are there to ensure the quality of electricity supply and infrastructure as it is important for development outcomes. Production requires energy to carry out work to convert materials into desired products and to transport raw materials, goods and people" (Stern et al., 2017).

Coal-powered energy is needed to operate mining equipment, gas to heat to manufacture and oil to burn to operate transportation. Even Small and informal businesses require basic access to electricity to operate and access markets. In the informal economic sector, energy is a key input into food and other enterprises (Matinga et al, 2018). For lighting purposes, internet connectivity and productivity, informal sectors require reliable and affordable energy sources. This informal industry in SA does employ a few people, usually on a temporary basis, yet it offers services to homeowners or businesses where the major players are not entirely present, such as cleaning services (Businesswire, 2020). Energy policies should take into consideration the needs of informal enterprise owners and their customers, not by the general discourse in the energy sector that assumes that increased uptake of modern energy services makes positive contributions to enterprises (Matinga, 2018).

According to Sarkode and Adams (2020: 10), access to electricity and energy-related services are essential for achieving sustained economic growth, improved livelihoods and quality of life. Their study found that there is a positive effect on increasing income levels on access to electricity. Affordability of modern energy services is a critical barrier to upscaling solutions that improve access to electricity (Sarkode and Adams, 2020: 10). Energy policies are becoming more diversified, although developed and developing countries are differently and strategically focused on increasing energy production from renewable energy sources, and improving energy efficiency (Szustak,

2021). Therefore, changes in energy policy will undoubtedly affect the economy of any country (Szustak, 2021). More research on the relationship between energy and their impact on micro- and macro-economic outcomes should be continued.

Sarkode and Adams (2020) study concludes that there is a negative relationship between access to electricity and corruption, which reflects on poor governance and institutional environments. Although economic growth is essential to materialize electricity, their study demonstrated that good governance and institutional quality is critical to ensure energy security — availability, accessibility and affordability. A secure supply of electricity, at a cost of which South African citizens can afford, is essential for sustainable development as well as to provide access to electricity for all (Sarkodie & Adams, 2020). The provision of electricity is essential for promoting employment, health and educational outcomes, the overall quality of public service and the quality of life.

Social impact of electricity

Lana Franks' (2014) South African case study of "The impact of rising electricity tariffs on tariffs on the urban poor", stresses the need for balance between the utility and the customer and the price of service delivery and the level of affordability, especially for the poverty-stricken households. Franks further highlighted that Eskom's tariff increases may affect the access and long-term affordability of electricity for poor South African citizens and households. Franks (2014:16) does take note that Eskom increasing tariffs for more cost reflectiveness is essential to achieve the objective of meeting the growing electricity demand in the face of an ageing electricity network and a historically reasonably-priced electricity. However, Franks recommends that energy poverty indicators used in SA should be improved upon, to adequately track multidimensional energy poverty impact on poor households (Franks, 2014:19).

In reflection of the apartheid era, energy services in SA were apportioned according to race and socio-economic status, the electricity sector was exclusively directed towards the consumption needs of the elite, largely white minority aimed at shoring up their power through energy independence, due to isolation from the international community (Carruthers, 2019; Power et al, 2016). The black majority experienced energy poverty in contrast to the white minority that enjoyed efficient energy services

(Fakier, 2018). Although it has been 26 years of Democracy, one can still see evidence of high inequality in the quality of access to electricity.

The demand for energy in SA has racial differences in access to energy. According to Mhlanga and Garidzirai (2020: 201), the white population despite making up around 10% of the population, demands more energy compared to the other three racial groups combined. The reality is that many of the black households are affected by energy poverty.

Energy poverty is calculated for each of the households using the economic expenditure approach. This allows for determination of the number of households below the energy poverty line within the households spending more than 10% of their household income on acquiring energy as measured by the DMRE's definition of energy poverty (Ismail, 2015). This is one measure to determine household energy poverty, as in some instances income data is unavailable. The socio-economic factors such as gender, income, sex of the households, age and household size, these further define the level of energy poverty through the lack of basic access to cooking space, electricity, modern fuels and appliances (Mhlanga and Garidzirai, 2020).

Rural households and informal settlements without electricity access, which are almost exclusively occupied by black residents, often experience the effects of air pollution indoors as well as outdoors, with the resulting risks to human health and the environment. This arises from the burning of alternative and unclean energy sources in human dwellings which leads to the emissions of GHGs into the atmosphere, including CO2, carbon monoxide (CO), nitrogen oxides (NO2), sulphur hexafluoride (SF6), and volatile organic compounds (VOCs). These GHGs emissions are harmful to human health and negatively impact the global climate (Longe, 2021).

Although the GoSA has made substantial progress in its expansion of electrification for previously disadvantaged groups to have more access to energy and making provisions of FBE, much still needs to be done for more households to have access to energy. Access to secure and affordable energy for low-income households can help reduce poverty, increase livelihoods and improve living standards. It is approximated that 64% of SA's population currently resides in urban areas (StatsSA, 2021b). Of that 64%, 40% of the population reside in metropolitan municipalities (NT,

2020). It is projected by the UN that urban populations in SA will reach 70% by 2030 (UN, 2020). The influx into urban areas is based on health, education and income generating impact that access to electricity provides (Singh & Inglesi-Lotz, 2021). Despite higher electricity access in urban areas, new urban arrivals from rural areas, move into some form of informal housing, living in either freestanding or backyard shacks and does not guarantee safe access to electricity and affordability to modern energy sources as highlighted in the Background of the dissertation.

Considering the above-mentioned, if the energy problem in SA is not addressed to meet the growing demand, more people are likely to suffer, since almost 45% of the population is already suffering from energy poverty (StatsSA, 2020b). Investment and upgrading of backyard shacks, safe grid connections may provide a relatively low-cost solution to increasing energy access (Le Roux & Choumert-Nkolo, 2021). Informal urban settlements remain a key challenge for universal energy access. Given the social gains associated with energy access, extending grid infrastructure to informal settlements can significantly improve livelihoods at relatively low cost, given their density and proximity to other formal urban settlements (Le Roux & Choumert-Nkolo, 2021).

SDGs and Trade-Offs

The SDGs are intended to be more integrated and produce synergies yet the interactions among them also lead to trade-offs (Menton et al., 2020). As noted above, energy is distinctly linked to every other crucial SDG. It is, however, argued that energy deprivation is a leading contributor to indisposition, political unrest, and environmental instability (Sovacool, 2014). Assessing trade-offs and synergies among the SDGs, the magnitude and direction of the interaction can vary between countries, and is dependent on national circumstances (Menton et al., 2020).

In many instances, the SDGs fail to combat the global economic and geopolitical systems that create gender inequality and other injustices in the first place (O'Manique & Fourie 2016; Kopnina (2016). It is challenging to have win-win situation in achieving all SDG goals, as it is difficult to address poverty, hunger, inequalities, and sustainable development without trade-offs (O'Manique & Fourie 2016).

By focusing a sub-set of the SDGs, the gaps, and contradictions in particular SDGs can be highlighted but also the interactions among SDGs for the Food–Water–Health Nexus (SDGs 2, 3 and 6), climate and energy (SDGs 7 and 13), poverty and inequality (SDGs 1 and 10), and environmental conservation (SDGs 14 and 15) (Menton et al., 2020:1623).

Menton et al (2020: 1623) emphasize the contradictions are inherent in promoting environmental sustainability within a framework that promotes GDP growth (SDG 8) and operates within a neoliberal capitalist system that values consumption and growth often at the expense of environmental sustainability. The implementation of the SDGs could have both negative and positive implications for climate & energy justice (SDG7 & SDG13). The problem is that the climate dilemma is framed as a problem of excessive GHG emissions and of adaptation to climate-related extreme events that can be solved through technological change and voluntary international agreements and energy security is reduced to a problem of decarbonization of energy sources and energy poverty (Menton et al., 2020). SDG 7 focuses exclusively on the material domain (physical infrastructure) of the current socio-technological energy system but remains mainly silent on the social factors (user practices and meanings, lifestyles, business models, markets, power, etc.). The Unequal structures of ownership and control of energy are unrecognized and consumerist aspirations of the vast majority are under recognised (Menton et al.2020: 1636).

Many studies have been conducted to examine the effects of energy and electricity provision on economic growth with a few focusing on poverty and income inequality (Sarkode & Adams, 2020). There is a gap of limited studies on income inequality-electricity access nexus. SA is a suitable case study to explore this as a developing country, with one of the highest accesses to electricity in its region yet has very high-income inequality in the subregion and the world (Sarkode & Adams, 2020).

Barriers to Renewable Energy

With regards to steps taken by the GoSA to promote renewable energy and enhance energy efficiency, it is important to take note of Anna Pegels' report of (2010) "Renewable energy in South Africa: Potentials, barriers and options for support". Pegels (2010) stresses that SA has large recoverable coal reserves therefore, if an energy shift takes place, it will not be due to a lack of coal. This is where contestation exists, as mining coal provides for more labour and more energy supply to generate electricity, however, more consideration to the environment and public health is required. Pegels (2010) further highlights that the 2010 electricity shortages were caused by rising demand and inadequate investment in additional energy supply, although this issue has persisted and remains a current and pertinent issue.

According to Todd & McCauley (2021:1), there are policy barriers which are acting in SA to impede the delivery of the energy transition away from fossil fuels. The main barriers to renewable energy have been observed in three areas – technological, cost-effectiveness and market barriers (Todd & McCauley, 2021). These barriers are linked to policy and knowledge gaps which are preventing the delivery of measures to reduce the usage of fossil fuels. Yet in consideration, developed and developing countries' public, financial, institutional and innovation capabilities fall short of implementing far-reaching measures at scale of upholding the Paris Agreement and implementation of SDGs (Todd & McCauley, 2021).

Building on the work of Painuly, Pegels and Wiseman, Todd & McCauley (2022: 4) argue that the difficulties of the state electrical utility are the principal barrier to an energy transition in SA. The coal mining sector and labour unions are considerable barriers to transformation in the energy sector, as industry and labour from the mining sector have political influence that can affect the energy transition in SA. Unions have their own ideas about the form of transition needed but are uncertain about the path to transition, because renewable energy jobs require higher skills, and are found in coastal areas and not in the main coal-mining areas (Todd & McCauley, 2021:6).

It is widely argued that Eskom remains the primary barrier to an energy transition, as it remains committed to coal and Eskom's contingent liability of R250 billion is the largest threat to the South African economy (Todd & McCauley, 2021). The corporate

governance breaches and exorbitant remuneration bill at Eskom have wasted government resources. Second to Eskom in importance is the role of the GoSA at national and municipal level. According to Todd & McCauley (2021). The GoSA was the second-most important barrier to delivering a just transition based on policy and practical deficiencies which were due to inadequate consultation, a lack of strategic direction, and weak institutional governance (Todd & McCauley, 2021). For instance, NERSA is the most important factor in the transformation of the energy sector, as they have the ability of private developers to sell into the grid system and approve Eskom's tariffs (Todd & McCauley, 2021).

The GoSA has introduced IPPs programme to encourage the uptake of renewable energy, yet the volume of private investment in renewable energy generation is still low (Pegels, 2010: 4947). Furthermore, the adoption and maintenance of renewable technology comes at a cost. According to Pegels (2010:4948), SA's barriers to renewable energy and energy efficiency are: insufficient investment on innovation in the renewable energy system; the exorbitant prices of renewable energy technologies; as well as low levels of education and capacity, hence Pegels has recommended that investment in energy research and development should be mainly financed by Eskom (Pegels, 2010). State-owned entities such as Eskom, are still reliant on Legacy "outdated" technology and equipment, as they are reluctant to modernize because of the upfront cost of new equipment and products.

Inglesi-Lotz (2019) has highlighted that there are three key areas that can lead SA towards greater energy efficiency, as well as reductions in carbon emissions. These are:

- technological innovations for energy efficiency;
- changing the energy supply mix; and
- promoting structural changes in the economy.

All these can be combined in national energy policies and strategies, but they differ in two points: the time horizon of the results and the risk of outcomes (Inglesi-Lotz, 2015). The introduction of technological innovations that can achieve higher energy efficiency levels depends heavily on the availability and cost of the innovations. It also depends on the receptiveness in sectors where they will be adopted (Inglesi-Lotz, 2015).

The GoSA appreciates the need to reduce the energy intensity of the economy over the long-term. Inglesi-lotz (2019) has recommended that SA's transition from a resource-based economy to a knowledge, service and quality of human capital-based economy that requires information, education and research and development. In 2015, Inglesi-lotz (2015) called for a new strategy to include investment in research activities that will show the way to innovative solutions. Areas to be explored could include structural changes in the economy as well as more efficient ways to consume energy.

In this transition, Inglesi-Lotz encouraged the GoSA to investigate alternative fuels that will make even the high energy intensive sector's consumption cleaner and more environmentally friendly (Inglesi-Lotz, 2015). For this, a properly planned, organised, managed, and monitored market for renewable energies needs to be put in place. This needs to be combined with a comprehensive policy to provide consumers with alternatives to fossil fuel-based energy (Inglesi-Lotz, 2015).

Lastly, Inglesi-Lotz argues that instead of penalising intensive users, which happens with a carbon tax, an alternative would be to incentivise them. This could be done by introducing a reward programme, such as an emissions trading system or, even more suitable to SA, an energy-intensity trading scheme. By trading credits of energy intensive use, the sectoral users would aim to reduce their energy consumption as well as trade their credits for additional profits (Ingelsi-Lotz, 2015).

SA's economy is uniquely dependent on electricity and is electricity-intensive (Fine & Rustomjee, 2018). This is because SA's economic trajectory has been based on the nexus of the South African mining and energy sectors. According to Fine & Rustomjee (2018: 8), mining and mineral processing accounts for close to 40% of electricity consumption in SA. Economic activity has been centred on mining activities, as well as their ancillary services and supplies. The country's stock exchange was established in 1887, a decade after the first diamonds were discovered on the banks of the Orange River, and almost simultaneously with the gold rush on the world-famous Witwatersrand (Minerals Council of South Africa, 2021).

The term to describe the above mentioned is the Minerals Energy Complex (MEC), which is a network of policy stakeholders in SA that the benefit policy adopted in 2011. The MEC is a set of well-developed industries and institutions that have developed

around the mining, energy, and financial sectors of the South African economy (Hlongwane, 2015). The political economy of SA has led to the involvement of electricity policy actors and obstacles to reform the electricity sector. An electricity supply crisis, new energy technologies, environmental policy, and renewed attempts by government through IRP and civil society holding Eskom accountable, have led to litigation against fossil fuelled energy power generation (Omorogbe & Ordor, 2018). Coal mining for electricity generation continues to dominate with continuing effects on the environment and the low skill labour intensive nature of mineral-energy and reinforces the survival of this industrial complex (Takala, 2008).

The South African economy has been stagnant, and the energy sector is the engine to economic development, therefore, Eskom requires policy intervention and increased investment. The electricity supply and economic growth in SA are drifting apart, clearly highlighting that SA's decline in economic activity can be associated with decreasing electricity sustainability (Ateba, Prinsloo & Gawlik, 2019). Thus, the consequences of declining quantity and quality of energy directly impacts the development and the wellbeing of South African citizens.

In 2018, the mining sector contributed R351 billion to the South African Gross Domestic Product (GDP) and a total of 456,438 people were employed in the sector (Minerals Council South Africa, 2021). There is significance in electricity supply sustainability that contributes to industrial growth in SA, thus, the loss of production in mining takes place when the unpredictable supply failures occur at Eskom power stations.

According to Baker, Newell, and Phillips (2014: 792), the dependence of the mining and manufacturing industry on cheap coal for electricity generation is no longer economically or environmentally sustainable. The continuity of the electricity supply problem requires diversified energy sources to curb the outages that are interrupting industrial and socio-economic development. However, the political economy of energy transition in South Africa is characterised by unique social, political, and economic legacies of apartheid which continues to impact policymaking of energy transition (Baker, Newell & Phillips, 2014: 792).

The legacies of apartheid are rooted in racial and spatial segregation and continue to reinforce inequality in South Africa (WB, 2022b). Profound economic disparities are evident in township and informal settlements of South Africa. Inequality has consistently been higher in urban than in rural areas and the main driver of inequality is differences in educational attainment, followed by labour market factors, such as labour force status or participation (that is, whether people work or not) and their occupation or industry of employment (WB, 2022b).

According to the World bank report on Inequality in Southern Africa: An Assessment of the Southern African Customs Union (2022b:10) in South Africa, political progress in these countries has not been matched by progress in equity and economic fairness, mainly because distortions from their past pose critical obstacles to social progress. The wealth gap is closely related to unequal ownership of assets and therefore, differences in wage income. For instance, financial assets represent 75 percent of the total assets of wealthy households in South Africa, against only 36 percent of those of poor households (WB, 2022b: 11).

In South Africa, townships and informal Settlements are associated with lower access to basic public services such as education, improved sanitation, safe water, and health insurance. These spatial disparities affect the opportunities and access of where people reside. The World Bank (2022b: 118) has found that infrastructure gaps for electricity, internet connectivity and roads are worse in rural areas. Yet most poor people that live in rural areas experience challenges around affordability of electricity, data, and transport.

Rural areas that are legacies of Apartheid are disadvantaged in accessing electricity and the lack of access to electricity adversely affects people's economic opportunities and perpetuates inequality of opportunity which remains an economic legacy of Apartheid. Approximately 16 million South African households are still relying on paraffin, fuel, wood, candle lights, and coal to provide for their energy requirements (Baruah & Enweremadu, 2019). This could be due to low-income and poverty-stricken households' inability to afford monthly electricity because of experiencing irregular cash flows, hence the significant reliance on non-electrical energy sources.

The energy policies such as IRP, RE IPPPP and Clean Development Mechanism (CDM), shed light on the contested terrain of energy politics in the country, as well as the difficulty and complexity of mobilizing socially and economically for a just energy transition (Baker, Newell & Phillips, 2014: 798). There is suspicion held by organised labour that white elites, backed by foreign investors, are accruing power and wealth through opportunities opened as part of a transition through the IPPs programme (Baker, 2011). Wealth distribution and the role of labour in the energy transition must be addressed more thoroughly to balance social and economic interests in shaping South Africa's energy future.

The electricity generation megaprojects of Medupi, Kusile and Ingula have been problematical to build for Eskom (Gregory, 2020). All three projects demonstrate difficulties, with the first two anecdotally contributing to the effective bankruptcy of the national electricity utility and it is now in the GoSA hands for its' survival (Gregory, 2020). From 2011, Maldevelopment, local and global environmental degradation, and energy poverty have been the theme of the 4800 MW Medupi coal-fired power plant project in South Africa (Rafey & Sovacool, 2011).

According to Gregory (2020), the megaproject implementation is observable as being a socio-technical process between multiple actors, driven by competing agendas within a socially constructed environment, making governance issues central to such a processes productivity. Eskom is the responsibility of the DPE, whose minister has been frequently changed, which has probably led to sub-optimal shareholding (Gregory, 2020). Furthermore, the absence of appropriate engineering and project management capabilities, which is supposed to be customary in Eskom, has led to cost overruns and inevitable completion delays (Gregory, 2020). In January 2023, President Ramaphosa announced the move to DMRE, as a means to improve the efficiency of Eskom, which has been failing to meet the nation's electricity demand (Energy Capital & Power, 2023).

Conclusion

The reliability of Eskom has decreased and the cost of electricity has increased, which has led to IPPs being carefully considered in the literature above. Authors have investigated the potential of renewable electricity sources, the skills required and cost

of renewable energy technology systems. Furthermore, this literature review has highlighted that the SDGs framework are complex and more contextualized policy efforts are needed to achieve sustainable development. Continuous engagement and research on the energy sector is crucial in ensuring energy development is sustainable, adequate investment in research and mitigation of social impacts from shifting into a diverse energy mix.

