The Challenges of Power Generation, Transmission, and Distribution in the South African Power Sector

Gideon Simon Ghajiga
Dikeledi Jacobeth Warlimont
Mzansi Youth Leadership Academy for short MYLA (NPO/NGO), South Africa
gghajiga@gmail.com
djwarlimont@gmail.com

Abstract

The South African Power Sector which since inception, over the years has come to be monopolized by the behemothic South African Utility Companies, has been undergoing some supply stress due to increased demand for electricity in the face of death of investment, corruption, climatic change due to gas emission; and its inability to meet these demands. Since their establishment the utility companies, are facing one of their toughest transition from a majorly coal-powered generating business to alternative sources of energy. These are not unconnected to the numerous challenges, which range from aging plants, lack of adequate investment to climatic change; particularly so when 26 % of South African electricity is powered and anchored coal-fuelled technology. Power is a critical component and factor in the developmental process of every nation, more so when every country owes it to its citizens a fundamental duty to provide a safe environment in the developmental trajectory of its economic and social programs.

Key words: electricity generation, transmission, distribution, challenges
J.E.L. classification: E2, P28, L94, O4

1. Introduction

The power sector of any nation, specifically the electricity supply of any country is the most critical segment and the fulcrum that every developmental process rest on. Without energy, particularly electricity supply, in this technological age, life will be grim and boring. Every human activity now revolves around the use of one form of electricity or the other; from powering our computers, phones, to industrial concerns. Kenny (2015) affirmed this assertion in his submission that the provision of power, specifically electricity as a service, underscores its importance and centrality among current millennium innovations, technical and scientific developments; because of its value-added and transformative role in the world for the benefit of humanity.

It is because of the importance of electricity that every nation, in their quest to develop their economy and industrialize that they give priority to the provision of electricity to ensure there is steady, stable, and uninterrupted; and unhindered electricity supply; not only to power households but also industries so that economic activities can be sustained to an assured growth in every sector. (Eskom, 2010a)

Unfettered access to electricity is no more an exclusive privilege and preserve of a few developed economies but it is increasingly being treated globally as an integral and indispensable, but part of inalienable right of the human race; also, an important ingredient of the socio-economic development of any nation.

The forcefulness of this fact is captured in the speech made where he acknowledged that access to energy is important to human development. (South Africa 2008). The Head of the South African Government, President Cyril Ramaphosa (2019), highlighted this important fact in his Human Rights Day speech on 21st March 2019 where he also juxtaposed the importance of energy as human right issue in pari passu with housing, healthcare when he said that, while energy might not be listed in

among the bill of right, it goes without saying that It is equally sacrosanct to the dignity of man, safety of lives, health and of course the overall wellbeing of the human race. He pointed out that it is the inalienable right of every citizen to have unencumbered and access to energy, just like a place of abode; including their overall well-being. It is their entitlement. It may not be acknowledged in the Statement of Freedoms, but it is indispensable to the human decency, security, well-being of our societies.

2. Literature review

The importance of electricity to development in any society and indeed the world over has been amplified by no less a body than the United Nation General Assembly (UNGA 2011) when in its declaration stressed the fundamentals to consummating and achieving its developmental objectives is anchored on low-priced energy supply. The agenda of the world body, for example, specify the role of electricity in the eradication of extreme poverty and hunger, the attainment of global elementary learning, the advancement of feminine equal opportunity, by giving them the opportunity to realize their God-given potentials as equal stakeholders. (Goal 3), the curtailment in infant death, and enhancement in the well-being of childbearing women. It also inclusive of access to modern energy supplies which offers major benefits to general wellbeing, literacy, and certainly the ability and of capabilities of the female to contribute meaningfully to the society in general **(**Barnard 2013, 30). The global body upholds that avenue to dependable and inexpensive power supply is foundations of sustainable development, which is not achievable in the absence of a viable energy source (UN 2013).