7. Key Findings

Introduction

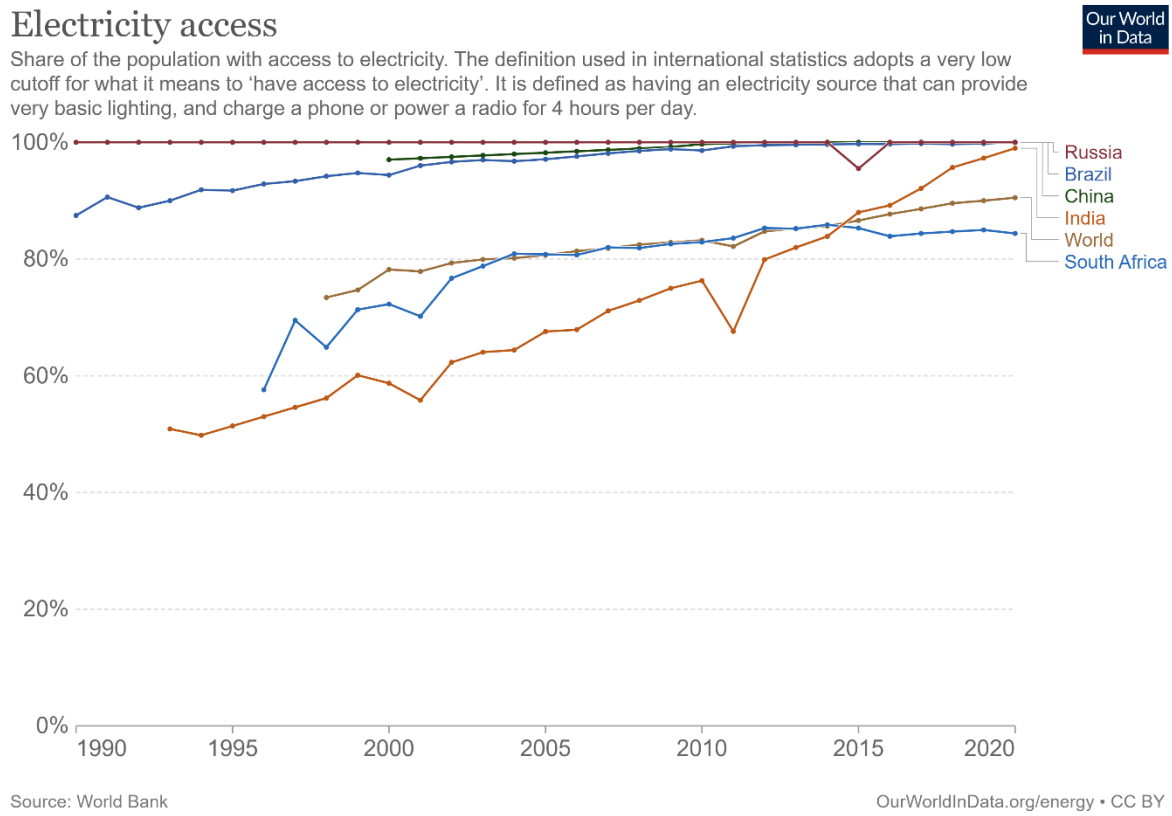
The key findings of this paper are provided in relation to SDG 7 from SDG 7.1, 7.2, 7.3 and SDG 7.b, based on the information gathered from interviews, literature review and the application of the SDG framework. These findings will depict an assessment of South Africa's progress in achieving SDG7, its obstacles, the measures that the GoSA has undertaken to attain SDG 7, as well as provide an opinion on what is the best and balanced way for SA.

SDG 7.1 – by 2030 ensure universal access to affordable, reliable and modern energy services

In tracking SDG 7, the UN provides the Energy Progress Report website that allows one to compare the results for each of its tracking indicators. In terms of access to electricity, SA is just below the global average for the total electricity access rate, yet SA's BRICS counterparts are well above it (Figure 7). Access to electricity in South African Development Community (SADC) is still very low - for example electricity access rates are less than 15% in Malawi and DRC - but some member states, such as Mauritius, Seychelles, South Africa, and Eswatini have electrification rates above 90% as of 2019 (Justo et al., 2022), The BRICS countries, however, offer a useful comparison as they are more comparable economies with South Africa's, compared to most SADC countries. After sustained improvement from 1996, as the new democratic government rolled out more connections to electricity, SA's rate of access to electricity has dropped since the year 2014 due to Eskom's major implementation of load-shedding (Monyei and Adewumi, 2017).

Eskom's power system came under severe strain due to maintenance backlogs and a failure to bring new generating capacity online timeously to match economic and social development. In contrast, India overtook SA in providing a higher rate of electricity access from 2015 (Figure 7). By 2016, India's economy grew at an average rate of 7.5%, outpacing China as the fastest growing large economy (BBC, 2016). This indicates the linkage of electricity, economic development and how SA has faltered even below world average. This highlights a strong correlation between economic growth and the expansion of electricity supply.

Figure 7: Access to Electricity Rate Country Comparison (source: World Bank)



SA has an electricity access rate of more than 80% of the population (WB, 2020a). The most common form of access to electricity is by households. Having adequate and affordable access to electricity is vital to address household poverty (StatsSA, 2021b). To satisfy basic human needs of cooking, lighting, heating water and space heating, reliable and affordable energy sources are required (StatsSA, 2021b). Unfortunately, poor households and small enterprises are trapped in a challenging circumstance as many are too poor to pay for electricity and are therefore affected by the implementation of load reduction (Francioli, 2018). Due to non-payment coupled with illegal connections and high electricity consumption in areas with high population density, access to electricity has been hindered (Francioli, 2018).

To provide an example of a relatable situation in most townships or high-density areas in SA, Eskom has cut off electricity supply to various parts of the country due to non-payment. Residents in Soweto are adamant about their demands from the GoSA to put pressure on Eskom to treat communities equally. The hindrance to access electricity which are affecting many Soweto households, include billing problems, the

installation of prepaid meters and debt recovery (DM, 2022). Residents in Soweto feel mistreated by Eskom's power reductions and feel victimize even though many of them are on prepaid electricity (IOL, 2022). Eskom has a dilemma, the utility is unable to keep electricity on for the buyers, leaving non-payers and payers in the dark, as the utility's network is configured in such a way that it is not possible to disconnect only those who are not paying during load reduction (IOL, 2022). Eskom has been implementing load reduction to avoid network overloading in high density areas in all provinces of the country (Eskom, 2022h). Load Reduction is implemented to protect Eskom's infrastructure and to reduce operational costs unfortunately at the inconvenience of paying customers.

The migration into the Gauteng province is associated with the increase in households in these highly populated areas. For instance, as Eskom has introduced load reduction that periodically shuts off power to large parts of Gauteng, including areas in Soweto, the West Rand, the Vaal, Katlehong, Vosloorus, Ivory Park, Ga-Rankuwa, Hammanskraal, Soshanguve, Benoni, Nigel and Brakpan (Eskom, 2022h).

The power utility has been cutting the electricity supply to areas across the Gauteng province, largely in townships and informal settlements during peak demand periods – specifically 5-9 am and 5-10 pm - to protect infrastructure from overloading due to illegal connections and unlawful bypassing of electricity (Eskom, 2022e). Eskom is suffering from capacity and connection constraints, which affect the quality of access to electricity. Communities have been encouraged to report meter bypasses, illegal connections and the vandalism of Eskom's electricity infrastructure (Eskom, 2022e), as vandalism and stealing of transformers, bypass meter boxes, substations, control rooms security fences and copper cables is impacting on the security of supply (The Witness, 2022).

According to Eskom, the long-term solution is eradication of illegal connections and meter bypassing, close the electricity ghost vending and formalisation of electrification (DM, 2022). However, load reduction will continue for as long as Eskom has overloading that exceeds its capacity in parts of the country (Eskom, 2022h). The load reduction programme will continue to limit power supply and affect access to electricity in condensed areas such as Gauteng indefinitely.

Eskom is losing revenue due to illegal power connections in Gauteng, particularly in Soweto. Originally in 2020, Soweto residents' debt stood at R18 Billion, which made the KI 3 question the fairness in the manner of electricity billing for communities around SA. According to the KI 3, Soweto residents have made some progress in paying off their electricity debt and there has been an effort to move to prepaid electricity as a way of getting Sowetans to start paying for their electricity. Furthermore, insights were provided on how energy in SA is distributed and accessed differently. Due to poverty, spatial development, informal settlements and illegal connections, safe and reliable distribution of electricity to communities differs, creating barriers to access and affordability of electricity. Soweto debt has decreased from R12,8 billion to R7,5 billion (including interest) at the end of 2020 (Eskom ,2021: 76). According to Eskom (2021:76), reduction in Soweto debt is mainly due to the write-off of prescribed debt of R5,3 billion and the writeback of non-compliant interest of R3,3 billion.

The Soweto Electricity Crisis Committee, is a social movement organisation that is advocating for the expunging of electricity debt for townships and hostels (Ngwane and Vilakazi, 2010). The Committee has called for Soweto's debt to be critically examined. Taking into consideration that Eskom had not been maintaining some of its infrastructure in the townships, which also discouraged residents from keeping up with the payments (IOL, 2022). Furthermore, the committee has requested that Eskom ensure that the poor received electricity regardless of their economic standing (IOL, 2022).

The case of Soweto is relatable to many parts of the country, as most South Africans cannot afford to pay for electricity and the price hikes are leaving many South Africans in the dark. Both poor and low-income households are now resorting to tampering with electricity meters to secure power at no cost. The price hikes are part of reviving the utility but have placed a growing burden on consumers, particularly those who cannot afford to utilize renewable energy.

An example of these challenges arose in July 2018, when Eskom took a decision to interrupt the electricity supply to the Emfuleni Local Municipality for four to six hours a day (OFM, 2018). This was a result of non-payment of their electricity account, which at that stage was in arrears by close to R900 million (Eskom, 2022d). The decision came after the municipality had already consented to a judgment in March 2018,

admitting liability towards Eskom in the amount of R614 million and further committed to pay these arrears (Eskom, 2022d).

The municipality failed to honour their undertaking and obligation to pay and had continued with their non-payment of the current electricity account. As a result of the continual non-payment, the Eskom debt continued to accrue, which prompted Eskom to bring a further court application (Engineering news, 2022d). The total municipal debt across SA has escalated to nearly R43 billion in 2022 (Engineering news, 2022d).

As unemployment levels increase, citizens will be forced to scale back on basic electricity access as citizens will not be able to afford electricity. Once basic electricity services are unaffordable due to unemployment, the affected South Africans' productivity will be reduced by this and exuberated by planned and unplanned power cuts. Having no hot water, no home internet access, and no power to use the stove to cook, will affect productivity and become an obstacle for affected South Africans to participate in the economy. Therefore, the lack of electricity is an obstacle to sustainable development.

Furthermore, the high levels of unemployment in the country is a compounded issue as more and more households are struggling to feed their families, pay for their electricity and the crippling effect that poor electricity reliability is having on South Africa's economy. Job creation and opportunities are affected by ongoing as well as periodic electricity blackouts.

SA's informal food sector operators are reliant on Eskom and traditional energy sources. For instance, this sector requires energy to prepare and process food. It is not only affected by the price of electricity but by any lack of availability of electricity based on energy-use patterns in this sector (Mohlakoana et al, 2019). The informal food sector, which is predominantly operated by South African women, is important not only for providing the convenience of affordable and readily prepared meals, but also as a source of income for women and men in the country (Mohlakoana et al, 2019).

Women particularly in this sector, often opt to use traditional energy sources as they are more reliable and less expensive than modern energy sources such as electricity

and gas (Mohlakoana et al, 2019). Some informal enterprises have access to electricity and are reliant on modern energy sources, however its unavailability reduces productivity and profitability. Electricity is further essential for the charging of cell phone batteries. The use of cell phones is important for the running of informal food enterprises and it is common for customers to place food orders telephonically (Mohlakoana et al, 2019). Furthermore, lack of access to modern and efficient energy sources has several negative consequences on the user's health including respiratory diseases from using wood and charcoal (Mohlakoana et al, 2019). With the on-going power cuts and increased cost of electricity, men and women will have fewer employment opportunities as they cannot operate in their households.

The national average daily consumption for South African households, according to Eskom, is over 30 kWh (Allsolar, 2021). Therefore, 30 units per day multiplied by R2.60 per kwh for average cost of electricity, equals to close to R78 worth of electricity a household consumes in a 24-hour period. Within a month, South African households spend an average of R2,340 in total for about 900 kWh. Thus, without the efficient use of energy to help lower household consumption using LED lights, Class A fridges and solar geysers, the cost of electricity will remain high.

The current direction of the energy system and governance is going to make it fundamentally unaffordable for most of the black and coloured population, as well as social grant receipts to purchase and access electricity. This will create energy poverty and push the poor towards the use of fossil fuels such as paraffin, which have implications on household safety, expenditure and the environment. Low-income households are burdened with high electricity costs to meet their basic energy needs which include cooking, water heating, space heating and lighting.

South Africans are paying close to R 2.60 per kwh for electricity (Business Insider, 2022). The world average price is 0.136 U.S. Dollar per kWh for household users and 0.123 U.S. Dollar per kWh for business users, converted into Rands, it equates to about R2 per kwh for households (Global Petrol Prices, 2021). Thus, SA is close to 60 cents above the global average of electricity price per KwH.

The cost challenges are getting worse as new tariff increases, which are approved by NERSA and applied to the tariff charges for Eskom direct customers. These took effect

from 1 April 2022 and tariffs applicable to local authorities (municipalities) will take effect from 1 July 2022 (Eskom, 2022c). The electricity tariff in SA is currently set (end 2022) at around R1.46 to R1.61 per KwH, up from R1.33 at the beginning of the year (BusinessTech, 2022a). Additionally, municipalities are required to charge their own tariffs for distribution of electricity to households to cover the higher cost they are paying to Eskom.

The South African Social Security Agency (SASSA) provides social grants to help improve standards of living in society (Kelly & Staff, 2017). The GoSA through this agency, provide grants to people who are vulnerable to poverty and in need of state support, which include people such as the elderly, people with disabilities and people with young children (Kelly & Staff, 2017). Nearly 50% of the South African population rely on social grants. According to Stats SA's General Household Survey, the percentage of households receiving a grant (excluding the Social Relief Destress grant) has increased from 45,5% in 2019 to 48,9% in 2020 (StatsSA, 2020d). SASSA grant increases have not been significant enough to alleviate households' financial pressure, due to high cost of food and electricity prices. The grants currently provided by the State do not go very far enough in covering electricity costs given the cost of other expenses and other needs that people have (Kelly & Staff, 2017).

The amount allocated to each grant provided by SASSA varies; the following are the current amounts received per grant (Kelly & Staff, 2017):

- Older Person (60-74 years old): R1890
- Older Person (75+ years): R1910
- War Veterans: R1910
- Person living with Disability: R1890
- Person with Care Dependency: R1890
- Foster Child: R1050
- Child Support: R460
- Grant-in-Aid: R460
- Special COVID-19 Social Relief of Distress (SRD): R350

Considering the effects of the pandemic, high unemployment, inequality, poverty, higher fuel and electricity prices, are likely going to increase food prices. The most

vulnerable people in SA are experiencing challenges accessing electricity, which prevents them from exercising their basic needs, hindering them from accessing employment as well as being economically productive. Consumer inflation has accelerated to 7,8%, in July from 7,4% in June 2022, pushing costs up for households and utilities (StatsSA, 2022a). South Africans will need to have at least R624 per month to meet the minimum required daily electricity intake (StatsSA, 2021b).

The KI 4 highlighted the need to minimise any adverse economic cost to the consumer and taxpayer. As the government addresses the challenges that Eskom faces, there is a need to ensure that there is meaningful consultation and dialogue with all key stakeholders. KI 4 stressed that SA requires a just transition plan that will address the needs of all those who have been affected by energy poverty. With Socio-economic factors such as rising electricity prices, low household incomes and energy inefficient homes, there should be urgency in developing energy poverty solutions.

Eskom has acknowledged that the unsatisfactory performance from the Generation division continues, with generally good performance from Transmission and Distribution (Eskom, 2022i). SA has a developed electricity network managed by Transmission and high rates of electricity access due to the good performance of Eskom Distribution (Eskom, 2022i).

The availability of electricity, which is the responsibility of Eskom generation division, is performing below par. The energy availability factor (EAF) stood at 65.27% on 30 September 2021, contributing to 21 days of load-shedding (Eskom, 2021). The below target availability has resulted in high utilisation of Open Cycle Gas Turbines (OCGTs) to the tune of R4.5 billion over the period ended 30 September 2021, an increase from the R2.6 billion spent in the same year period in 2020 (Eskom, 2021). According to Eskom (2021), the decline in generation performance was exacerbated by the explosion of Medupi Unit 4 generator on 8 August 2021 and the Kendal Power Station Unit 1 generator transformer fire on 11 September 2021. These two major incidents accounted to a loss of 1 360MW from the national electricity grid (Eskom, 2021).

Generation remains a major concern, specifically the availability of the coal power stations. There are still high levels of unplanned outages, even though there was planned maintenance over the summer months (Eskom, 2022i). Recovering the

operational performance is a top priority of Eskom's management and they have committed that they will not compromise on reliability maintenance and mid-life refurbishment of its power generation stations (Eskom, 2022i).

As of 10 May 2022, the increased breakdowns and low plant availability forced Eskom to implement load-shedding totalling 31 days since 01 January 2022, compared to last year. Due to the system constraints, Eskom have used more that the anticipated levels of diesel for OCGTs (Eskom, 2022i). Taking into consideration the global oil price hikes, has put Eskom's measures to avoid load-shedding are in jeopardy. With Eskom using diesel-powered gas turbines when its coal-power fleet breaks down is costly to the utility's operations.

The Russia-Ukraine conflict Ukraine has dealt a major shock to commodity markets, altering global patterns of trade, production, and consumption (WB 2022a). Crude oil prices have hit record highs this year in response to the invasion of Ukraine and sanctions put on Russia. With Russia being one of the world's largest crude producers and bans placed on its exports, oil prices are expected to rise more than 50 percent in 2022 before easing in 2023 and 2024 (WB, 2022a). The persistent high oil prices could cut a full percentage point off the growth off large oil-importing developing economies like China and SA (WB, 2022a).

As previously mentioned, Eskom regularly makes use of OCGTs and burns through diesel to supplement energy supply. The on-going conflict has led to a rise of oil and gas prices, and this is adding pressure to Eskom's liquidity, and this put measures to avoid load-shedding in jeopardy. The increased usage of OCGTs cost Eskom an additional R10.8 billion in 2021 (BusinessTech, 2022c). Considering Eskom's cost of operations stood at R196 billion in 2021, this additional cost equates to a 7.5% increase in operating expenditure (BusinessTech, 2022c).

If Eskom continues to burn diesel at its current rate, it risks totally depleting its reserves as Eskom does not have enough liquidity to afford the high oil prices to replenish its diesel reserves. Furthermore, due to the backlog in maintenance, this shortage of generating capacity in the country and the age profile of Eskom's generation fleet, load-shedding will remain high and frequent until there is adequate capacity in the country (Eskom, 2022i).

Eskom has had an increasingly negative impact on government finances. The amount of Eskom's debt guaranteed by the government poses a significant risk to the South African economy. In 2018/2019 financial year, Eskom's operating cash flows dropped below interest payments, requiring government cash transfers to stay afloat, with aggregate operating cash flows that are insufficient to cover debt service (Curran and Ahmed, 2020). Basically, the GoSA needed to borrow just to service its debt.

Eskom's unsustainable financial performance and liquidity challenges has contributed to compromised operations, inability to maintain its power plants and not meeting its mandate. This is exacerbated by high levels of debt servicing, higher wage demands, inadequate revenue previously awarded by NERSA, an increase in non-payment of municipal and other accounts leading to arrear debt growth and declining revenue, contractor challenges, reduced coal offtake against contractual terms leading to penalties, as well as Eskom's sub-investment downgrade credit rating (Eskom, 2021c: 53).Eskom has highlighted that it has also been negatively impacted by below prudent and efficient cost-reflective tariffs but acknowledges that the tariff on its own, will not be enough to fully mitigate the risk of load-shedding (Eskom, 2022c). South African citizens and Eskom are looking to see progress on government's emergency capacity procurement programme to close the generation capacity gap to fully service the country's demand.

However, Eskom's municipal debt and energy losses remain a challenge and that the utility is working closely with government, communities, and the public to resolve these issues through the support of Department of Cooperative Governance and Traditional Affairs (COGTA) and energy awareness programme to drive to sustainable energy savings (Eskom, 2022b). The City of Tshwane has failed to pay Eskom a total amount of R908 million which was due and payable by 17 June 2022 (Eskom, 2022b). The City's erratic payments over the past year have contributed negatively to Eskom's increasing overdue debt (which is more than R46.6 billion), liquidity, financial performance, and its sustainability (Eskom, 2022b).

Eskom is extending the Koeberg Nuclear power station's operating life as an investment into sustainable and less carbon intensive electricity generation infrastructure. The long-term operation project is to extend Koeberg's life by another 20 years, which includes the replacement of six steam generators, are progressing in

accordance (Eskom, 2021). In line with the IRP 2019, the extension of Koeberg is economically feasible and will secure 1 860 MW for another 20 years (Eskom, 2021). The nuclear power station in Koeberg Western Cape, with a base-load station with an installed capacity of 1 930 MW (DMRE, 2019). Koeberg is the only nuclear power station in Africa that has a pressurised water reactor (PWR) design (Eskom, 2021). According to Eskom (2021), Koeberg nuclear power plant ranks amongst the safest of the world's top ranking PWRs of its vintage and is the most reliable Eskom power station and continues to operate well and within the required safety parameters and is the lowest primary energy cost of base-load stations.

Nuclear power plants provide large amounts of clean, reliable, affordable energy (Eniscuola, 2021). Nuclear power can contribute to SDG 7, as it increases energy access enables economic growth which is pivotal to many other SDGs (Eniscuola, 2021). Unlike fossil fuel-fired power plants, nuclear reactors do not produce air pollution or carbon dioxide while operating. Nuclear energy with emerging technologies such as small modular reactors could support increasing electricity access for rapidly growing urban populations (Eniscuola, 2021). This indicates that, nuclear energy is considered as one of the most environmentally friendly resources as it does not generate polluting emissions such as sulphides, dust or GHG (Eniscuola, 2021). Therefore, nuclear power projects are long-term investments and can operate for more than 80 years, making them cost-effective and affordable.

The DMRE has initiated a tender to select a service provider to develop a procurement framework for a new 2,500 MW nuclear programme, including conventional pressurized water reactors (PWRs) and small modular reactors (SMRs) (Enerdata, 2022).

NECSA is well positioned in supporting the GoSA to ensure that the nuclear new build programme meets its key objectives of the security of electricity supply, whilst further contributing to economic growth in the country, as well as improving radioactive waste management (NECSA, 2021b). NECSA is a state-owned company (SOC), mandated to undertake and promote research and development (R&D) in the field of nuclear energy and radiation sciences and technology (NECSA, 2021a).. The SOC is also responsible for processing source material, special nuclear material, and restricted material as well as to reprocess and enrich materials (NECSA, 2021a).

Furthermore, The National Nuclear Regulator (NNR) regulates nuclear safety, monitoring the nuclear industries and their waste production in SA (NNR, 2021a). It is funded by government grants and is responsible for the licensing of nuclear facilities. It is required to protect the public from exposure to radioactivity from sources like mining, nuclear research, nuclear electricity production and other industries (NNR, 2021b).

The GoSA recognises Eskom's critical role in the economy and remains committed to ensuring Eskom's financial stability by means of providing continued financial support. Furthermore, the GoSA is considering more than doubling the amount of private power producers can generate without requiring a license in a bid to reduce blackouts. Eskom is offering access to existing generation sites in Mpumalanga province that already have transmission connections (cleanenergynews, 2022). It hopes as much as 4 GW of capacity can be added over time. Each facility where land will be leased to private renewable energy producers will be limited to 100 MW of capacity (cleanenergynews, 2022).

With the rising prices of electricity, households and businesses are likely to implement energy efficiency practices and thereby use less electricity to make their monthly bill more affordable. Yet there is a possibility for citizens to illegally bypass their meters, as energy conservation is not an affordable route and the only alternative energy sources that are still exploited are paraffin, gas, and wood. The affordability and availability of electricity for poor South Africans remains an issue of national importance that ought to be addressed. Access to electricity is critical for the growth of small businesses, employment creation and growth. The on-going load-shedding and load reduction will weaken development opportunities, as Eskom is failing to facilitate access to electricity for small enterprises and home-based employment opportunities. For this reason, achieving universal access in terms of reliability, affordability and availability should be a national priority of the GoSA. South Africans ought to have access to enough electricity to meet their essential educational, household, and economic needs.

Eskom’s fundamental problem is its failure to build new power generation when it has been an urgent need to do so. Eskom will not be able to fix the problems at its coal-fired plants until the power supply gap is closed and there is enough additional

generation capacity to give the Eskom the space to take units offline for extended periods of time to run maintenance, complete existing projects such as Medupi and Kusile and extend the lifespan of Koeberg.

SDG 7.2 - Renewable Energy Share in total Final Energy Consumption

South Africa has significant renewable energy potential in both wind and solar, however, inadequate investment in renewables has prevented the maximization of the renewable energy sector. This section will investigate SA's progress in increasing the share of renewable energy in the global energy mix substantially. This section will touch on government Renewable Energy programmes, initiatives, cost of IPPs and public-private partnership in renewable energy sector, and further focus on the viability and affordability of Solar panels and wind turbines. This paper will not cover all renewable energy sources and the government's renewable energy projects and development programmes.

While the REIPPP has made a strong case for private investment, the delays in the introduction of bid windows as well as a lack of financial, technical and procurement planning services has become a deterrent. This results in SA experiencing uneven renewables investment due to a lack of stability in the government 's programme (Capital Energy Power, 2022).

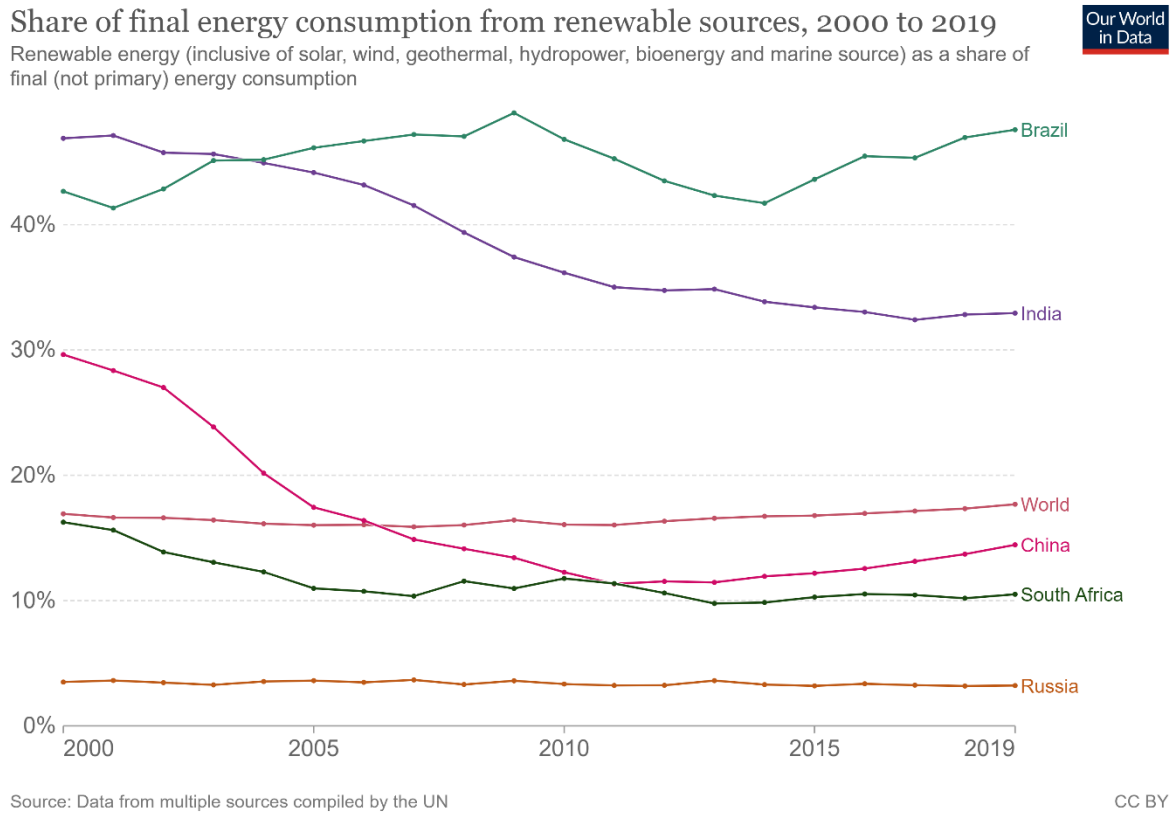
Despite efforts by the GoSA to accelerate renewable energy generation, through programmes such as REIPPP and policy reforms in the IRP 2019, a wide range of barriers continue to hinder the country in meeting its targets of expanding the share of renewables in its IRP recommended energy mix to 41% and SDG 7.2 target by 2030 (IRP 2019). The cumbersome decision-making structure has restricted Eskom from accelerating renewables rollout and deters the increased participation of the private sector in mobilizing funds and technologies required for the country to be green energy orientated. Electricity generation and transmission was highly regulated, therefore severely limiting private finance and investment options to build new power projects (Le Grange, 2019). For instance, unstable policy led to large annual fluctuations in

wind and solar project financing over 2015-20, dependent on the signing of PPAs (Power Africa, 2019).

Furthermore, in June 2022, Minister Gwede Mantashe reported that the IRP 2019 will be reviewed due to it supposedly being widely acknowledged to be out of date and failed to provide a timeframe for the publication of the update, nor indicate what process would be followed (Engineering News, 2022c). A month later, the DMRE confirmed that the IRP 2019 will continue to be implemented while it is in review, and consultations as well as updates on the process to review is set to continue well into 2023 (Engineering News, 2022a). Deep flaws in the prescribed energy mix, significant delays of new coal-fired power and unnecessary additional costs of regional integrated projects have become evident that the IRP 2019 is outdated (ESI Africa, 2022).

According to the chart provided in figure 8, from 2018, China, Russia and South Africa are below the global average for renewable energy share in total final energy consumption, while Brazil and India are substantially above the global average. Brazil has stable energy policies, and the country was the leading producer of biofuels, following hydropower, until 2014, however its energy supply is also supported by wind and solar power development (Pathak & Shah, 2019).

Figure 8: Renewable Energy share Country Comparison (Source: compiled by the UN)



According to Pathak and Shah (2019), Russia requires improvement in its legal and regulatory framework with more incentives in energy policies; China is improving on wind and hydropower but requires stronger policy measures to curb CO2 emissions; India needs revision in energy policy and requires extra incentives and consumer specific energy policies for research-infrastructure and energy generation technologies; and SA requires lessons to increase renewable energy and reduce coal mining. Pathak and Shah (2019) highlights that the importance of renewable energy and transition in SA only began to be acknowledged by the government in 2014. SA mostly uses its coal reserves for electricity generation; however, the country has a tremendous potential for renewable energy generation.

The coal reserves in SA make it hard for the country to shift away from these resources. According to WorldoMeter (2021), SA holds 35 053 million tons (MMst) of proven coal reserves as of 2016, ranking it 8th in the world and accounting for about 3% of the world's total coal reserves of 1 139 471 MMst. SA has reserves equivalent

to 173,3 times its annual consumption. This means that the country has about 173 years of coal left to generate electricity from (WorldoMeter, 2021).

In my consultations with the relevant government departments, in gathering information on barriers to upscaling renewable energy and energy efficiency in SA, there were key challenges in securing electrical energy from the private sector for renewable and non-renewable energy sources, that are imperative to highlight. These are the following issues that were captured:

- Delayed Eskom Transmission Grid investment: Eskom Transmission has no ring-fenced capital apportionment in Eskom, expropriation mandate to obtain servitudes and for power line right of way, creating a lack of Grid Capacity to connect IPPs. Grid Capacity to connect IPPs is due to inadequate local market resource capacity to implement the construction and manufacturing of designated equipment. Sustainable procurement of IPP programmes is needed to ensure a sustainable supply chain.
- Through the unbundling of Eskom, the independence in the Transmission System and Market Operator will ensure grid development. According to parliament hearings under the Select Committee on Public Enterprises and Communications, the legal separation of Transmission was to be completed by December 2021. It is anticipated that by the end of this financial year, there will be progress with the first milestone, which is setting up the Transmission business as an owned subsidiary of Eskom (PMG, 2021). This will open private investment opportunities in Eskom Transmission.
- Energy efficiency financial incentives: Eskom's financial sustainability is based on the sale of electrical energy. Energy efficiency is reducing sales and therefore conflicting with the financial sustainability objectives. Surprisingly, Eskom generates sufficient cash flow out of its operations to pay for its operating costs and to cover its debt obligations.

According to the KI 1 views on Eskom, the transition to more sustainable, reliable and affordable electricity is possible for SA. In consultation, it was highlighted that the growing energy demand and protection of the environment may be addressed although it requires long-term commitment from the government, innovative research would need to be funded, and clear focus will have to be placed on the needs of the

consumers and the country. Eskom's power stations operate throughout the year and Eskom's Generation Group maintains a varied portfolio of the plant, specifically the gas turbines, hydroelectric, pumped storage and nuclear units in addition to the coal fired plant (Eskom, 2021c). Although coal-fired power stations make up the largest portion of Eskom's energy mix, the utility is constantly investigating other forms of energy and renewable energy sources that could be of use to expand its current energy mix.

Solar energy utilized for water heating has its benefits as SA has higher degrees of solar radiation than most countries. The annual 24-hour global solar radiation average for SA is about 220 Watts per square meter (W/m2) panel - this is higher in comparison to about 150 W/m2 for parts of the USA and about 100 W/m2 for Europe as well as the United Kingdom (DOE, 2019b). This makes SA's solar energy resource one of the highest in the world and the intensity is almost twice as that of the UK.

Water heating is primarily a high load electricity usage and the utilization of installed solar water heating geysers in residential property and commercial buildings would be a great benefit in freeing up electricity capacity and in reducing the load on the National grid (Eskom, 2021). Water heating constitutes approximately 30% of the South African energy consumption in the combined domestic, commercial, and industrial sectors thus, solar water heating is a cost-effective renewable technology. For instance, solar water heating has been successfully installed at Rouken Glen Flats and Ethembeni School for the Disabled to name a few, to reduce energy consumption (Eskom, 2021).

In 2015, Eskom announced its first large-scale renewable energy project, Sere Wind Farm near Vredendal in the Western Cape has achieved its full commercial operational capacity of 100 MW (AfDB, 2015). The Sere Wind Farm is Eskom's first large-scale renewable energy project and forms a part of their commitment to renewable energy and reducing our carbon footprint - Eskom is building a world-class, utility scale wind farm (AfDB, 2015). In 2011, The African Development Bank approved a loan of USD 45 million with USD 50 million contribution from the Clean Technology Fund, which is one of the Climate Investment Funds (CIF) for this first state utility scale renewable energy project (AfDB,2015).

In gathering data from unions working in the energy sector, since 2018, NUM and NUMSA have been against the signing of contracts with IPPs. The unions believe that IPPs are detrimental to the working class of Mpumalanga in particular, due to is large coal sector, and the country. They believe signing of the IPPs is an indication that Eskom will require less coal-fired electricity in the future. Therefore, it is likely to lead to the closure of the coal-fired power plants and mines and the impact will cause at least 30 000 working class families to suffer due to job losses.

According to NUM (2018), it has been suggested that Eskom is buying electricity at R2.16 - 2.22 kWh from REIPPPs and has been selling at a loss of 89 cents per kwh. Their position has remained that, IPP renewable energy are much more expensive than other forms of electricity generation. Trade unions have vowed to fight the agreement set to be entered into between IPPs. Furthermore, at the heart of the disagreements over the IPP contracts is the potential loss in coal mining. There have not been enough assurances by the government that the agreements could possibly create more jobs and create opportunities for mine workers to reskill.

As recorded in the Eskom 2021 integrated report, Eskom generated 201 400 GWh for the year, from the primary energy sources, as shown in Figure 9. This shows that Coal-fired stations make up by far the largest proportion (over 90%) of all Eskom energy generation. Renewable energy is minimal, with solar energy not featuring and wind making up just 305 GWh, which is only 0.15% of total generation.

Figure 9: primary energy sources (Source: Eskom, Integrated report 2021**)**

Source, GWh	2021	2020
Coal-fired stations	183 553	194 357
Nuclear power	9 903	13 252
Pumped storage stations	4 795	5 060
Hydro stations	1 387	688
Open-cycle gas turbines (OCGTs)	1 457	1 328
Wind	305	283
Total	201 400	214 968

The comparison of the primary energy unit cost of the various generation categories is shown in Figure 10. This provides a breakdown of Eskom's primary energy costs and OCGTs and IPPs that are the biggest contributors to Eskom's costs after Coal as well as Nuclear.

Figure 10: primary energy unit cost (Source: Eskom, Integrated report 2021**)**

Unit cost, R/MWh	2021	2020	% change
Coal[1]	421	397	6.0
Nuclear	105	100	5.0
Eskom-owned OCGTs[2]	2 778	3 231	(14.0)
IPPs[3]	2 280	2 347	(2.9)
IPP OCGTs[4]	3 579	4 049	(11.6)
Renewable IPPs	2 178	2 206	(1.3)
International purchases[3]	567	550	3.1

Based on the Integrated report of Eskom's Annual results and financial statements as of 31 March 2021, the use of more expensive OCGT and IPP production to avoid or minimise load-shedding will cause Eskom to suffer from under-recovery of costs and earn insufficient returns. The new power purchases will negatively affect Eskom's financial position as the share of electricity supplied by IPPs continues to grow, largely in wind and solar PV power (Eskom, 2021: 6). IPP renewable power is more expensive than the current average unit cost of coal and nuclear power. Solar and wind require storage capacity as backup generation and this escalates the costs of renewables (WNA, 2021).

It is imperative to allow for the recovery of efficient and prudent costs and to place Eskom on a path towards operational as well as financial sustainability, and to secure energy security, economic growth, and job creation.

Taking into consideration the increasing cost-reflective tariffs as well as deteriorating energy generation performance, the current energy shortages South Africa is experiencing and cost to government through bailouts of Eskom, the uptake of renewable IPPs are a prime energy expense and consumers as well as taxpayers are bearing the cost.