The benefits of unfettered electricity supply cannot be overemphasized. A stable electricity supply is the key to unlocking the great economic potential of South Africa, considering its huge mineral based that is waiting to be tapped; and has the capacity to make South Africa one of the ten top economies of the world. It has the capacity to transform the countries communication and digital system necessary for industrial and cutting-edge technical discoveries and innovations. This ultimately, will greatly impact on the country's healthcare delivery system, thereby upping the living standard of the citizenry.

One of the fundamental principles of state policy is provide security and also meet the basic needs of its people, whose collective endeavors will contribute immensely to the economic development of the country. A healthy people are a pride to any nation. Therefore, the energy sector holds a prime place in every national government developmental effort. The need for electricity is paramount for the growth of any country. Therefore, access to electricity as the basic form of energy supply to the masses is vital for the development of a nation's economy. It is undoubtedly so, its indispensability, and its irreplaceability in our day-to-day lives, particularly in respect of home appliances; and offices to power our machines, and equipment.

However, aside from the fact that very few developing countries were able to get it right by ensuring adequate and uninterrupted electricity supply, most third world nations over the years have been struggling and battling to provide 24/7 electricity which can be attributed to so many factors; some of which are historical, structural as well as funding.

While access to unhindered electricity supply is a necessity and a sin qua non to the long-term wellbeing of the nation, it is equally expensive and capital intensive.

This paper is an attempt to examine the challenges that South Africa power sector is facing, in its quest to increase the quantity of power being generated in order to meet its soaring electricity demand as a nation; which is still grappling with load-shedding, an euphemism for power outages and shortages; which has become a recurring decimal in the daily lives of South African. This has greatly slowed down the economic development pace of South Africa in the last ten (10) years. It is evidenced in the dwindling fortune of the South African economic indices (Oxford Policy management, 2020). The country is therefore facing one of the toughest challenges post-apartheid, particularly in the industrial and commercial sector of the economy.

The choice of South Africa has some historical significance, particularly if we juxtapose post-apartheid South African society during the White Minority rule. South Africa's retrogressive industrial and economic decline can be attributed to decreasing electricity sustainability to keep up with increasing demand for energy by consumers and increase tempo of industrial and commercial sector, as a prime economic contributor to South Africa's GDP. This state of affairs is reflected in the

current South Africa's economic statistics. The GDP from Utilities in South Africa decreased to 62937.37 ZAR Million in the first quarter of 2021 from 63350.26 ZAR Million in the fourth quarter of 2020.(:Trading Economics,2021).

Historically speaking, South Africa has been the hub for mining activities particularly home to some of the biggest, coal, diamond and goldmines in the world as well as industries which are energy-dependent, and require constant but stable electricity for their operations. Over time, the provision of energy to the nation has been dwindling, retrogressively and this forced South Africa's utility companies to ration supply to consumers. The quantity of energy supply in the country has been persistently on the decrease and this has led to rationing of electricity by Eskom and other municipal authorities.

It goes without saying that South Africa's main utility company since inception in 1894 when it debuted as EVOM has dominated the sector for decades, taking on the enviable task of generating and transmitting electricity across the entire nation, owning and operating virtually 92 percent of generation capacity in the country; and these are largely dependent on coal-fired technology that fuels the power stations, and of course municipalities and private generators splitting the remaining six and two percent, respectively. The total quantity of electricity generated in 1993 was 190TWh. **(**National Energy Report, 1999).

It is in the light of these creeping challenges that have motivated me to undertake this study on the South African Electricity Power sector. To identify the causes of such a state of affair in the sector, because South Africa can be regarded as a developed nation, and also offer concrete suggestions and the way forward in navigating out of this quagmire mitigating these challenges.

It is pertinent to emphasis here that cheap, abundant energy is crucial to keep up the momentum of continuous economic growth, which is critical to helping South Africa recover from the global crisis, and bolster industrial competitiveness.

South Africa's main generating technology is coal-dependent in the running of most of its power stations, which are sited in the prime coal-mining shafts and also proximity to big consumers of the electricity generated in these plants. By December 1999, South Africa has 49 power stations, out of which 20 are coal-driven, generating 90 percent of their combined capacity of 43142MW; exclusive of others in the pipeline, as well as those in reserve. These power stations were construction out of pressing necessity during sanctions imposed by the United Nation on the white-minority rule in order to meet their energy needs. South Africa therefore had older Coal-fired power station that had extra generating capacity capable of adding 3556MW.

It is also important to mention here that South Africa also ventured into generating electricity using nuclear technology; this is called the Koeberg nuclear station; operating at 4% of its 1,930 MW capacity. The Construction of Koeberg Nuclear Facility which was cited in the Western Cape Province of the country, started in 1976, but it was only in 1985 that it started operating. It contributes 4.4% of South Africa's generating capacity. It earned itself and an enviable position and accolade of being first nuclear power station, with an installed capacity of 1910 MW of power, but current total net output is 1860 MW. The Table below shows a breakdown of energy sources of South Africa.

Figure no. 1 Electricity output by source

ENERGY SOURCE	**PERCENTAGE**
Coal	94.20%
Gas	0.03%
Nuclear	4.27%
Hydro	1.17%
Geothermal	0.24%
Solar, renewable & Waste	0.09%

Source: DME (n.d)

3. Research methodology

The approach we chose in writing this paper is basically intellectual in form, scrutinizing and collecting material from printed books and articles, by other authors; bulletins as well as budgetary and policy documents, pronouncements by the government Departments of South Africa.
This study tends to fill the gap in understanding the challenges and the opportunities affecting electricity generation, transmission and distribution in South Africa and proposing strategies to help South Africa in providing its citizens with stable and steady and efficient electricity supply.

4. Findings

4.1. Overview of the South African Electricity Sector

The current edition of Africa's Energy Report of 28th April, 2021 on South Africa, captures the grim prospect of the energy sector of Africa's most industrialized nation, which painted a pessimistic outlook. It is there considered opinion that the threats confronting the South African energy management have escalated in the last decade. With current burdensome pandemic putting a heavy toll on the economy at the same time copping with intense rationing of electricity supply, (under the prevailing circumstances. (African Energy Report, 2021).

The article illustrated and threw light on some of the inherent and underlying symptoms plaguing the energy sector to include political power scuffle, administrative issues, despite catalogues of policy guidelines that provides the road map for charting a new course; taking cognizance of the country's huge inherent potential for alternative sources of energy. This includes wind, solar, kinetic and other renewable energy potentials that will propel South Africa through a seamless passage away from coal.

4.2 Generation

South Africa according to the International Energy Agency Report (IEA March 30, 2021) has a GDP of USD 325.94BN and a population of 57.78 million people. Eskom alone presently produces 47,000 MW, as against its established capacity of 52,000 MW. (Oxford Policy Management 2020). Meanwhile, based on government figure, The Ministry of Mineral Resources and Energy

According to the report declared by the government of South Africa, the entire national bulk electricity production is 58,095 megawatts (DME 2020).

Consequence, coal-fired production facilities are the predominant being used to generate energy comprising 80 percent of the country's energy matrix. Not with standing, it is an urgent priority of government to phase out the use of conventional method in the next two decades which encompasses thermic and coal-dependent technology; a combined capacity of 24,100 Megawatts.

While, the country is currently heavily dependent on fossil fuel as its main source at this point in time, the proportion of overall quantity is expected to progressively decline as additional renewable generating capabilities are commissioned in the future. The Government hopes to achieve this by using Renewable Energy Independent Power Producer Procurement Program (REIPPPP).

To show its total commitment to the present goal, the government through the nation's Renewable Freelance Power Producer Acquisition Program (REIPPPP) by inking twenty-seven (27) energy purchase deals in June 2018; mainly on renewable and sustainable energy. The renewed IRP outlines a number of measures the government plan to fulfill, in order to structure South Africa's disreputable and deteriorating energy sector, concentrating on expanded acceptance of natural gas, preserving the nuclear sector, while emphasizing the social inclusiveness as the core driving force. (Oxford Policy Management 2020).