Nonetheless, SA is set to receive $8.5 billion (R154 Billion) in the form loans and grants to help end its reliance on coal in a deal announced at the COP26 climate summit on 12 November 2021 (Presidency, 2021). The United States, United Kingdom, France, Germany, and the EU have agreed to this climate finance deal with South Africa to accelerate its shift away from coal and towards renewables, and to provide support to coal workers and coal communities (M&G, 2021a).

A political declaration on the Just Energy Transition in South Africa was agreed upon by the governments of the Republic of South Africa, the United Kingdom of Great Britain and Northern Ireland, the United States of America, the Republic of France and the Federal Republic of Germany, and the European Union (Presidency, 2021).

The governments mentioned above drafted and agreed to a resolution to (Presidency, 2021):

- Establish an ambitious long-term partnership to support South Africa's pathway to low emissions and climate resilient development, to accelerate the just transition and the decarbonisation of the electricity system, and to develop new economic opportunities such as green hydrogen and electric vehicles amongst other interventions to support South Africa's shift towards a low carbon future.

- Establish an inclusive task force comprised of SA and international partners, to enable: accelerated decarbonisation of SA's electricity system to achieve the most ambitious target possible within SA's NDC range to the extent of available resources; SA's efforts to lead a just transition that protects vulnerable workers and communities, especially coal miners, women and youth that are affected by the transition from coal; South Africa's nationally determined efforts to manage Eskom's debt, define the role of the private sector, and create an enabling environment through policy reform in the electricity sector, such as unbundling and improved revenue collection; successfully and sustainably; local value chains (including Micro, Small and Medium Enterprises) to benefit from new areas of economic opportunity; and opportunities for technological innovation and private investment to drive the creation of green and quality jobs as part of a prosperous low emission economy.

Eskom is already drowning in debt, there is a lack of investments in coal plants and the utility has struggled to supply reliable power, often resorting to rolling blackouts to meet demand. For South Africa to meet its ambitious climate goals by 2030, the rationale is that the country will most likely need to speed up the retirement of existing coal plants while building large amounts of renewable energy generation and transmission lines to meet growing demand.

The international pledges made could help the country just transition by accelerating investment in renewable energy, while ensuring that Eskom can access resources to repurpose old coal stations scheduled for retirement over the next 15 years. The Partnership is expected to prevent up to 1-1.5 gigatonnes of emissions over the next 20 years and support South Africa to move away from coal and to accelerate its transition to a low emission, climate resilient economy (M&G, 2021a).

Even so, South Africa's electricity industry is still facing major supply challenges. New capacity additions in renewable energy and IPPs have been insufficient to arrest the decline in electricity generated, and severe load-shedding has been imposed in 2021. This is against the backdrop of the coronavirus which has subdued economic activity.

Traditionally, Eskom was responsible for IPP procurement efforts, yet they have made minor progress. When the DOE that is now known as DMRE took over this role, it had little institutional capacity to run a programme of the size and complexity envisaged for the Renewable Energy IPP Procurement Programme (REIPPPP), it then approached the NT's Public Private Partnership (PPP) Unit for assistance (Eberhard and Naude, 2016). the DMRE, NT and the Development Bank of Southern Africa (DBSA) established the IPP Office for the specific purpose of delivering on the IPP Procurement Programme in 2016 with the objective to secure electrical energy from the private sector for renewable and non-renewable energy sources (DMRE, 2021a).

A small number of technical staffs from the Unit at Treasury and the DOE established a combined team known as the DOE IPP office with full authority to run the programme with the exclusion of Eskom (Eberhard and Naude, 2016: 4). In November 2010, the DMRE and NT entered into a Memorandum of Agreement (MoA) with the DBSA to provide the necessary support to implement the IPPPP and establish the IPP Office (IPPPP, 2022). A new MoA was agreed upon by all parties in May 2016 for an

additional 3-year period, then again in April 2019 for another year, and further extended for an additional 3-year period in March 2020 to 2023 (IPPPP, 2022).

According to Eberhard and Naude (2016: 3), in international renewable energy tenders, the practices that governments had typically chosen the sites and borne the cost of connection and generally assumed more of the risk of projects. In the case of South Africa, this would have placed undesirable fiscal pressure on the government and the decision was made to transfer some of these responsibilities to the IPP bidders. Due to the government's financial position, the negotiated RE projects tended to be more expensive to cover the costs of investment in transmission systems, to connect to the national grid and land acquisition (Eberhard and Naude, 2016).

The DBSA did provide a sizable R80 million for the DOE IPP unit to hire transaction advisors, a project office and to facilitate capacity building for the REIPPPP (Eberhard & Naude, 2016). The REIPPPP required sources of funding and further succeeded in generating interest from local, regional, and international project developers and financiers (Eberhard & Naude, 2016). The five largest local banks (ABSA, Nedbank, RMB, Standard Bank and Investec) contributed 68% of the external debt, and the DBSA and Industrial Development Corporation, which were instrumental in the REIPPPP's success, provided 13% of the debt (Eberhard & Naude, 2016).

Most major commercial banks have coal power exclusions or limitations, and proposed coal plants or other fossil fuel energy projects have faced legal and regulatory challenges from civil society. In March 2022, Standard Bank Group became the latest South African bank to confirm that it will no longer finance new coal-fired power plants or support the expansion of existing coal-fired power plants as part of its newly unveiled commitment to achieve net-zero carbon emissions from its portfolio of financed emissions by 2050 (Engineering News, 2022e).

It is noted that it is essential for governments to build on best international practices in running competitive tenders for new power generation capacity, including renewable energy. However, throughout this process, Eskom was not included in the development and implementation of the IPP policy as well as the evaluation and approval of tenders, yet Eskom is the single buyer of the electricity produced by IPPs (Eberhard & Naude, 2016). Taking into consideration Eskom's weak financial position

and the need for NT guarantees, the high cost of renewable IPPs cannot be prudent if the decision to procure REIPPs was not made by Eskom. The IPP procurement programme was intended to procure around 30GW of power from IPPs, except the IPP office took away Eskom's energy procurement mandate and its role in shaping as well as the rollout of IPPs (PMG, 2018; Eberhard & Naude, 2016).

Solar is weather dependent and Solar Energy Storage is expensive. Furthermore, it is more efficient to utilize solar energy during the day, as the storage of surplus solar energy quantity produced cannot be stored for a long period of time (Lakatos, Hevessy, and Kovács, 2011).

Moreover, PV panel waste presents a new environmental challenge. According to the International Renewable Energy Agency (IRENA) and International Energy Agency Photovoltaic Power Systems Programme (IEA-PVPS) technical Report on end-of-life management: Solar PV Panels, it highlights that recycling or repurposing solar PV panels at the end of their roughly 30-year lifetime can unlock an estimated stock of 78 million tonnes of raw materials and other valuable components globally by 2050 but only if it is fully injected back into the economy (Weckend, Wade, and Heath, 2016). Therefore, if policy action and enabling frameworks for end-of-Life Management are not in place, decommissioned PV panels will become a waste problem and an environmental risk (Weckend, Wade, and Heath, 2016).

In the case of SA, with virtually non-existent prior training on SWH maintenance, it is not surprising that the heaters were easily prone to damages. The dysfunctionalities observed in the SWH were further aided by the lack of proper quality control measures to checkmate such defectiveness in the local and imported SWH (Akinbami et al, 2021). The technical challenges of SWH are especially worrying in industrial and commercial settings where experts are required to navigate through the challenges that will be experienced during large-scale planning, installation, and maintenance of the SWH systems (Akinbami et al., 2021: 5088). The lack of experience and technological knowledge as such have created situations that are potentially devastating to the SWH industry (Akinbami et al., 2021).

A study by Edzisani Netshiozwi 2019, provided findings from interviews conducted with households from two communities in the Gauteng Province (i.e. Soshanguve and

Alexandra) and officials from the DoE, the Gauteng Department of Economic Development (GDED) and two municipalities (City Power on behalf of the City of Johannesburg and the City of Tshwane) found that the programme failed due to the subsidization of imported products, poor quality installations leading to non-functioning SWHs, lack of training and poor planning by the involved institutions as well as unreliable verification of the number and location of installed heaters as a result of lack of systematic reporting and independent verification (Netshiozwi, 2019). The programme would successfully contribute to the reduction of the electricity load, reduction of GHG emissions and further improve the livelihoods of the poor. There is a need for better ecological governance systems which include improved institutional arrangements, improved capacity for the technology and scaling up the roll-out of the SWH programme as intended (Netshiozwi, 2019).

As for wind energy, its production fluctuates and changes depending on the season's changes (Lakatos, Hevessy, and Kovács, J., 2011). Furthermore, wind turbines may be dangerous to flying animals, as many birds and bats have been killed by flying into the rotors. Experts are currently conducting research to learn more about the effects that wind turbines have on marine habitats as a further step to analyse the environmental impact of wind energy (Lloyd, 2014). There is potential for wind energy generation to have adverse environmental impact that can possibly reduce, fragment, or degrade habitat for wildlife, fish, and plants due to its effects on migration of flying animals. Moreover, wind turbines have high recycling potential, however decommissioned blades are also difficult and expensive to transport (Stella, 2019).

Furthermore, the disadvantages of wind power are that does not operate solely from wind, turbines must be equipped with conventional generators, which are an additional cost to utilising this energy source (Bratley, 2017). Another disadvantage that is costly, is that to get good wind often requires remote locations, which means new transmission lines are required to be built from wind farms (Bratley, 2017). Wind energy development may not be as profitable.

Therefore, like solar panel end-of-life cycle mentioned above, if there is no careful consideration of various wind turbines end-of-life options, location of wind farms and how to reduce costs, this poses potential risks to the ecosystems as well as hidden costs (De Jager, 2021). Wind turbines make a noise when in operation (De Jager,

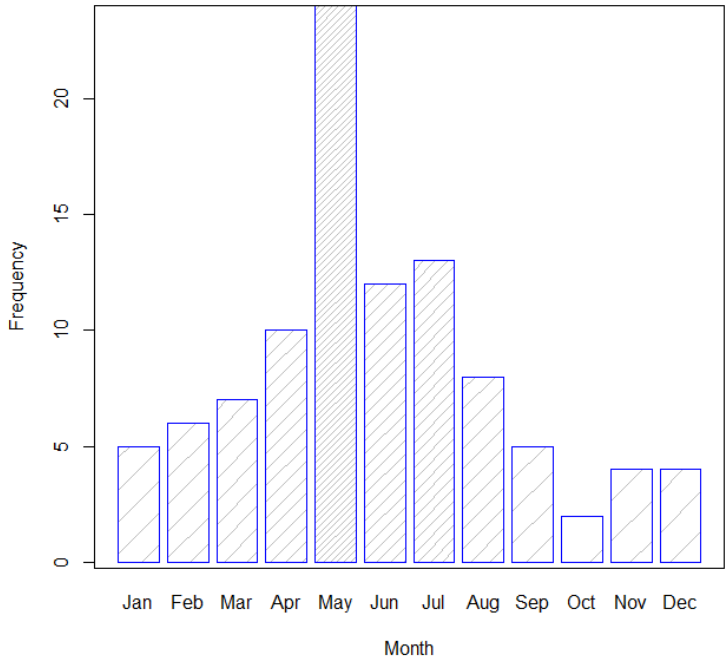
2021). Early wind turbines were designed for maximum generation and emissions savings, with the reduction of noise not being a priority. The sound levels of wind turbines are high during periods with higher wind speeds (De Jager, 2021). Wind farms and park can have a negative implication on the local ecological system of an area. Like other energy sources, wind projects can affect the habitat on which they are built, which may alter or kill the suitability of that habitat for certain species.

Furthermore, with large electricity generation system cannot be based upon renewable sources of energy, because the latter are alleged to be 'intermittent' sources that cannot provide efficient and low energy cost baseload (24-hour) power (PennState, 2020). Renewable energy can contribute to the grid when it is available, it cannot be stored in an economically viable manner and can therefore not provide base load power at a reliable and affordable manner. Solar and wind systems can be efficient means to help reducing dependence on fossil fuels, but Solar and Wind energy systems cannot be immediately employed to respond to peak demands (PennState, 2020).

In the case of SA, the energy production structure consists primarily of coal, crude oil, and nuclear energy, providing base-load power while natural gas and renewable energy provide the reserves to meet peak demand. Base-load power stations, largely coal-fired, are designed to operate continuously at a steady load 24-hours a day (Eskom, 2021). Base-load power is also supplied by nuclear power stations at Koeberg, Western Cape (Eskom, 2021).

Solar and wind energy as well as with the current technological infrastructure being implemented, cannot effectively provide for base-load electricity. Base-load is the minimum amount of electric power delivered or required over any given period at a steady rate (EIA, 2021). Therefore, solar and wind energy generation capacity cannot normally operate to serve loads of electricity on an around-the-clock basis and throughout all seasons of the year. Unless there is battery storage capacity. However, Battery lifetimes and performance is the cost of services. battery storage remains a costly component. Until the prices in energy storage fall, higher costs in batteries will be less attractive than other energy generation resources.

Figure 11: The monthly frequency of occurrence of extreme inter-day increases in peak electricity demand in South Africa



The electricity demand in South African households is highly sensitive and related to cold temperatures (Chikobvu, and Sigauke, 2013.). Extreme low average daily temperatures very rare in South Africa, however they only occur about 8 times in a year and result in huge increases in electricity demand as depicted in Figure 11 above. South Africa has stochasticity of peak electricity demand, and extreme inter-day changes in electricity consumption (Sigauke and Chikobvu, 2017). In a constrained power system such as that of South Africa, which is currently operating with a very tight reserve margin (Sigauke and Chikobvu, 2017). So, unless there is a base load effective electricity generation system in place, solar and wind energy systems cannot be relied upon to meet constant electricity supply needs, nor can they be immediately employed to respond to peak demands.

Furthermore, raw materials are key critical components to renewable energy. The material intensity of the different technologies for renewable energy storage has driven the global demand for raw materials, namely lithium and cobalt (Meindertsma and Blok, 2014). Energy storage is key to providing added value to renewable energy. Battery electricity storage is a vital technology in the transition to sustainable energy (Ralon et al., 2017).

Batteries play an important supporting role for renewable energy sources such as wind and solar, allowing excess power to be stored for usage when direct solar or wind power are unavailable (USGS, 2019). The Battery system provides support in storing surplus energy and releasing it later, when the sun is not shining or the wind not blowing strongly enough (Ralon et al., 2017). Furthermore, electricity storage capacity can reduce constraints on the transmission network and can suspend the need for major infrastructure investment (Ralon et al., 2017).

Battery energy storage systems (BESSs) offer desirable services for peak demand, but these services are depended on effectively the size of the battery capacity (Brogan et al., 2020). Furthermore, BESSs may not be as profitable under certain service payments, but returns can be maximised through revenue stacking (Brogan et al., 2020). Revenue stacking raises challenges such as maximising battery revenue across multiple markets, increasing battery investment viability, and understanding the impact of market participation on the lifespan of a Battery Storage System (BSS) (Seward et al., 2022). The most common method to generate revenue for BSSs is purchasing electricity when the price is low and selling it when the price is high (Seward et al., 2022).

Batteries for renewable energy storage have not been extensively commercialised due to their comparatively high cost (Ralon et al., 2017). For instance, the disadvantages of the battery storage include its relatively low efficiency and its complex system architecture, potentially leading to a high cost for repair and maintenance (Ralon et al., 2017). At the same time, BSS will grow in the future as costs fall and performance improves.

These batteries rely on critical mineral commodities, particularly in cobalt, graphite, lithium, and manganese (USGS, 2019). The Democratic Republic of Congo (DRC) is the World's largest cobalt producer (Statista, 2021). Despite having the largest reserves of cobalt as well as other minerals in the world, the DRC still suffers from poverty and corruption, however, DRC’s mine production of cobalt has tripled since 2008 (Statista, 2021).

Studies have recorded alarming radioactivity levels in some mining regions - mining waste often pollutes rivers and drinking water, neither do the diggers use power tools

nor wear face masks and often, they do not wear gloves (Sovacool et al., 2021). Due to a huge surge in the global demand for cobalt, in the effort to reduce carbon emissions and slow climate change, the health consequences and dangerous working conditions are dire for the people of the DRC (Sovacool et al., 2021). Cobalt extraction, smelting and other related industrial practices in the Southern region are polluting the environment and contaminating people working in the mines and those living close to them (Sovacool et al., 2021: 17).

In the path for zero carbon emissions, let there be provisions of social safety nets (social assistance, social insurance, and labour market policies) to mitigate the impact of a just transition that may aggravate poverty, unemployment, and inequality (Hallegatte, 2016). There is a lack of consensus around the just transition that is creating barriers to strengthen climate action, social acceptance and substantially, increasing the share of renewable energy into Eskom's energy mix. Albeit the public has mostly welcomed the recommended least-cost electricity supply plan while advocating for the energy mix in line with the NDP and the IRP in 2019(IRP, 2019).

Renewable technologies are not without their own potentially negative environmental and other impacts. They can lead to several concerns, principally their direct ecological impacts associated with land and water use, and their increased consumption of iron, cement, and copper (Hertwich et al., 2016). Renewable energy projects are complex to install and are local environmental and condition sensitive, as their forecasting, execution, and planning require more consideration (Kumar, 2020). Similar ecological impacts related to land and water use are also associated with fossil fuels: for example, land use by coal mining is similar in scale to that of wind and solar power and Windmills.

The relocation of people from the areas where renewable energy power plants are going to be constructed is a major social problem (Kumar, 2020). Fossil power plants use somewhat less water than concentrated solar power plants, but options such as air cooling are now becoming available for abatement technologies (Hertwich et al., 2016). There are some shortcomings that exist in renewable energy output, not only just due to seasonal change.

Lastly, with the electricity supply crisis, renewable energy technologies, environmental policy, and renewed attempts by government and civil society to hold Eskom accountable have not done enough to accelerate reform in the energy sector. Coal mining for electricity generation continues to dominate with continuing environmental effects (Omorogbe & Ordor, 2018). This industrial complex is damaging to air and water quality and is a barrier to sustainable and inclusive development (Sharife & Bond, 2011).

The SA's renewable energy market is expected to experience significant growth due to supportive government measures recently introduced. Therefore, significant investment needs to be directed towards energy storage solutions, improving energy security and reliability. The frequent power cuts and the pressure to reduce dependency on energy generation from fossil fuels, are expected to drive renewable energy generation. As costs continue to decline with technological advancements, the social appeal of clean energy is expected to grow, which will lead to an accelerated interest in South Africa's green energy sector.

The GoSA through PPP and Eskom, should take into consideration the up-skilling the workforce in the mining-energy sector, prioritize capacity building and skills transfer toward the green energy sector to prevent unemployment rise for coal workers and ensure that there is an adequate workforce of South Africans for the clean energy.

The country has abundant wind and solar power resources. But a trade off in the energy mix prescribed by the IRP 2019, is a solution to the crisis. Low-carbon electricity generation could help meet demand while reducing climate change effects. But new technologies could create new environmental problems as highlighted above in my findings.

There are benefits, risks, and trade-offs of low-carbon technologies for electricity production that need to be carefully and strategically considered. Cost of technologies, high skills requirement, the social as well as environmental cost of mining minerals needed for necessary components of renewable energy, affordability of electricity and accessibility are very important considerations to find a balanced approach to making trade-offs to a long-standing energy supply solution.

SDG 7.3 - double the global rate of improvement in energy efficiency by 2030

South Africa has the potential to improve in energy efficiency atdouble the global rate by 2030. Energy efficiency is an important component in reducing emissions, energy poverty and enabling sustainable development. However, it requires public and private participation and collaboration. To best support energy efficiency will require incentives and policies aligned with the operations of certain sectors and industries, as energy efficiency initiatives can assist in creating new jobs, reducing energy costs, and lowering demand from Eskom.