4.3 Transmission

At the moment, electricity transmission in South Africa covers a distance of 28,000km, across the length and breadth of country, which is a task being shouldered by the Transmission arm of Eskom SOC Holdings. (Oxford Policy Management 2020)

On the distribution side which is currently being carried out by Eskom in conjunction with 187 municipalities. (DMER 2021)

The electricity supply sector is playing a very pivotal role in meeting the economic development of the country, as a catalyst to industrial development but also in improving the quality of life for the previously underprivileged majority.

The Electricity generated by coal-fueled stations in South Africa account for 25percent of the total; with liquid fuels making up the rest (DME, 2000). Major consumers of energy supply electricity in South Africa are, principally in the productive sector, which comprises industrial and the prospecting sectors consumes 60% of the energy produced. Fortuitously, they are the main catalyst for development and growth; making huge contribution to exports and ultimately powers South Africa's economic growth. (Berger, 2000; DME, 2000; Trollip, 1996).

Hitherto during the apartheid era, before the ushering of majority rule, many impoverished South Africans black communities have been neglected. Most such neighborhoods are left without electricity. But under the ANC-dominated democratic rule, whose main policy thrust, anchored on Reconstruction and Development was able to successfully impact the lives of many households through the holistic provision of electricity for the masses.

4.4 Distribution

On the distribution side which is currently being carried out by Eskom in conjunction with 187 municipalities. (DMER 2021).

5. South Africa energy challenges

The numerous challenges confronting the nation's energy segment, specifically electricity supply to its growing population is daunting; not just in its capacity to generate, but to carry what is produced and distribute it to where it is needed.

One of the major challenges is inadequate generating capacity. South Africa currently generates approximately 47,000 MW against an installed generation capacity of 52,000 MW). The industry is also bogged down by operational failures and which by extension includes but not limited to the issue of maintenance of its plants and facilities. The blackout started in 2008 and has become a permanent part of South African lives. For instance, during covering January to April, 2008, these blackouts were felt across the nation, with attendant destructive effects on South Africa's commercial and industrial life. Based on the report issued by the National Energy Regulatory of South Africa, it gave a gloomy verdict, with the South African economy loosing over R50bn (NERSA).

There are ongoing cases of corruption bordering on grafts, underhand deals as well as Eskom officials with stakes, interest and financial ties with companies having transactions with Eskom personnel's. There were 278 cases of grafts; an underhand payment in court, with 82 cases bordering on criminality is being handled by the police; as at September, 2020.

Another very important challenge is in the area of distribution of electricity if South Africa wants to achieve the desire goal the government set for itself. Lack of technical and financial capability is one of the challenges that need to be tackled. Another ominous challenge is the frequent breakdown of its generating companies due to aging facilities that over the years, due to corruption and grafts are poorly maintained or at best neglected, hence the frequent blackouts and load shedding.

Other challenges of course include: i. poor utilization of existing assets and deferred maintenance; ii. Delays in the implementation of new projects; iii The National Grid is yet to cover many parts of the country; iv. Vulnerable and overloaded existing transmission system; v. The current maximum electricity wheeling capacity is 47,000 MW which is awfully below the required national needs of 58,095MW; vi. Some sections of the National Grid are outdated with equipment in a state of poor and inadequate maintenance; vii. Low tariff.

6. South African current national energy policy

In spite of all the demands currently besetting the South African economy, the Government has through the instrumentality of the state budgetary and fiscal policies has taken the challenge by rolling out strategic policy initiatives, aimed at meeting the electricity supply challenges.

In his speech to the parliament during the budgetary debate by the South African parliament, the President, Cyril Ramaphosa lay out the country energy policy guidelines to meet these challenges; and this undoubtedly underscore the centrality of the energy sector in South African quest to mitigate these challenges in both the short-term, medium- and long-term.

7. Charting a New Course for the Future

The genesis of the South African power sector began way back in 2008 when Eskom's operation in the electricity industrial suffered set back which, which ushered in shortages and outages of power. The generating stations experienced a decrease in capacity. They were not capable of generating enough power to satisfy needs of the nation. The electricity shortage has been an issue for better than a decade, with industrial and commercial activities being seriously interrupted whenever there is an energy reduction, affecting both smaller and big businesses alike. This has over time contributed to sluggish growth and low investor trust.