This subsection will touch on how private sector and consumers have led the way to energy efficiency and how can government promote and incentivize the conservation of energy. Government's policies and strategies will be highlighted and its progress in implemented. It should be noted that this will cover all government and private initiatives, as that is beyond scope of this research.

Eskom has introduced energy efficiency programmes to reduce energy usage by specific end-users, typically without affecting services provided or operations. Through energy saving tips, Eskom has presented methods for households to reduce monthly electricity bills, to preserve the environment and to minimise the possibility of load-shedding by means of lessening the demand on electricity supply (Eskom, 2020). Eskom drove a large-scale Energy Efficiency Demand Side Management (EEDSM) programme involving the rollout of Compact Fluorescent Lights (CFL) in households, the hospitality and commerce sector (Eskom, 2012). Efficient lighting reduced energy costs, emissions produced during the burning of fossil fuels to produce electricity and through private sector participation the CFL project created jobs (Eskom, 2012).

In 2005, the National Energy Efficiency Strategy (NEES) was approved by the Cabinet and released to explore the potential for improved energy utilisation through reducing the nation's energy intensity with the target of 12% by 2015 (DOE, 2008). As a part of implementing the 2005 NEES (DOE, 2008), interventions were to:

- Enhance energy security by making better use of existing and new generation capacity;

- Improve South Africa's global competitiveness through reduced energy input cost; and
- Decouple growth in energy consumption (and GHG emissions) from growth in GDP**.**

The GoSA has redeveloped and published the post -2015 National Energy Efficiency Strategy (NEES), as a setting to update its vision to promote energy efficiency as the first fuel in driving balanced, socially inclusive, and environmentally sustainable economic growth, boosting job creation and leading technological innovation across the SADC region (DOE, 2015).

The strategy demonstrates an intention to implement, however, it is not completely evident as the associated results have not been sufficiently shown in the public. The government has made substantial progress with the introduction of solar heating water geysers, building retrofitting and gas appliances.

Several government-led initiatives have been implemented to promote the energy efficiency, green growth, and renewable energy uptake in the South African economy, which include (NT, 2021):

- Putting a price on carbon, via the carbon tax, and the publishing of offset regulations to enable reduction of those taxes through climate-positive investments
- REIPPP
- R&D tax incentives including for green technologies (150% deduction)
- Tax incentives for biodiversity conservation
- Energy efficiency savings tax allowance
- Regulations for carbon offsetting under the Carbon Tax (Nov 2019)
- Motor vehicle emissions tax to promote the sale of vehicles with lower carbon emissions during their operating phase
- Incandescent globe taxes to stimulate the uptake of low energy light bulbs

In 2020, 15 out of the 18 participating municipalities in Government solar water heater programme, accounted that 61 096 out of 87 000 of the geyser units had been delivered to them (PMG, 2020). Furthermore, nine service providers had been

appointed to install the geysers and the DMRE has aimed to complete the installation of 33 000 units from 61 096 geysers delivered by the end of December 2020 (PMG, 2020).

The Department did account to Parliament that some of the challenges the programme was facing included water quality, structural problems, and non-standard plumbing in the houses where the geysers were intended to be installed and other challenges were coordination with municipalities and ensuring the participation of local businesses (PMG, 2020).

On 8 December 2020, government introduced legislation to make it mandatory for accounting officers and building owners to display and submit an Energy Performance Certificate (EPC) for their building, with an effective end date of December 2022 and failure to publicly display the EPC is in contravention of the Act (Act No. 34 of 2008) (SANEDI, 2022).

A substantial proportion of SA's non-residential buildings will be required to submit and display an Energy Performance Certificate (EPC) come December 2022. Energy Performance Certificates for buildings indicates how much energy is being used to operate a building. The energy performance of the building is based on measured energy consumption and is compared to the maximum energy consumption provided for (SANEDI, 2022). The energy performance of a building is measured in terms of kilowatt-hours per square metre of net floor area(kWh/m2/pa), per annum (SANEDI, 2022)

All specified data used to determine the EPC and a certified electronic copy of the EPC must be submitted to the South African National Energy Development Institute (SANEDI) and then it will be uploaded to the National Building Energy Performance Register (NBEPR) (SANEDI, 2022).

Energy efficiency policies and Eskom's programmes have also targeted low-income households have made positive impacts and are more effective in reducing energy poverty. As stated in the background of the research, the government, and local municipalities in South Africa to provide free solar water heaters to low-income households. Furthermore, DMRE has mandated SANEDI to conduct energy research

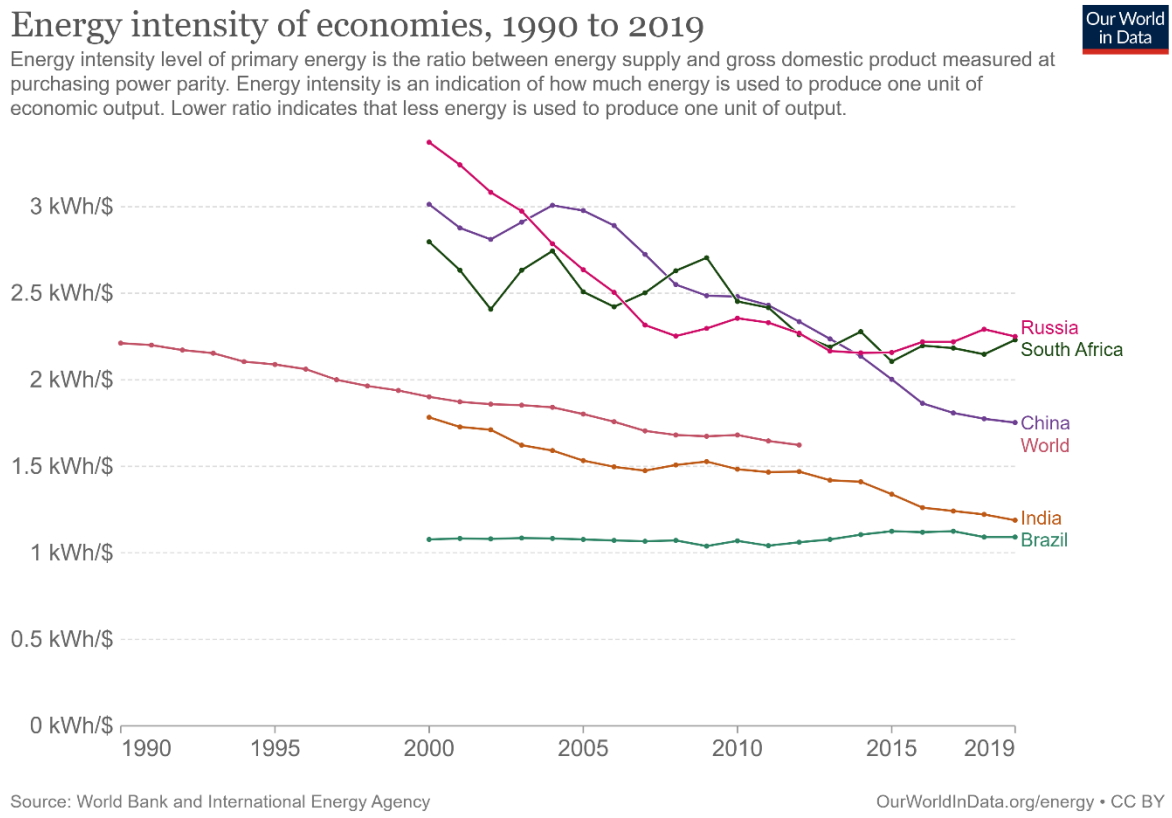
and development, as well as undertake measures to promote energy efficiency (SANEDI, 2022).

SANEDI has launched several programmes, which has implemented the installation of 12,200 smart metres across 10 municipalities to enhance revenue, advance metering infrastructure and implement active network and asset management (SANEDI, 2022). SANEDI has established a smart grids laboratory, provided bursaries to 47 engineering students, developed 12 training curriculums for municipal officials, produced 21 technical publications and presented 12 conference papers (SANEDI, 2022). Furthermore, SANEDI developed guidelines to provide insight into government's Energy Performance Certificate (EPC) regulations, standards, and easy-to-implement processes so that accounting officers and building owners can obtain mandatory compliance (SANEDI, 2022).

Energy efficiency has been high on the agenda of the BRICS countries. BRICS energy ministers have committed to improve efficiency in the use of natural resources; promote energy efficiency technology to reduce the use of fossil fuels; strengthen energy security cooperation through joint research on strategic reserves, renewable energy, and energy efficiency; and develop investment opportunities for the New Development Bank (NDB) especially in the fields of renewable energy and energy efficiency (BRICS, 2018).

These commitments were made in 2018, although unfortunately, the IEA and the UN Statistics Division (UNSD) have not recorded or captured any data on improvements of energy efficiency for the global average post-2012, as depicted in the chart below (Figure 12). Nonetheless, taking into consideration the trends displayed in Figure 12, energy efficiency had been depreciating globally. Even so, South Africa, Russia and China are at least above global average. As noted above, the SDG 7.3.1 indicator applies energy intensity per USD of GDP is an imperfect proxy for energy efficiency, but it does give some indication. Tracking efficiency improvements is difficult to record and compare.

Figure 12: National Efficiency Intensity (Source: International Energy Agency (IEA) and World Bank**)**



For South Africa to meet its climate change commitments it must attempt to employ building efficiency tools through means of better regulations, standards, initiatives, and certifications. To build efficiency, more incentives and financing are means promote the uptake of new green builds and the energy-efficient retrofitting of existing buildings and alleviate the burden of the upfront costs associated with renewable energy components and installation (Boshoff et al., 2020).

The biggest driver of private initiatives to improve energy efficiency is the increasing cost of electricity. There has been a significant increase in electricity expenditure and there is an expected increase in tariff for the financial year of 2022, and households have already started looking for ways to cut down on their electricity bills. Households that can afford to, will invest in appliances and technologies that reduce their demand on the grid (Goliger & Cassim, 2018). The impact of rising electricity tariffs on households and household investment in electricity efficiency has the potential to cause a reduction in electricity demand that will reduce profits for electricity suppliers, namely municipalities and Eskom (Goliger & Cassim, 2018). As households begin to

demand less electricity or choose not to pay, the electricity revenues at municipalities and at Eskom, will be affected (Goliger & Cassim, 2018).

Incorporating energy efficiency technologies in the design of developers' projects creates extra costs for these green measures and can affect the returns of investors. Thus, it is important, Government plays an important role in developing financial incentives and programmes to promote construction of energy efficient residential as well as non-residential buildings. However, collaboration between government and the private sector is essential in the development of energy market and requires a large campaign rollout to broaden public awareness of EE to educate the public on improved energy efficiency but such collaboration has been quite limited in South Africa (DOE, 2018a).

In South Africa, the main barrier to the investment opportunity in green buildings was due to the lack of investors and financiers to finance (Likhacheva Sokolowski et al., 2019). Banks and fund managers required that the GoSA create an enabling environment for developers to build green, create conditions for the growth of green fiancé and assets in the financial sector (Likhacheva Sokolowski et al., 2019). As mentioned above and the background on Government's policy, the Government has implemented a series of reforms that promote economic transformation and green growth. Government is facilitating the shifting of green infrastructure investment by mobilising private sector funding of new and more sustainable projects, through the REIPPP, Social Compact on Eskom, the President's reconstruction, and Recovery plan, as well as ESG-related regulations are creating an enabling environment for reducing carbon emissions, using resources more efficiently and cutting down waste production and complying with environmental regulations.

Two South African banks are offering 'green loans' to citizens and construction developers to provide financing to incentivize green adaptability and resilience (Boshoff et al., 2020). Nedbank, one of the big banking groups in South Africa, offers an extension to their home loan product, where renewable and energy-saving products from a specific supplier can be rolled into homeowners' home loans (Nedbank Limited, 2019). In 2020, ABSA, another large banking group, in collaboration with Baldwin Properties, launched 'Absa Eco Home Loan', which provides preferential interest rates on the 16 000 EDGE-certified homes under

development by Baldwin Properties (Engineering News, 2020). EDGE is a rating tool that measures and proves the financial case for building green and is set at a minimum of 20% reduction across energy consumption, water usage, and embodied energy in building materials (GBCSA, 2022).

South Africa's construction industry has taken substantial steps towards going green. Since the introduction of energy-efficient building regulations that came into place in 2011, the industry has been boosting a growing trend of cutting-edge green architecture throughout the country (Old Mutual, 2020). In 2013, South African Banks started to incorporate the concept of sustainability building into their business and are working with communities in the push towards going green (SA Commercial Prop News, 2013).

South African commercial property services companies and the South African Council of Shopping Centres have made massive energy shift. South African retailers, shopping centres and property developers are investing to reduce its environmental footprint, following the green sustainability-linked loans being finally provided by local banks (BusinessTech, 2022d). New and existing retail centres around the country are harnessing solar energy to limit their environmental footprint and reduce high electricity costs. Owners of buildings in South Africa have until December 2022 left to obtain and prominently display an EPC or risk a fine.

The GoSA has at least begun to implement carbon tax to disincentive to carbon-intensive businesses, which would encourage greater energy efficiency. This new tax is in response to climate change and is aimed at reducing greenhouse gas (GHG) emissions in a sustainable, cost effective and affordable manner (SARS, 2022). Carbon Tax gives effect to the polluter-pays-principle and helps to ensure that firms and consumers take the negative adverse costs (externalities) of climate change into account in their future production, consumption, and investment decisions (SARS, 2022). The carbon tax came into effect from 1 June 2019, the first carbon tax payment which was due by 31 July 2020 was delayed to 31 October 2020 due to the economic impacts of the COVID-19 pandemic (SARS, 2022). According to the International Energy Agency (2020) a review of the impact of the tax will be conducted before the second phase, after at least three years of implementation of the tax, and will consider

the progress made to reduce GHG emissions in line with South Africa's NDC Commitments.

Government has extended the first phase of Carbon Tax by three years to 31 December 2025, to support businesses in their clean transition (NT, 2022). The carbon tax rate has increased from R134 to R144 per tonne of carbon dioxide equivalent, effective from 1 January 2022. The carbon fuel levy for 2022 will increase by 1 to 9 cent per litre (c/l) for petrol and 10c/l for diesel from 6 April 2022 (NT, 2022). This tax aims to encourage investment into cleaner technologies which improve energy usage and incentivise energy efficiency. the postponed deployment of the carbon tax provides temporary relief, companies would encounter steep taxes if they failed to put in place plans to reduce their emissions over the coming years.

According to Gustafsson (2021) South Africa's carbon tax rests on several modelling exercises and has been considered exemplary by international organisations such as the Intergovernmental Panel on Climate Change (IPCC) for its comprehensiveness and relative simplicity. South Africa has a well-designed carbon tax that is efficient insofar as it minimises the high economic costs on operations and production, for instance, in power generation (Gustafsson, 2021). Hence the GoSA has provided a 3-year extension to alleviate pressure on Eskom as well as Sasol and has set a sufficient rate that will not discourage doing private business in South Africa.

There are critiques of the new carbon tax. For example, most sectors and industries will be forced to explore to avoid the carbon tax and use cleaner energy in their economic activities. The tax will thus increase production costs and will effectively be passed on to consumers (Kalaba, 2020). Overall consumer welfare will be negatively affected by the increase in prices arising from the carbon tax (Kalaba, 2020). Another challenge is that the policy applies to domestic products, but there is no equivalent policy to address imported products that may have been produced using similar methods. This will make domestic products uncompetitive, while imported products may undermine the whole policy (Kalaba, 2020).

Another example, Greenpeace argues there are too many loopholes in the form of exemptions and states that Eskom and Sasol were able to avoid paying its carbon tax obligations because of these exemptions. They also argue that the revised tax rate

remains significantly lower than the effective carbon rate of R292.55 – R585.10, proposed by the High-level Commission on Carbon Prices (Greenpeace, 2022).

On 23 September 2019, the Commission was launched on the margins of the UN Secretary-General's Climate Action Summit, to provide key insights and considerations that can guide countries in introducing mandatory pricing of GHG emissions, explore policies that can provide assistance to emerging green industries, can support carbon pricing, and alleviate competitiveness concerns, especially for energy-intensive trade-exposed (EITE) industries (IISD, 2019). With that being said, NGOs such as Earthlife Africa and Greenpeace have contended that South Africa cannot rely on market mechanisms such as carbon taxes to mitigate climate change, these measures that encourage Energy Efficiency must be more aggressive with decarbonisation strategies and widespread uptake of renewable energy, as Sasol has set no measurable emission reduction target until 2025 and has not committed to ensuring that its emissions do not increase in the next three years (Greenpeace, 2022; Earthlife Africa, 2021).

In 2010, the GoSA introduced the vehicle CO2 tax, to reduce the carbon output of the new vehicle fleet by incentivising the purchase of more fuel-efficient vehicles (Nkosi et al., 2021). It is an environmental levy is payable on certain locally manufactured motor vehicles, The tax is largely based on engine size and is levied based on the amount of CO2 emitted per vehicle, increasing for every g/km emitted over 120g/km of CO2 (Nkosi et al., 2021).

Based on subsequent new- fuel efficient vehicle sales data, from 2013 to 2018, the reforms have led to significant CO2 reductions. Overall, CO2 taxes moved consumer preference to low-emission vehicles and discouraged the purchase of bigger, heavier, and more powerful vehicles (Nkosi et al, 2021). Moreover, there is some evidence that the tax has affected the mix of new vehicles that vehicle manufacturers sell in the South African market, as the volume of low carbon intensity new vehicles increased significantly, to 31% of total sales in 2018 compared to 13% in 2010 (Nkosi et al, 2021).

However, there is another view, the structure of this tax policy does not suit the dynamics of the South African vehicle market and the policy would require restructuring for it to be more effectively reduce fleet emissions (Vosper and Mercure,

2016). South Africa experiences large growth in vehicle sales is to due poor public transport with limited rail networks and a low percentage of airline traffic, so this tax is not incentivizing less cars or driving on the roads (Vosper and Mercure, 2016). In addition, for the vehicle tax to effect significant fleet emissions reductions in the future it will require the emergence of low- and zero-carbon vehicle technologies in the lowest price brackets of the market, possibly via subsidy policies (Vosper and Mercure, 2016). But SA does not have the fiscal policy space to incentivize manufacturers to accelerate the adoption of zero-emissions vehicle technologies.

The GoSA can do more to strengthen national incentives or legislative directives to enforce energy efficiency and help reduce the upfront cost burden. Environmental accountability is the new norm, and companies ought to begin looking for innovative means to reduce their emissions footprint now or risk suffering the consequences of inaction. Furthermore, based on all the above, there is a need of improved and strengthened Energy Efficiency Policy as well as Incentive Programme Frameworks in SA, due to (DOE, 2018a):

- Limited public commitment and prioritisation of policy and regulations to enforce energy efficiency.
- Limited delivery and implementation capacity among the public and private sectors implies a need to create dedicated public and private entities towards scaling up energy efficiency.
- Lack of effective regulation and coordination between the public and the private sector resulting inconsistent energy efficiency and limited financing.
- Limited coherence with relevant sectoral policies and legislation in terms of strategic implementation.
- Split incentives: the advantages of the incentive might not benefit the part of making the investment in energy efficiency, particularly evident in building regulations.

Lastly, the immediate priority has been to stabilise Eskom's financial position and improve generation capacity. Sources of finance are being channelled more towards Eskom’s capital requirements than energy conservation. Thus, one can speculate that the interest in energy efficiency has become more of a secondary priority, as means

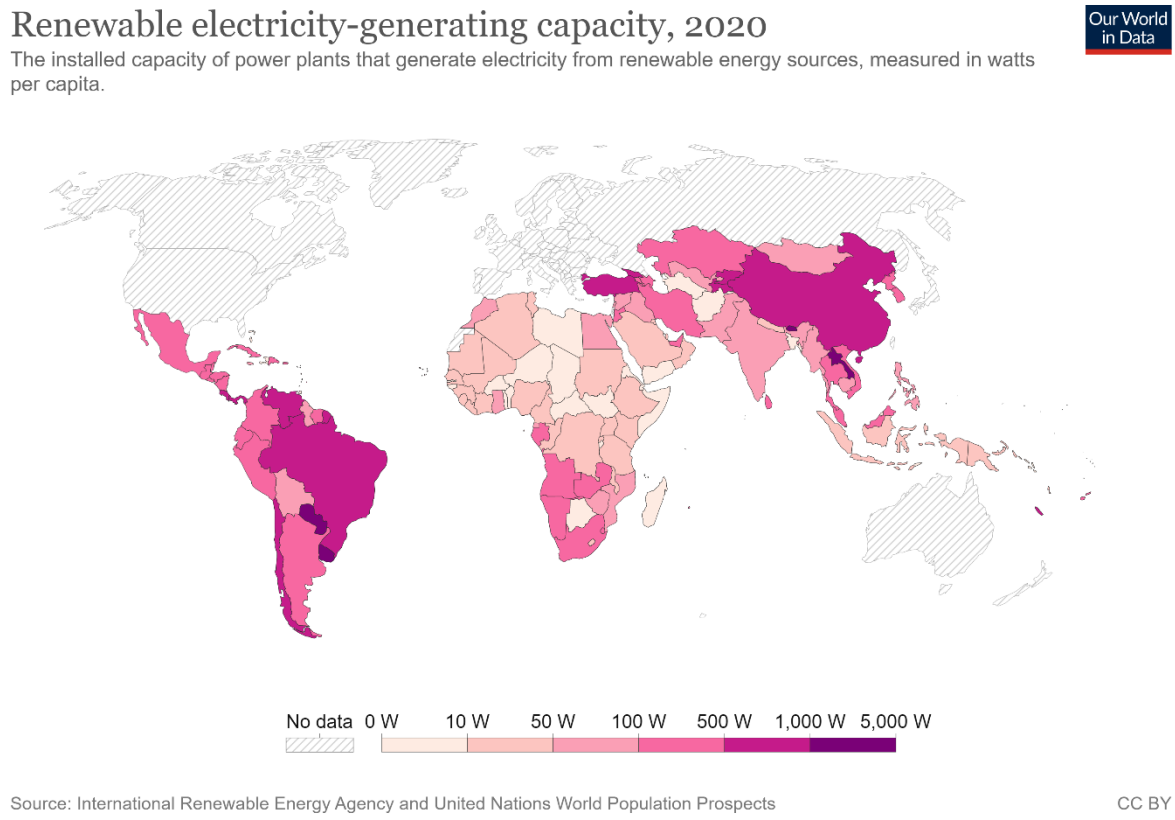
of encouraging consumers and businesses to reduce electricity demand and to practice energy efficiency.

SDG 7.B - by 2030 expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries

SDG 7.B target is by 2030, is to expand supply of sustainable energy in developing countries and the indicator to assess progress of its implementation is the results of installed renewable energy-generating capacity in developing countries, in watts per capita generated. South Africa has an opportunity by 2030, to expand infrastructure and upgrade technology for supplying modern and sustainable energy services. This last-mentioned SDG 7 target will explore how is South Africa accelerating expansion of renewable energy generation and expanding on other modern as well as sustainable energy services to mitigate risk of load-shedding and meet SA's energy demands. Furthermore, this section will touch on certain government driven energy initiatives and opportunities that are not renewable which has received some resistance from NGOs on the IRP proposed energy mix in electricity generation.

South Africa renewable energy generation is standing at 729.78 kWh per capita (World Data, 2019). In 2019, renewable energies accounted for around 10.5 percent of actual total consumption in South Africa (World Data, 2019). Please see Figure 13 below that provides a comparative imagery of Installed renewable energy-generating capacity in developing countries (in watts per Capita) as of 2020. The DOE (2021) recorded that the REIPPPP power production was dominated by onshore wind power at 60%, followed by PV power at 30%. Concentrated solar power and small hydro power contributed 10% and 1%, respectively, to electricity produced through the REIPPPP in 2018 (DOE, 2021).

Figure 13: Renewable electricity-generating capacity in 2020 (Source: International Renewable Energy Agency and United Nations World Population Prospects)



On 15 March 2021, Eskom's CEO Andre de Ruyter, publicly warned South Africans to expect another five years of load-shedding as the country faces a shortfall of 4000 MW per day (BusinessTech, 2021). He further stated that SA will have to accelerate the addition of new capacity to the grid and that the shortfall could be reduced as more renewable energy options are approved (BusinessTech, 2021). New generation capacity is required to maintain social and economic activity and to avoid downside risks of further shortfalls in generation capacity.

Due the current shortage of energy generation, the Minister of Mineral Resources and Energy established the Risk Mitigation Independent Power Producer Programme (RMIPPP) to procure 2000 MW of new capacity, which was gazetted on 7 July 2020, following NERSA public consultation and concurrence (DMRE, 2021b).

NERSA approved to procurement for a range of energy sources but requested that(NERSA, 2020):

- An updated short- to medium-term adequacy study should be developed by the System Operator to specify the type of capacity in renewable energy (Solar and Wind), baseload (Nuclear and Coal), Peaking (Open Cycle Gas Turbines), or mid-merit (Hydropower) and corresponding MW required by the system to close the supply gap;
- Capacity from the Short-Term Power Purchase Programme Request for Proposal issued by Eskom in March 2020 must be taken into account; and
- Energy Efficiency and Demand Side Management should be encouraged, since it is already included in the Integrated Resource Plan 2019, as there is lower demand in relation to the intermediate demand forecast.

On 18 March 2021, Minister Gwede Mantashe announced preferred bidders for the RMIPPP to address the immediate energy shortages, and the RMIPPP was released to the market in August 2020 (DMRE, 2021). The aim was to alleviate the electricity supply constraints and to reduce the extensive utilisation of diesel-based peaking electrical generators in the medium to long-term (GoSA, 2021a).

Karpowership SA (Pty) Ltd was a successful bidder out of six to be selected to generate electricity from gas using the Turkish owned powerships, which would be moored in the ports of Richards Bay, Ngqura and Saldanha Bay on the coasts of SA for 20 years (NERSA, 2021b). Karpowership SA (KPSA), is 49% Black owned, and was the preferred Bidder to provide power to SA's national electricity grid under RMIPPPP (Karpowership, 2021b).

According to the Centre for Environmental Rights (CER, 2021), Karpowership has not proposed necessary supporting structures and facilities to connect to the grid in these three ports in its construction plan. CER claims that each of the ports have sensitive surroundings such as estuaries, mangroves, seagrass, and reefs which all serve as nurseries for fish and crustaceans and have not been thoroughly considered in the powership project proposal (CER, 2021). NGOs such as CER argue that the three powerships will emit a potent GHG in the form of methane, which has a global warming potential of 84-86 times more than that of carbon dioxide over 20 years (CER, 2021).

The governments' procurement and development of new energy sources has become controversially delayed by the three powership projects, partly because of its design, being the preferred bidder, and tying consumers into contracts for the next 20 years (Greenpeace, 2021). Greenpeace has highlighted that although the cost of procuring electricity from Karpowership may be relatively cheaper in the short-term, in the long-term, the GoSA risks robbing South Africans desperate to join the workforce of job opportunities (Greenpeace, 2021). These powerships are complex engineering projects that will be assembled off-site and delivered fully equipped. The project will most likely require high-skilled labour sources from abroad. Further, Karpowership obtained exemption from the Department of Trade, Industry and Competitions (DTIC) to comply with the local-content stipulation, requiring 40% of the goods and services associated with this project to be locally sourced, a decision which could have potentially empowered our local manufacturing industry (Greenpeace, 2021).

Furthermore, the Karpowership company registered in SA was taken to court by its opposing bidder. The court has granted losing bidder to karpowership, DNG Energy leave to appeal a judgment setting aside its corruption allegations (Engineering news, 2022b). The Karpowership projects have also faced difficulties in securing environmental authorisation and the Organisation Undoing Tax Abuse has filed an application for the review and setting aside of the decisions by NERSA to grant the three projects generation licences (Engineering news,2022).

The Karpowership company has listed obstacles, with the failure by the DFFE to rule on a 13 July 2022 appeal filed against its 23 June 2022 refusal to grant Karpowership environmental clearance (Engineering news, 2022b). Karpowership said the appeal process should have legally been completed within 120 days but it has been told a decision cannot be expected before 1 July 2022; the departments of transport and public enterprises have yet to make a decision on whether the company's ships will be allowed to moor at the nation's ports and their application was made on May 12, 2021; 23 March 2022, Eskom demanded that Karpowership sign a "wide-reaching, open-ended indemnity agreement" that "potentially renders the projects unbankable." Karpowership has not received a response to a proposal it submitted to Eskom and other bidders were not asked to do the same (Engineering news, 2022b).

Looking at the current need for generation capacity, in August 2022, had the Karpowership be commissioned and operationalized, the power plant fleet using liquified natural gas would have produced 1 220 MW in the grid (Karpowership, 2021a). This is a significant blow to SA's attempts to reduce stages of load-shedding, and the GoSA did not receive enough civil support on this gas-power plant project. Environmentalist have disputed the need of powerships for the next 20 years. Furthermore, Karpowership will have to refile its environmental authorisation application to the DFFE for their bid to move its project forward.

PetroSA is currently experiencing a critical decline in the supply of indigenous gas feedstock to its refinery (PetroSA, 2021). The South African oil company has responded by implementing various short-term initiatives to keep the facility operating. for instance, Project Ikhwezi was expected to keep its feedstock supplies flowing until 2020. However, given the facility's long-term strategic and commercial importance, PetroSA has explored alternative options – such as importing Liquefied Natural Gas (LNG) (PetroSA, 2021).

The gas-to-power projects with LNG, will meet the country's immediate electricity requirements while progressing it towards net zero carbon emissions and Shell SA will be the exclusive supplier of LNG to the powerships (Business Day, 2021). It can be noted that delays in the project will affect SA's electricity security and reduce the opportunity to bring additional gas into the market for industrial and commercial purposes.

Since the discovery of sizable natural gas reserves in 2019, SA has redirected its attention to developing a robust, natural gas sector. This offers opportunities for increasing energy supply and stimulating investment in the gas industry. Furthermore, a massive gas reserve was discovered off the coast of SA by French energy conglomerate, Total, in early February 2019 (Averda, 2022). The gas field, namely Brulpadda Block, covers an area of 19 000 square kilometres under the Indian Ocean between George and Jeffreys Bay. Total and its partners own the exploration rights to this area and will pay 28% on corporate tax on all income from the Brulpadda gas well (Averda, 2022). According to Total's estimates, if correct, the gas reserve could generate around R13-trillion, which means about R3,6 trillion will be paid in corporate tax to the South African Revenue Service (SARS) (Averda, 2022).

Internationally, natural gas is being seen as an important and critical transition fuel. Natural gas does contribute to producing levels of energy that heat homes, power electricity and supports some industrial processes (Hernan, 2022). As countries significantly reduce coal in power generation and transition to renewable energy, gas is seen as an energy source that serves as bridge to renewable energy (Hernan, 2022). A position such as this indicates that there are countries that are claiming that gas is a transitional fuel represents that lifeline for ensuring energy security (Hernan, 2022). With the history and current experience of load-shedding, gas has been a lifeline for heat and cooking during planned and unscheduled power cuts by Eskom. Taking into consideration, the economic performance of the country and Eskom's planned power cuts to due to depleted capacity, Gas could be urgently needed to help meet energy demand in SA during the transition to clean energy.

In support of regional electricity interconnection, the IRP 2019 stipulates that, South Africa will participate in strategic power projects that enable the development of cross-border infrastructure needed for the regional energy trading (IRP, 2019: 48).

In 2014, South Africa entered a treaty regarding the Grand Inga Hydropower Project with 2 500 MW offtake (IRP, 2019). According to DOE, there is a need to finalise the technical solution for the evacuation of this power from the Grand Inga across the transit countries from DRC, Zambia, Zimbabwe, Botswana and then into South Africa. The necessary agreements must be concluded as soon as possible if the hydro option from Grand Inga is intended to materialize (IRP, 2019: 48).

The Grand Inga project on the Congo River envisages the installation of 40 GW of hydro-generating capacity, which would make it the largest hydro facility in the world. It is to be developed in 8 phases (IRENA, 2015). Inga 3 is the first phase of development that has a total potential to generate 7.8 GW of electricity and was aimed to be commissioned by 2023 (WB, 2014). A significant share of electricity is destined for exports which will go as far as SA and the transmission lines totalling 1 850 km are to be developed to support Inga 3 exports of electricity (IRENA, 2015). Inga 3 is the third phase of the Grand Inga project, which is an endeavour to build the world's largest hydropower dam in DRC (ESI Africa, 2021).

The GoSA has not finalized plans to procure power from the proposed Inga 3 hydroelectric dam project in the DRC as it would cost Eskom over R10 billion or more per annum, compared to procuring the same energy from alternatives such as wind and solar (M&G, 2021b). According to the Mail & Guardian (M&G, 2021b), the GoSA has been advised to cancel its financial commitment to the DRC's hydroelectric power project. International Rivers and WoMin African Alliance reported that (2021), Inga 3 would cost SA over R10 billion more per year compared to readily available solar and wind alternatives locally and this additional burden would likely fall on ordinary South African citizens through increased tariffs and taxpayer subsidies for Eskom.

Given the adverse impacts of Covid-19 on the South African Economy, the GoSA does not have fiscal funds to finance this project. Furthermore, pursuing Inga 3 will be much more expensive for SA compared to domestic wind and solar generation. Taking into consideration the cost of developing transmission lines, importing 2 500 MW on top of the massive cost overruns and delays in the construction of Kusile and Medupi (International Rivers, 2021).

The GoSA has made some progress toward adding new generation to the underpowered electricity grid, with the signing PPAs of three emergency power projects with 150 megawatts of capacity from private projects by developer Scatec ASA (Bloomberg, 2022). Scatec ASA is starting construction of the three Kenhardt projects in the Northern Cape Province of South Africa under the RMIPPPP after reaching financial close (SATEC, 2022).

However, the emergency power programme has experienced delays as the country continues to head towards a record high year of electricity cuts. The DMRE has pushed back the deadline for the closure of financial agreements for the winning bidders of its emergency power procurement programme (Business Day, 2022b). The extension of the deadline for financial close — which refers to, among other things, the conclusion of financial agreements that ensure the winning bidders have the required financial capabilities to execute the projects — means the government's plans to ease the country's electricity shortages by having the projects operational from the initial date of August this year have been pushed back by a further 12 months, therefore, the RMIPPP plants will not be operational until March 2023 (Business Day, 2022b).

Civil society has made several legal challenges to offshore exploration and to new gas plants, while socially and economically it is largely agreeable that contribution from gas is needed as a transitional energy and is affordable for heating purposes be it for industrial or households. Gas-fired power plants can provide support and backup energy to an integrated renewable energy power generation. gas exploration has received environmental pressure. But the balance of environmental concern, reliable as well as affordable electricity and creating new jobs in the gas sector has not been imbued by civic organizations.

One can infer that the gas discovery also has advantages for other numerous industries - waste management, logistics, catering, and engineering industries will all be able to create more jobs and support gas companies. Gas has the potential to become a reliable and affordable source of energy for SA in the pursuit of an energy mix.

Investment in energy infrastructure contributes to economic growth and sustainable development. SA should have adequate supply security in electricity that entails an energy mix as prescribed by IRP 2019. South Africa's energy system needs to be supported by effective policies, institutions, regulation and, where appropriate civil society and labour. Thereby, the country's energy market will be more diverse, with greater opportunities for investors to provide innovative, sustainable energy solutions within credible and predictable regulatory frameworks.

Following a particular severe series of blackouts and power cuts due to Eskom’s lack of generation capacity during the winter season, on 25 July 2022, President Ramaphosa addressed the nation about the energy crisis that is confronting our country and further announced several interventions to overcome the immediate crisis. This direct and public intervention by the President is worth briefly reflecting on. This subsection will take note of announced interventions, compare them to previous pronouncements and plans. Thereafter, this section will reflect on whether there is a difference, or some issues remain the same.

The president announced a number of interventions to overcome the immediate crisis, which were the following (Presidency, 2022):

- Fix Eskom and improve the availability of existing supply
- Enable and accelerate private investment in generation capacity
- Accelerate procurement of new capacity from renewables, gas, and battery storage.
- Unleash businesses and households to invest in rooftop solar
- Fundamentally transform the electricity sector to achieve long-term energy security
- Establishment of the NECOM – a National Energy Crisis Committee – comprising of all relevant government departments and Eskom, led by the Director-General in the Presidency, Ms Phindile Baleni
- The South African Police Service (SAPS) setting up a special law enforcement team to help Eskom in confronting crime and corruption.
- Eskom intends to import power from Botswana and Zambia through the Southern African Power Pool (SAPP) arrangement

Based on the interventions delivered by the President, are means to move forward on addressing the energy crisis, but it is nothing new or detailed different to the plans and interventions that have been highlighted in the key findings. In 2020, the President spoke of a plan to fix Eskom in his State of the Nation address and in 2021, President Ramaphosa informed South Africans that load-shedding would be significantly reduced from September 2021. However, in the second half of 2022, South Africa has come off the worst periods of load-shedding ever.

SA's megaprojects, Medupi and Kusile, major challenges have been related to poor site management, inadequate managerial skills, poor monitoring and control, and poor organisation structures (Tshidavhu & Khatleli, 2020). These are the major causes of operational delays and cost overruns as Eskom and the GoSA have not been able to ensure proper planning and effective implementation of energy megaprojects (Tshidavhu & Khatleli, 2020). The lack of leadership at Eskom has caused slow client decision-making, shortages of skilled labour, inaccurate material estimating, poor material planning, changes in scope of work on-site, contractual claims, and poor site management (Tshidavhu & Khatleli, 2020).

The GoSA's' pursuit to increase private sector investment to accelerate new generation capacity and transform the energy sector has been on-going. The new

emergency measures to deal with South Africa's electricity crisis, buying power from private producers and relaxing regulations in the sector are already part of the Social Compact on Supporting Eskom for Inclusive Economic Growth and the President's reconstruction and recovery plan.

The establishment of the NECOM composed of 'relevant' Ministers is similar to the Eskom War Room when Ramaphosa was then the Deputy President in 2015 (SA News, 2015). The operation was overseen by Cabinet to address the electricity challenges facing the country, to oversee the turnaround of Eskom. The war room was made up of the DOE, Department of Cooperative Governance and Traditional Affairs, DPE, NT, Department of Economic Development, Department of Water and Sanitation and Eskom (SA News, 2015).

South Africa has needed stronger security in place to stop the sabotage of Eskom's power supply. Cable theft, electricity bypassing, executed sabotage and theft of Eskom's supplies is not a new issue but a long-standing issue which has not been addressed with serious sense of urgency (DefenseWeb, 2022). The plans to solve the country's devastating electricity supply crisis did not include any prerequisite solution to protect the Country's energy infrastructure (DefenseWeb, 2022). The attacks on Eskom's critical infrastructure led to severe damage. The result has corresponded with the losses of generation capacity and damage to economic activity. Eskom staff protests have also impacted planned maintenance and repairs (Eskom, 2022g).