The resolve in bring about the needed transformation in energy challenges isn't just important; but it is equally imperative to South Africa's economic resurgence. It is in tandem with this new paradigm shift that the government is making great strides in bringing alternative sources of energy into operation at soon as practicable.

A giant leap forward in this direction was the unveiling of new policy initiative by screen and approving some power producers to generate additional 200MW of energy to fill in the deficit and meet the supply gap in the country's power demands.

This emergency power capacity is expected to be sourced from variety of sources. These includes liquefied natural gas, wind, batteries and solar. Funding for this ambitious project will come from private capital and it is projected to cost R54Bn. The main attraction and benefit of such project is the fact a greater part of the material required in the execution of these project will be procured from local sources in South Africa. It is the projected that by August 2021, these programs will come on stream, and be up and running.

The Government of South Africa is also looking at the renewable energy as an alternative source of energy. During this period the government of South Africa called for proposal from interested investors for the procurement of an additional 2600 megawatts of renewable and sustainable energy. It is the country's fifth bid in its quest to look at tap into the renewable energy source from independent energy producers.

It is important to note that this program has seen a quantum leap in the number of venture capitalist interested in the country's power sector.

The government has also showed its commitment in realizing its objectives in this regard through the instrumentality of parliamentary legislation and policy guidelines to make it easier for industries to generate electricity for their use. Such a self-generated power will curtail the demands on Eskom's power stations and help free resources by Eskom to invest in alternative energy sources. It also has the capacity to increase and strengthen the power pool that is badly needed through private investment.

The ANC-led government, in its current Integrated Resource Plan, it emphasized emphatically and unambiguously that renewable energy will be the next frontier for the next decade, towards meeting the energy needs of the country. As a demonstration to its unavow commitment, a hitherto comatose contract program for Independent Power Producers (IPP)was kick-started with a timeline by year 2030 to increase the electricity generating capacity to 17,800MW through renewable energy sources. It is envisaged that will help leap-frog the country seamless transition from Coal-dependent to a sustainable, leaner, cleaner and environmentally friendly power sources, thereby reducing; and in the long run eliminate the country's environmentally hazardous and polluting carbon emissions.

The sad reality at this point is that, 80% of South Africa's energy supply is largely dependent on coal, principally because it has a large untapped reserves of it, while 20 % are a mixture of thermal, fossil, hydro, solar and wind. Nonetheless, this is about be change, as contained in government's 2019

white paper on Integrated Resource Plan (IRP). It is proposed that in the next two decades the use of coal and thermal energy will be deemphasized, skewed in favour of renewable alternative sources of energy.

The main source at this point in time, its proportion of overall quantity is expected to decline as additional renewable generating capabilities are commissioned in the future.

The IRP program, recently outlines a number of measures the government plan to comply with in order to complement South Africa's disreputable and deteriorating energy sector, concentrating on expanded endorsement of use of liquefied natural gas, preserving the nuclear sector, while emphasizing social inclusiveness as its core attraction for renewable and source of power.

8. Conclusions

The transitional years are ahead being very crucial for South Africa in terms of getting it right by strictly implementing and adhering to the policy framework on power reforms that will transform South Africa as a leading economy in Africa; by generating sufficient power to power its economic growth thereby lifting the living standard of its citizens.

However, South Africa's strategic choice of transforming its electricity mix is based on a multi-facet strategy. There is rising apprehension as to whether the extra electric capacity to be injected into the national network is economical and affordable by the populace.

And this is an important ingredient that needs critical analysis, because it could be a potential restraint on this variegation strategy. Statistics indicates that the pattern of expenditure on electricity is biased towards higher wage category, with the wealthiest making up 20% of the public, making up 50% more of the overall. In recent survey conducted by the Department of Energy, 75% of South Africans said that the preference for government energy program should be to hold electricity prices down: commercial factors outweighed other preferences by an ample surplus. Regarding the ultimate fuel mix, virtually one third of the peopled surveyed concurred with the assertion that every source of energy is desirable to fill in the gap as long as it is affordable to every consumer.