In June 2022, Eskom employees embarked on a strike following another deadlock in the 2022 wage negotiations. Eskom confirmed that protests at several power plants following a breakdown in wage negotiations (BusinessTech, 2022b). Groups of demonstrators blocked roads and hampered the movement of people and goods into or outside of several coal-fired stations (BusinessTech, 2022b). The labour protests caused operational disturbances and led to the implementation of load-shedding at higher stages (Eskom, 2022i). Weeks of protestors obstructing access to power stations due to protestors attacking Eskom employees reporting for duty could have interrupted security at power stations and operations (Eskom, 2022g).

According to Crisis 24 (2022), there have been several incidents of sabotage at Eskom power stations, worsening energy supply constraints. Since mid-May, several

incidents of sabotage have been reported at power stations managed by Eskom. All the impacted stations are located in western Mpumalanga Province. The assailants' identity is not clear; however, Eskom officials have indicated that they believe that the incidents were perpetrated by persons with knowledge of the power plants (Crisis24, 2022).

With regards to energy imports from the Southern African region, on 18 July 2022 Zambia recently declared a surplus of 1 156.8 MW following the commissioning of four out of five generators at its 750 MW Kafue Lower Gorge Power Station (ZESCO, 2022). Zambia's current national electricity generation capacity stands at 3 456.8 MW against a peak national demand of about 2 300 MW (ZESCO. 2022). The Zambia Electricity Supply Corporation (ZESCO) Limited has welcomed plans by South Africa to import power to meet its power needs (ZESCO, 2022).

Zambia is an established member of the SAPP and is currently undertaking construction of transmission lines to ensure ZESCO remains at the centre of power trading among the Eastern, Western, Northern and Southern African states (ZESCO, 2022). ZESCO has started exporting 100 MW of electricity to Zimbabwe, as neighbouring Zimbabwe was currently facing a shortage of electricity due to depressed degeneration at its power plants and Eskom's power needs, has resulted in less export of power from South Africa (the Star, 2022) -;

Botswana is willing to sell its off-peak generated power to Eskom since electricity cannot be stored on any scale and fluctuation can put strain on generators (Business Day, 2022a). Botswana Power Corporation (BPC) has started engaging Eskom to purchase the excess electricity supply generated during off-peak times (weekends) to protect our plants against load management fluctuations and to ensure that surplus electricity has a secured market (Business Day, 2022a).

Eskom has welcomed announcements made by President Ramaphosa to resolve the electricity crisis, as they empower Eskom to speedily acquire additional generation capacity from existing IPPs with excess capacity, to acquire spares and equipment from original equipment manufacturers (OEMs) and the resources to increase the funding of the maintenance budget (Eskom, 2022f). The reforms remove limits to private sector investments in electricity generation capacity, will help unlock

investments and help create jobs during the construction of the projects while helping to lower the cost of electricity in the long term (Eskom, 2022f).

The new interventions on the energy crisis, is not new nor will it provide immediate relief to the grid. Despite the initiatives and incentives announced by the President, there is no timeframe as to when will load-shedding come an end and the unpredictable performance of Eskom is an unfortunate reality. South Africans may try to reduce the amount of electricity they use but inadequate maintenance, poor management, lack of operational generation capacity, alleged sabotage, financial woes have led to high frequency and severity of load-shedding.

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Conclusion

Based on all key findings above, firstly, SA's electricity distribution has decreased due to power generation capacity constraints and its consumption has increased which has put pressure on Eskom. Eskom is in a state of unreliability and is struggling on to meet the different levels of electricity demand in the country. Eskom's poor performance has continued in 2022. The rotational blackouts, meant to save the national grid from collapse, have worsened.

SA may be able to provide electricity for all citizens by 2030, but the affordability and reliability of electricity is not ensured. Secondly, with the reforms recently introduced by GoSA, will allow for private sector and IPPs to invest in the South African renewable energy market, therefore, increasing substantially the share of renewable energy in total energy consumption is attainable by 2030. However, NUMSA has strongly rejected the decision made by the government to unbundle Eskom, and further implicates the leadership in government by stating that they are directly and collectively responsible for the mess of corruption and rot in Eskom (NUMSA, 2019a).

NUMSA has consistently warned workers and the working class of SA that the chosen path of development and the unbundling of Eskom is both dangerous and disastrous for our country (NUMSA, 2019a). NUMSA's position is that Eskom's performance is a self-generated crisis and a premeditated strategy to force the people of SA into believing that there is no other option but to break apart and privatise Eskom to secure future energy supply (NUMSA, 2019).

The KI 1 further highlighted that there is an effort to undermine NERSA's discretionary role to regulate energy. According to KI 1, in 2019, NERSA allowed Eskom to sign the IPPs without calling public hearings which was a reckless act on the Eskom board, the Minister of Energy, as well as the former Eskom CEO Phakamani Hadebe. NUMSA has stated that, of the R8.2 billion generated in revenue through NERSA tariff increases, R6.5 billion went to the IPPs (NUMSA, 2019b). Such decisions based on the PPAs, have worked against the interest of Eskom and as such, Eskom's equity was eroded, and its profits have depleted (NUMSA, 2019b). For NUMSA, The IPPs are costly and destroy the economy, as well as formal and informal jobs due to unaffordable electricity caused by tariffs (NUMSA, 2019a). The unions representing most of Eskom's staff support a move towards both clean energy and economy-wide decarbonization however, their concern is that the current unbundling and renewable IPPs procurement approach (privatization) will achieve neither economic, social nor ecological benefits.

Low emissions development is necessary for and is compatible with poverty eradication (Granoff et al., 2015: 2). Hence an adhered agreement between members of society to cooperate is necessary to overcome economic stagnation, inequality, and unemployment in SA. Every member of society - labour, government, business, civil society, youth, women and more particularly the unemployed - should agree on a framework on the just transition. However, it is important to recognize that Eskom's roll out of closing coal power stations should be done at a pace and scale that does not potentially damage the economy.

For this reason, in any remote mining town, closing the mine often leads to closing the town as well. The remoteness of many mining operations often means that there are few or no alternative employment opportunities after closure (Aung & Strambo, 2020). Furthermore, the social as well economic infrastructure that is developed within a mine

community may be scaled down or neglected when the mine closes unless provision has been made for maintenance and upkeep by government at large, the community and local businesses (Aung & Strambo, 2020).

Municipalities where coal mines are based around, may suffer the greatest impact as lower national taxes will reduce transfers to municipalities, limiting their ability to provide services and to pay their obligations (Strambo, Aung and Atteridge, 2019). Coal mine closures negatively affect communities and workers through job losses, reduced economic activity and the loss of funding from companies for social infrastructure (Strambo, Aung and Atteridge, 2019).

At the same time, coal mining generated electricity is causing environmental and societal damage. Acid Mine Drainage (AMD) is a poisonous legacy of abandoned coal mines. AMD is caused by underground chemical reactions between water, oxygen and rock formations containing sulphur-rich minerals (McCarthy, 2011). Acid drainage is one of the most serious environmental problems for SA's mining industry. With it left unchecked, it can result in long-term water quality impacts that could well be this industry's most harmful to coal mining communities (Feris & Kotze, 2014). Coal resources around critical river basins and rivers such as the Vaal River in the vicinity of the most densely populated and built-up areas in Gauteng that result in the prevalence of AMD (Feris & Kotze, 2014). Feris & Kotz (2016:2109) noted that AMD is manageable in small quantities, but SA has the potential high volume resulting from more than 100 years of mining which is alarming.

In 2021, The Vaal River water system, which caters for approximately 19 million people for drinking water and commercial use, is polluted beyond acceptable standards (TimesLive, 2021). The Vaal River supplies not only Gauteng but also many towns downstream, including Bloemhof, Welkom, Kimberley and Postmasburg. The major pollutants are the coal and gold mines, and because of their location in the upper portions of the Vaal River catchment, their footprint on the water supply is huge (du Toit, 2018).

Eskom has received decisions from the DFFE in response to its applications for the postponement of the implementation of some of the air quality compliance timelines set in air quality legislation for its power stations. In terms of the National

Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), all Eskom's coal and liquid fuel-fired power stations must meet the MES regulations published in terms of the act (DEA, 2019).

The MES regulations provide time frames for compliance to power plant air quality emission limits and arrangements in respect thereof, among other things: a once-off postponement with the compliance of minimum emissions for new plant for five years from the date of issue, and no once-off postponement would be valid beyond 31 March 2025; a once-off suspension for plants being decommissioned by 31 March 2030; and that the National Air Quality Officer may grant an alternate emission limit or emission load if certain conditions are met (Eskom, 2021b).

However, South African court ordered the government to take measures to improve the air quality in a key industrial zone, stating that it had breached the constitution by failing to crack down on pollution emitted by power plants operated by Eskom. and refineries owned by Sasol Ltd (Bloomberg, 2022).

Environmental Affairs Minister Barbara Creecy had a legal obligation to prescribe rules to implement and enforce anti-pollution regulations, and had unreasonably delayed in doing so, High Court Judge Colleen Collis said in a ruling handed down in Pretoria, the capital, on Friday. She ordered the matter to be addressed within 12 months and that the new rules provide for penalties for non-compliance and adequate monitoring (Bloomberg, 2022).

The emissions problems are made worse as Medupi as well as Kusile have not been installed with abatement technologies such as retrofitted with flue-gas desulphurization (FGD) to reduce emissions and improve air quality. GHG emissions and air pollution caused by Eskom's coal-powered plants are compromising the public health of citizens residing in South Africa. However, Eskom's Emission Reduction Plan (2019:9) outlines that the utility plans to decommission six power stations before 2030 (Totalling more than 10 000 MW), and an additional two by 2035 (totalling more than 7 000 MW) and the remaining existing plants by 2044 (excluding Majuba, Medupi and Kusile).

The GoSA has made substantial progress in effort to improve the performance of Eskom. At the 2019 State of the Nation Address, President Cyril Ramaphosa announced that Eskom would be unbundled into three wholly owned entities: Generation, Transmission and Distribution (PMG, 2021). Steps are being followed to complete the legal separation - that is setting up separate legal entities for each of the three businesses. Eskom's Transmission legal separation has been prioritised and was anticipated to be completed by December 2021. It was anticipated that Eskom's Generation and Distribution entities will be completed by December 2022 (PMG, 2021).

Following the actions, as mentioned in the Roadmap for Eskom (2019): A legally binding merger agreement was entered into between Eskom and its wholly owned subsidiary, National Transmission Company South Africa SOC Limited (NTCSA) in December 2021; the transfer of the Transmission division to NTCSA is subject to the satisfaction of certain suspensive conditions that still require applicable creditor consents to the transaction (Eskom, 2022j). The SIU has referred more than 5000 officials to Eskom to face disciplinary proceedings for fraud, corruption, and maladministration at the power utility (EWN, 2020). In 2020, IPPO confirmed that 70% of South Africa's 64 IPPs have indicated willingness to participate in the DMRE's renewable energy project refinancing initiative, in which could contribute to lowering the wholesale price of electricity (Engineering News, 2020).

In further addressing the energy shortage crisis of SA, President Ramaphosa announced the amendment to Schedule 2 of the Electricity Regulation Act, 2006 (Act No. 4 of 2006), to exempt private generation facilities up to 100 MW from the licensing requirement on 10 June 2021 (GoSA, 2021b). DMRE finally gazetted the amended schedule 2 of the Electricity Regulation Act, to enable private entities to generate up to 100 MW for distribution and self-generation on 12 August 2021 (DMRE, 2021c). It is envisaged by the GoSA that this step will unlock significant private investment in new generation capacity in the short-to-medium term, make significant inroads towards achieving national energy security, and reduce the impact of load-shedding.

Therefore, generation facilities (with or without energy storage) with a generation capacity of no more than 100MW and a point of connection on the transmission or distribution power system are exempt from obtaining a generation licence (DMRE,

2021c). The exemption is aimed at achieving energy security and reducing the impact of load-shedding on businesses and households across the country (DMRE, 2021c). This includes generation projects that are connected as well as those that are not connected to the grid. The decision to allow private business, mines, and firms to build their own generation can be viewed as a positive action, as it will result in some investment and job creation, which is better than shutting down factories.

Minerals Council South Africa CEO Roger Baxter told Mining Weekly that lifting of the licensing exemption threshold would be significant and the benefits specifically to mining would be (Polity, 2021):

- "Security and consistency of supply for the industry (these projects are supplemental and will not replace Eskom as our base-load supply);
- more predictable and manageable electricity cost increases;
- both would provide greater certainty and attractiveness of investors; and
- a reduction in carbon emissions and many projects would involve renewables."

Nonetheless, despite the potential of a decline in sales revenue for Eskom, businesses and firms will become less energy-intensive demand from Eskom and potentially more competitive and sustainable, and it will contribute to environmental objectives whilst contributing to investment in local communities and infrastructure (Goliger and McMillan, 2018). Building self-generation and supplying different sites requires transmission and distribution infrastructure. All existing transmission infrastructure is owned by Eskom, and distribution infrastructure is owned by Eskom and the municipalities (Goliger and McMillan, 2018) hence, Eskom and the government have paved the way for action to separate the management and control of Eskom Transmission. In turn, this will allow for open competition to attract private investment and will lower the cost of production which will benefit consumers.

Taking note of the strides made in environmental levies, local banks providing financing for energy efficiency in infrastructure development and the implementation of the EPC in December 2022, SA has the potential to improve in energy efficiency by 2030. Lastly, Eskom and GoSA continue to struggle to complete the Medupi and Kusile megaprojects. There is an urgent need for skilled labour, improved

management by Eskom and political as well as social commitment to sustainable energy development. International Partners have committed $8.5 billion in development finance to expedite SA's transition from coal to renewable energy, this provides an opportunity for SA to expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in a just and equitable manner.

The findings above have also highlighted the progress made in the attainment of SDG 7 and how SA has made progress to create the conditions for adequate investments in required and necessary energy infrastructure for development. Electricity reliability and affordability has been and continues to be a key challenge in SA. The GoSA has given Eskom billions of Rands to help service its huge debt and to try to put a stop to the power cuts, yet Eskom is still struggling. The reliability of Eskom has also decreased with self-generation increasingly being the alternative.

8. Discussion, and Conclusion

Discussion

Ideally, renewable energy is a solution to combat climate change and is an attractive investment. Furthermore, Solar and wind energy that has availability and capacity of the power system to meet the demand, can provide electricity to South African's when affected by planned and unplanned outages, load-shedding, and coal shortages. However, serious consideration needs to be given to the range of constraints and competing interests when making decisions about decarbonizing the energy system is required. However, shortages of skills in the energy sector, limited renewable energy technology systems, the volume of investment in renewable energy and energy efficiency as well as the unreliability of the electricity are constraints to sustainable, modern energy development in SA.

Furthermore, renewable energy is beneficial in as far as climate change impacts are concerned, but their impacts on ecosystems, waste management and additional costs require further assessment. For SA to overcome the hidden end-of-life and environmental costs of renewable energy such as solar and wind, research and development is required to uncover the hidden costs and create frameworks that will mitigate risks. This will contribute to moving toward a low-carbon economy and catalyse the just transition.

Sustainable development, job creation, cost-reflective pricing of producing and distributing electricity, environmental considerations and the transition to an energy efficient low-carbon economy is attainable as well as achievable. Theoretically, the Just Energy Transition to a low-carbon economy through renewable energy and energy efficiency can ensure economic security for unions, coal workers and communities.

Yet the reality is, the partnership framework for public and private sector has not delivered enough innovation and infrastructure development in renewable energy, the slow rate of private investment in energy sector, Eskom management has not been able for years to sustainably supply electricity and unions are calling for community-owned renewable energy generation.

It is unlikely that SA will achieve SDG 7 in its entirety, but it can achieve some of targets as mentioned in the key findings. Upscaling renewable energy and investing in battery storage could offer a better long-term solution and create decent jobs for the youth of SA. It cannot be ignored that renewable energy has high investment and maintenance cost. Renewable energy development hinges on a significant workforce transformation. This just transition may exacerbate existing inequities, skills shortages, and talent pipeline difficulties in SA.

On SDG 7.1, SA could provide universal access to electricity to all citizens by 2030 if it can fix its generation challenges, but the quality of access could be continuously hindered by load-shedding and load reduction. Even if SA ensures modern energy services are developed, not all citizens will be able to afford it. For instance, further electricity price increases will put electricity access beyond the reach of more citizens who are in poverty, and it will have a negative impact on the economy and sustainable development. Yet the increasing of tariffs to reflect the actual cost of electricity provision is argued to be essential to help ease Eskom's dire financial situation and to cover the cost of operations.

The operational and financial stability of Eskom requires attention. Without reducing the risk of load-shedding and debt of the power utility as well as the assurance of fair regulatory returns in the form of tariffs, there will continue to be tensions surrounding access, affordability, and reliability of electricity as well as upscaling renewable energy. Furthermore, the challenge of theft and vandalism of Eskom's infrastructure has been overlooked and unaddressed for years and can be linked to Eskom's poor generation performance and load-shedding. The current leadership of Eskom is required to address sabotage, generation power struggles and financial debt. Eskom dependency to procure urgent energy significantly rests on the shoulders of the GoSA, the public security of Eskom's infrastructure is the responsibility of the SAPS, and the financial sustainability of Eskom depends on recuperating funds from municipalities, renegotiation of prices with contracted suppliers, cost-reflective tariffs approved by NERSA and financial support from the NT.

The demand for electricity has grown tremendously over the past few years and an even greater growth is expected. Due to the high demand for electricity and the expected growth, Eskom has begun building additional power stations and buying

energy from alternative energy sources. However, it is uncertain when Eskom will meet its demand, as Medupi and Kusile will have further costs before completion, poor maintenance continues and the RMIPPP has been pushed up to March 2023. All of this comes at a cost, which means that there will be increases in the price of electricity to cover the costs of the development of new generation plants.

Electricity unavailability and economic inactivity are the key bottlenecks preventing South Africans from exercising their basic needs and hindering sustainable development. Electricity use and access is strongly correlated with economic development. Eskom's energy supply woes and less than affordable tariffs have provided evidence on how the lack of availability of electricity can be a considerable constraint to growth and social development.

SA has the potential to increase its renewable energy share of the energy mix with solar and wind energy, contributing more energy supply to achieve SDG 7.2, by 2030. The GoSA has made strides to incentivize private sector to invest in renewable energy by introducing reforms to allow for private generation and distribution of up to 100 MW of electricity without a licence. Based on the IRP's promising future roadmap and the drive to reform the electricity supply industry, through IPPs, Eskom, private business and citizens will increase the share of renewable energy substantially by 2030. However, the delay in IPP projects and lack of local private investment in renewable energy sector has slowed the uptake in renewable energy.

Business leadership is key to a successful transition: one that is just and equitable, driving economic growth and competitiveness with tangible social benefits. The just transition presents a real opportunity for private sector to lead in guiding this transition both in response to climate change and addressing socio-economic disparities. The GoSA has encouraged businesses to take the lead, as there is an increased interest from businesses to improve energy efficiencies and secure energy supply due to positive regulatory reforms.

On SDG 7.3, by 2030, SA has the potential to improve energy efficiency to double the global rate. However, this is not being achieved as the GoSA's immediate priority has been to stabilise Eskom's financial position and improve generation capacity. Energy conservation is not of prime importance to the utility currently. Meanwhile, South

Africans living in poverty are unable to afford electricity or to access FBE. They continue to burn wood, coal, candles, and paraffin, which all pose severe health, environmental and safety risks.