Conversely one quarter of those surveyed unanimously backed the use of alternative energy source, particularly renewable energy; and 14% specifically placing priority on sources that are not harmful and does not endanger the environment.

It is important to stress here that government will be confronted with complex alternatives as it engages in its intentions of variegating and diminishing the impact of its power matrix on the environment. It is also imperative that the government pursues a progressive, inclusive but effective strategy of national discuss on the issue.

In spite of the challenges and tough choices confronting the government, there is unanimity of opinion that the aggregation of its consultative but holistic policymaking, backed by strong legislation, with an investment friendly and attractive policies for renewable energy; will achieve the desire objectives.

Consequently, by recognizing the critical role of private equity financing, based on rational resource allocation process, based on market fundamentals, coupled with regional integration strategy adopted, South Africa is well positions to accomplish such an important exercise.

9. References

- Barnard, M., 2013. *Nuclear Energy in Africa: A Legal Framework for Sustainable Energy Access*. Unpublished thesis, North-West University, Potchefstroom, South Africa.
- Berger, D., 2000. *South Africa Yearbook 2000/2001*. Government Communication and Information System, Pretoria.
- Department of Minerals and Energy (DME) (n.d.). *Energy security master plan: Electricity 2002–2025*. Pretoria, South Africa: Government Printer.
- Department of Mineral and Energy, 1998b. *White Paper on Energy Policy for South Africa*. Department of Minerals and Energy, Pretoria
- Department of Minerals and Energy, Directorate: *Energy Planning and Development. Annual Price*

- Eskom, 2010a. It's All Systems Go for the Start of Boiler Construction at Medupi Power Station. Joint Media Release from Eskom and Hitachi Power Africa. 16 January. [online] Available at: http://www.eskom.co.za/live/monster.php?URL=%2Fcontent%2FEs-kom-Hitachi+Joint+Statement+16012010.doc&Src=Item+13938
- General Comment No. 4: The Right to Adequate Housing (Art. 11(1) of the Covenant), 13 December 1991, E/1992/23. Accessed February 5, 2015.
- Kenny, A., 2015. The rise and fall of Eskom and how to fix it now. *Policy Bull. South Afr. Inst. Race Rel.* 2 (18), 1–22.
- South African Department of Public Enterprises, 2008. *Department of Public Enterprises Annual Report 2007/2008.* 8 October. [online] Available at: http://www.info.gov.za/view/DownloadFileAction?id=91013.
- South African Department of Energy, 2010a. *Integrated Resource Plan for Electricity*. 8 October.
- Trading Economics, 2021. *South Africa GDP from Utilities.* [online] Available at: https://tradingeconomics.com/south-africa/business-confidence (accessed on 20.06.21).
- Trollip, H., 1996. *Overview of the South African energy sector*. Report No. EG9404. Department of Minerals and Energy, Pretoria.
- UNCESR (United Nations Committee on Economic, Social and Cultural Rights). 1991 [online] Available at: https://www.iea.org/countries/south-africa https://www.gov.za/speeches/president-cyril-ramaphosa-2019-human-rights-day-21-mar-2019-0000
- UN (United Nations). 2020. About the Sustainable Development Goals. Accessed March 22, 2020. [online] Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
- http://www.energy.gov.za/files/media/pr/INTEGRATED_RESOURCE_PLAN_ELECTRICITY_2010.pdf
- https://www.africa-energy.com/report/south-africa-power-report-202122
- https://www.usaid.gov/
- https://www.researchandmarkets.com/reports/5313483/generation-of-electricity-in-south-africa-2018?utm_s
- https://pemedianetwork.com/petroleum-economist
- https://www.opml.co.uk/blog/south-africa-s-crippling-electricity-problem#
- http://www.refworld.org/doc
- https://www.globenewswire.com/
- https://www.worldbank.org/en/home
- https://usea.org/sites/default/files/event-file/497/South_Africa_Country_Presentation.pdf