There has been limited commitment and prioritisation of policy to enforce energy efficiency. There has not been synchronised coordination between the public and the private sector which has resulted inconsistent energy efficiency practices and limited financing. Companies and building owners ought to be working towards reducing their carbon footprint now or risk suffering the consequences of inaction through implementation of EPC and mentioned environmental levies.

On SDG 7.B, by 2030, SA will have to accelerate the addition of new capacity to the grid to attain this target. The RMIPPP gazetted on 7 July 2020, is still underway and the delays have been highlighted by the blocking of the Karpowership project, which could have provided much needed MW to the electricity gird and gas infrastructure to provide transitional energy and reduce dependency on gas imports that continue to increase in prices due to the Russia-Ukraine conflict. SA's strategic power projects such as Medupi and Kusile have experienced setbacks of cost overruns design failures and poor planning. Ultimately, Eskom has a critical skills shortfall that leaves it struggling with project management of the two megaprojects, struggling to produce power and struggling to execute required maintenance.

On the positive side, SA has pledged to cut emissions as part of its climate commitments. The coal-powered energy sector is the largest domestic emitter, and a shift to cleaner energy has been unfolding with the increase in REIPPPs and international support for our just transition, the implementation of carbon tax with high levies in 2025, and enforcement of EPC in December 2022. The decline in renewable energy costs have also made renewable energy a desirable option. Renewable power generation has become the choice for new capacity presently and for the future, as renewable energy sources are safer and cleaner than fossil fuels. While the shift away from coal is inevitable, policies must be put in place to mitigate the effects on coal-mining workers and communities and to ensure a just and equitable energy transition.

SA committed to its NDC as part of the Paris Agreement, the UN SDGs by 2030, adopted NDP to advance an eco-friendly economy and reviewed policies with the aim

to transition to an inclusive green economy. However, the GoSA simultaneously recognises the importance of coal. A lack of proper co-ordination of policy objectives has led to DFFE not providing environmental authorisation for the DMRE Karpowership project. The pledges and policies of GoSA are not aligned, and this will continue to lead to contradictions in the implementation of these policies. A more balanced approach is required that will focus on sustainable development, addressing climate change and efforts to eradicate poverty. The NDC are sighted as an integral part of mitigation strategies to curtail the climate crisis, however, it is important SA does not further exacerbate socio-economic disparities that exist for climate mitigation.

Nonetheless, the GoSA recognises the need to contribute its fair share to the global effort to move towards net-zero carbon emissions by 2050. It is possible for SA to have a realistic balanced approach to transforming the country's energy system. Delivering affordable electricity, renewable energy sources, safe and efficient use of energy and investment in the development of new energy generation is a complex challenge. In addition to that, the COVID-19 pandemic has exacerbated the vulnerability of people lacking access to clean fuels and technologies.

Increasing FDI in renewable energy in SA will significantly help our country to increase its clean energy research and development and its renewable energy implementation and production. The pledges and declaration made to support SA's Just Energy Transition at the COP26 climate summit, will provide significant financial assistance. This International partnership for the just transition could help unlock billions of dollars in climate financing, primarily in the form of concessional loans as well as some grants.

It is not clear on how the energy mix transition will be able to provide job security for coal mine workers and communities as Eskom is working on its Emission Reduction plan aimed at net zero emissions by 2050. There has not been enough clarity on how to retain and reskill workers in the affected sectors. In this international partnership, it was agreed in principal that efforts to lead a just transition must protect vulnerable workers and communities. It is crucial that the energy workforce is prepared and ready for the transition and more importantly to ensure that no-one is left behind.

The setting of climate targets and commitments for sectors is important yet ensuring that the transition does not create further socio-economic disparities should be equally

important. Furthermore, the gas-to-power plants that are under litigation could be providing much needed energy and job creation. A trade-off must be explored to utilize gas as a transitional energy and an improved public participation process for this development must take place to ensure that gas is considered as a short to medium-term energy supply option in support of the transition to a low carbon economy.

Environmentalists as well as labour representatives should aim to support policymakers in making informed decision about energy technologies, infrastructure, and the energy mix. In addition, given the energy challenges the country is facing, the GoSA needs to promote civil society and private business participation in these projects for key sector stakeholders, to align strategically and map the way forward to deliver energy security. The right mix of low-carbon electricity generation technologies with coal power generation that has effective abatement technology and gas as transitional energy will help to stabilise and potentially reduce pollution, impacts on the environment, and ensure sustainable, affordable as well as accessible electricity.

Global efforts to mitigate climate change are gearing up, with a rising number of countries, companies and financiers taking action to address climate change. Simultaneously, climate changes such as temperature, weather changes, and extreme weather events are already having dramatic impacts on populations. These are also having material impacts on the economy and society. In the short-term, dealing with this transition has materialised primarily in a focus on the decarbonisation of the energy systems. In the medium-to-long term, this will extend to all sectors and segments of society.

SA is still exposed to economic, social, technological, governance and environmental challenges. A key approach is necessary to mitigate the exposure to potential environmental and social risk and to have a ‘sustainable’ as well as ‘shared’ value creation, where businesses are focused on generating profit while simultaneously generating socio-economic and environmental benefits. More detailed and nuanced consideration for the just transition can prevent offsetting further social and historical disparities and further support more inclusive sustainable development.

The GoSA requires all social partners to make more effort to get alignment around common interests and goals that corresponded to the NDP, Roadmap for Eskom in a

Reformed Electricity Supply Industry 2019, Integrated Energy Plan and Integrated Resource Plan 2019 and the Framework Agreement for a Social Compact on Supporting Eskom and Revised Implementation Plan. SA has a successful story of a social contract to tell, which is the Framework Agreement for a Social Compact on Supporting Eskom and Revised Implementation Plan. The social compact between the GoSA, businesses, and civil society sets the basis for long-term economic development and growth underpins that SA is confronting the specific challenges that threaten electricity supply and constrain the economy.

Conclusion

In conclusion, as is clear from the recent electricity debates in SA and the literature mentioned above, that there is wide agreement on the importance of energy, in particular electricity, for sustainable development. However, there are contestations, tensions and competing interests that make debates about how to generate electricity for sustainable development extremely difficult. There are complexities involved in simultaneously achieving access, affordability, and reliability of electricity, while also upscaling renewable energy and practising energy efficiency.

There is a lack of well-informed studies that take into consideration the tension between the cost-reflective needs of the utility and affordability for the customer, as well as the social tensions and environmental factors in the transition to an energy efficient low-carbon economy. There are synergies and trade-offs related to SDG 7, however, the SDG 7 tilts more towards protecting natural resources and the environment than meeting current real human needs. Developed countries, such as SA, need to keep in mind their country's circumstances when implementing all the targets within SDG7. They have to find the best balance within their particular contexts when it comes to addressing the three dimensions of economic, social, and environmental development.

I share the following recommendations as a humble contribution to debates on how we can achieve the sustainable energy supply in SA that we so urgently need for our sustainable development.

The reforms announced by President Ramaphosa aim to restore SA's business competitiveness in the energy sector and to build energy security, while improving health, energy efficiency and promoting equality and economic prosperity in SA. As part of reforms of the sector, a clear and credible plan regarding jobs is essential to ensure unions, coal workers and communities are an integral part of, and benefit from, the transition to renewable energy. The GoSA should ensure that public participation is prioritised as it is an important requirement in the decision-making process. People have the right to be informed about decisions that may affect them and to be allowed to influence those decisions without needing to resort to litigation or other means to try and enforce and protect their interests.

Business leadership, in partnership with GoSA, should apply ESG considerations in their investment into the energy mix. It is a matter of importance for the private sector to support the initiative of decarbonisation that is to be implemented in a prompt manner that promotes and sustains employment, livelihoods and economic inclusion for historically marginalised communities and sectors of society. The GoSA has introduced reformative policies in environmental taxes, EPC requirements and the amendment of the Electricity Regulation Act. Local banks are finally providing well-adapted finance options to spur green growth, modern energy self-generation for households and green buildings. Nonetheless, the just transition presents a real opportunity for the private sector to apply ESG standards and to lead in this transition both in response to climate change as well as in addressing socio-economic disparities.

Eskom, GoSA, municipalities as well as NGOs need to educate and encourage a culture of compliance and managed electricity consumption country wide, more particularly in high-density areas. Electricity has become increasingly unreliable and expensive, at the same time, the consumption behaviour from illegally connected consumers is wasteful which is leading to the failure of Eskom's systems. Municipalities require capacity to provide services and facilitate local economic development. Civil society can assist by bringing the GoSA closer to the people and transmitting important information to communities about local government processes as well as available social support initiatives.

The GoSA needs to put in place policy frameworks and legislation to enforce efficient waste management and maintenance of solar panels and wind turbines at their end-of-life cycle. There are opportunities for solar panel recycling and the private sector with the support of the GoSA, should take the initiative to establishing services for PV collection and handling. This is an economic opportunity to create a local industry of renewable energy components recycling, that could create jobs for low skilled mine workers. Then again, if not handled well, these clean energy sources may continue to contribute to resource waste and environmentally damaging waste disposal practices.

An integrative approach to the just energy transition in SA is necessary, to ensure that social equality, job creation, upscaling renewable energy and sustainable development. Investment in the renewables sector can create decent jobs, upskill workers from coal-mining communities, and ensure universal access to electricity, with relatively immediate positive effects on SA's economy.

I recommend that SA further diversifies its energy mix to halt energy disruptions and strengthen its energy security. Gas should remain in the energy mix. The gas discoveries off SA's coast could be beneficial to the urgent need for more energy and reduce reliance on oil as well as gas imports. There are civil concerns surrounding extracting gas so close to our coastal lines. However, the GoSA should garner the support of civil society to pursue gas-powered energy. There is uncertainty about the Russia-Ukraine war that has increased cost pressures on Eskom, and diesel imports that are now far more expensive. Projects like karpowership can provide necessary power to the grid and provide investment into gas infrastructure, therefore, reducing dependence on gas imports and creating more jobs. If the procurement for 1220 MW generation capacity from karpowership had been successful, it could have reduced one stage of load-shedding and provided gas that would have been more accessible and affordable to households and businesses.

Coal remains the backbone of the country's energy supply. Coal powered generation should remain in the energy mix in line with Eskom decommissioning plans. The reliance of coal should be reduced, but it will have to be over the medium to long-term. This approach, while admittedly having negative impacts for climate change and the environment, will provide enough room for the public and private sector, in partnership, to upskill mine workers in the renewable energy sector and repurpose power plants to

ensure coal mine communities have secured jobs. With the ongoing power energy unreliability, rolling blackouts and its effect on the economy, nuclear will also be important in the energy mix to close the electricity supply gap. although safety and waste management is a matter of concern, however, with NNR and NECSA implementing their mandates diligently, nuclear could provide necessary energy when planned or unplanned maintenance of different power sources is needed.

Renewable energy and energy efficiency need to be a greater part of energy generation in the future. Renewable energy sources, such as sun and wind, should strategically and gradually grow to contribute more to the energy mix, so that SA can develop its workforce for transformation in the energy sector, while the costs for renewable energy technology reduces. The key to reliable renewable energy usage is BSS. SA requires more efficient and cost-effective batteries to store and dispatch the energy produced by renewables and obtaining this requires private investment in research and development on BSS. This recommended path will further diversify the energy mix that will reduce over reliance on coal and other fossil fuels.

Lastly, it is worth recommending further research on the outcomes of the review of IRP 2019, the unbundling of Eskom, the alleged sabotage of Eskom's infrastructure and the energy interventions recently put forward by President Ramaphosa. These require further study for development of a decarbonized workforce and low-carbon economy. The research for this dissertation was being concluded at the end of August 2022 and as one student's master's project was limited in scope. It will be essential to have in-depth and independent critical analysis of all new plans and to have monitoring of their implementation. The SA's energy sector has been a constantly evolving during this research. A number of important developments have unfolded after August 2022, such as, the fifth bid window for the REIPPPP, the Just Energy Transition Investment Plan, appointment of a new Eskom Board and criticism of Eskom's CEO.

One can conclude that this dissertation has made a small contribution to this important discussion that needs further research, monitoring and dialogue to find, not only ideas for solutions, but ways to ensure that the just transition is implemented equitably. The current low growth and rising unemployment and their contribution to the persistence of poverty and inequality in SA cannot be ignored. Unlocking a just transition for SA must address these crises and avoid exacerbating inequality in order to contribute to

sustainable development, poverty reduction, and mitigate the impacts of climate change. If the just transition can do this successfully there is more chance for it to be widely supported and for the social cohesion necessary for its implementation to be strengthened.

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Annexure A: Interview Guide

A paper-based list of questions was prepared prior to the engagements with the interviewees. This will be interview guide. The semi-structured interviews will be conducted in the following manner, the guide is developed in with general questions (column “QUESTIONS”) designed to open up conversation about the topic; In the column “ADDITIONAL QUESTIONS” a set of possible follow-up questions is included in a case an interviewee is not responsive about the topic or as the interviewer more clarity is needed; and in the last column (“RATIONALE”) reasons for asking particular sets of questions is provided.

Task 1: List of questions

QUESTIONS	ADDITIONAL QUESTIONS	RATIONALE
What concrete steps are being taken to contribute towards the reduction in Price of Electricity and improving access to electricity?	what initiatives or partnerships does government have with private sector alleviate the high cost of electricity for citizens that are unable to afford electricity?	To gain data on how South Africa will ensure accessible and affordable to electricity for all by 2030.
What is the plan to increase or maintain security of supply to support economic recovery?	Will IPPs be the viable option to provide sustainable and reliable energy?	To understand how South Africa will provide reliable electricity and will Eskom will Eskom uptake IPPs on the National Grid.
What have been the barriers to energy efficiency in South Africa?	Why is that Eskom is not leading in the creation and innovation of energy efficiency technologies?	South Africa is one of the world's least energy efficient nations. It would be beneficial to gain data on how South Africa will move forward in energy efficiency

		considering SDG Target 7.3.1 by 2030.

Task 2: List of questions

QUESTIONS	**ADDITIONAL QUESTIONS**	**RATIONALE**
Why are unions against the decommissioning Eskom's power production units and outsourcing the energy requirement to private companies?	Are unions more concerned over job security than the severe environmental and public health impacts of coal mines and coal powered stations?	Reducing dependency on coal is being actively opposed by powerful labour unions. It would be important for this research to understand why.
Are unions in support of reliable and clean energy?	Are unions engaging Government and Private Sector on a compact to a transition to renewable energy that will retain jobs of coal mine workers and communities and support the adoption renewable energy mix?	There is contestation between energy production and democratic labour demands. It is essential for this paper to understand if unions are environmentally considerate.
What are NGOs take on tension of cheap coal powered energy and environmental impactions in South Africa?	What solutions do NGOs have for the balancing carbon emission reductions and social economic development for sustainable development?	Addressing climate change and ensuring sustainable development is current dilemma. NGOs insights on balancing the two would be beneficial to this research.

Annexure B: Confirmation of Consent Form

Energy and Development: An assessment of South Africa's progress towards achieving SDG 7

Confirmation of Consent form

Signing to show your consent is to ensure that you understand the purpose of your involvement and that you agree to the conditions of your participation.

1. I confirm that I have read (or had read to me) and understand the participant information sheet for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.

3. I understand that all the information I provide will be treated in confidence and will be cited anonymously, unless at the end of this interview I expressly give permission to be identified either in general, or for certain information to be attributed to me.

4. I understand that the interview will be recorded, and a transcript will be produced, the Research Participant will be sent the transcript and given the opportunity to correct any factual errors and the transcript of the interview will be analysed by the Research Investigator.

5. I understand that I have the right to change my mind about participating in the study for a short period after the interview has concluded (within 2 weeks of interview).

6. I confirm that this interview will be conducted on online digital platforms and adheres to COVID-19 safety protocols.

7. I confirm that my participation in this research does not expose me, or anyone else, to additional Covid-19 risk.

8. I agree to participate in this research project on these terms identified above.

Participant name:	Participant signature:
Researcher name:	Researcher signature:
Date:	

NOTE: The interview is conducted only via cell phone or video call (e.g., WhatsApp, Zoom, Microsoft Teams, Google Meet and Cisco Meetings) the researcher will read out the statements above and ask the respondent (Participant) to confirm verbally that consent has been granted and verbal consent will be recorded by the researcher.

Annexure C: Informational Sheet

Participant's Informational sheet

Research title: Energy and Development: An Assessment of South Africa's Progress Towards Achieving SDG 7
Research investigator: Oratilwe Teisho
Research Participants name:

1. INTRODUCTION

You are invited to volunteer for a research study. I am doing research for a Masters in Development Studies degree purpose at the University of Pretoria. This information in this document is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what is involved. If you have any questions, which are not fully explained in this document, do not hesitate to ask the researcher. You should not agree to take part unless you are completely happy about all the procedures involved.

2. THE NATURE AND PURPOSE OF THIS STUDY

The aim of this study is to evaluate South Africa's progress towards achieving SDG 7 (Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all). By doing so, the researcher wishes to learn more about electricity demand, electricity tariffs, renewable energy, and energy efficiency in South Africa.

3. POSSIBLE RISKS AND DISCOMFORTS INVOLVED

There are no medical or reputational risks associated with the study.

4. POSSIBLE BENEFITS OF THIS STUDY

Although you may not benefit directly. The study results may help us to improve the debates surrounding electricity and sustainable development in South Africa.

5. COMPENSATION

You will not be paid to take part in the study. There are no costs involved for you to be part of the study.

6. YOUR RIGHTS AS A RESEARCH PARTICIPANT

Your participation in this interview is entirely voluntary and you can refuse to participate or stop at any time without stating any reason.

7. ETHICS APPROVAL

This Protocol has been approved by the Research Ethics Committee of the Faculty of Humanities, University of Pretoria, telephone numbers 012 356 3084 / 012 356 3085 and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki (last update: October 2013), which deals with the recommendations guiding doctors in biomedical research involving human/subjects. A copy of the Declaration may be obtained from the investigator should you wish to review it.

8. INFORMATION

If I have any questions concerning this study, you can contact:

The Researcher, Oratilwe Teisho. Cell: 071 887 9426

Or his supervisor, Dr Marc Wegerif. Tel: 012 420 2597 or cell: 076 373 4115

10) CONFIDENTIALITY

All information obtained during the course of this study will be regarded as confidential. Only the researcher will be able to identify you as participant. Results will be published or presented in such a fashion that patients remain unidentifiable. The hard copies of all your records will be kept in a locked facility at the faculty of Humanities, The University of Pretoria.

Annexure D: Ethical Clearance

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Humanities 100
Since 1919

11 August 2021

Dear Mr OG Teisho

Project Title:	Energy and Development: An assessment of South Africa's progress towards achieving SDG 7
Researcher:	Mr OG Teisho
Supervisor(s):	Dr MCA Wegerif
Department:	Anthropology and Archaeology
Reference number:	12072754 (HUM012/0521)
Degree:	Masters

I have pleasure in informing you that the above application was **approved** by the Research Ethics Committee on 29 July 2021. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely,

Prof Karen Harris
Chair: Research Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: tracey.andrew@up.ac.za

Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Research Ethics Committee Members: Prof I Pikirayi (Deputy Dean); Prof KL Harris; Mr A Bizos; Dr A-M de Beer; Dr A dos Santos; Ms KT Govinder Andrew; Dr P Gutura; Dr E Johnson; Prof D Maree; Mr A Mohamed; Dr I Noomé; Dr C Puttergill; Prof D Reyburn; Prof M Soer; Prof E Taljard; Prof V Thebe; Ms B Tsebe; Ms D Mokalapa