Original Research Article

Energy resources of Southern Africa; potentials and sustainable energy delivery

Abstract:

Energy resources constitute a substantial part of natural resources of many nations. The energy resources confer advantages on the resource nations as they provide the base for energy development, support economic development and provide export commodities. Southern Africa commands some fossil fuel resources of natural oil, natural gas, and coal. It also has uranium deposits for nuclear energy development. With the global attention shifting to renewable and cleaner energy sources, it is seen that Southern Africa is also endowed with renewable energy resources. The advantage of its position relative to the Equator, the vast land that accommodates high wind speed, the vast tropical forest that yields bio-energy resources and coastlines that permit access to the ocean for off-shore wind energy and ocean energy, all provide the renewable energy resources to that help in achieving universal access. The objectives of the study are to profile the non-renewable energy resources of the Southern Africa subregion, understand the potentials of the renewable energy resources and draw implications of the energy for energy delivery in the Southern Africa subregion. The paper notes that while non-renewable energy resources are confined to a few countries, all the countries have advantages of renewable energy resources with adequate distribution of wind and solar energy resources. The paper also notes that clean non-renewable resources of natural gas and uranium could be adequately combined with the renewable energy resources to achieve sustainable energy mix and harvest the advantages of the two groups of energy resources for achieving not only universal energy access but also to achieve green development.

Keywords : energy resources, energy potential, renewable, non-renewable.

1.0 Introduction

Natural resources are materials in the environment naturally formed and valuable for use by human beings. They are 'materials, energy and their attributes, that are derived from the earth and are useful and of value to the maintenance and improvement of human life'(Arocena, and Driscol, 2003). Resources are natural assets (Ushie, 2013) and constitute a significant part of the national wealth of most nations (OECD, 2011). The underlying issue here is that raw materials are (1) part of the environment (2) formed naturally and (3) are useful to man. The uses that natural resources have are multiple and relate to aspects of human activities. Every creation of human society has a trace of the natural resources. Resources are affected by the three elements of inheritance (mineral, energetical resources); economic probability of regeneration (actual consumption and taste) and present and future technologies (resource exploitation) (Rajovic and Bulatovic, 2017) Natural resources occur in varying forms and volumes across space. Many are closely related to natural systems balance and some are latent in relation to the natural balance until tampered with by man. Hence, natural resources provide support services for both the human society and the environment. These services are encapsulated in the idea of ecological services. That is, services provided by the functioning of natural systems provide much of the necessary foundation for the economy and society .

They are summarized as purification services:, regulation, habitat provision, regeneration and production, and information and its support (OECD, 2011).

For example, energy resources are part of the global carbon cycle, a critical aspect of the world ecosystem. Carbon takes place in organic carbon compounds within organisms; dissolved carbon in water bodies; and carbon compounds inside the earth as part of soil, limestone (calcium carbonate), and buried organic matter demonstrated by the fossil fuels (coal, natural gas, peat, and petroleum (Sekercioglu, 2010). Africa has significant natural resources hosting the world's largest arable landmass; second largest and longest rivers. second largest tropical forest, 8% of the world's proven oil reserves and 7% of natural gas (African natural Resource Centre, 2016) . Southern Africa is a significant contributor to this continental resource wealth.

Natural resources may occur in single form or in complex, and separated through human technologies. Generally resources have been classified as renewable or non renewable resources. Renewable resources are 'resources that are continually available and are ' products of the natural processes resulting from the harmonious interactions of the physical and biological components of the Earth systems; (Arocena and Driscol, 2003). On the other hand, non-renewable resources that are 'present in finite quantities and cannot be regenerated within the lifespan of humans after they are harvested' (Arocena and Driscol, 2003). In addition, while renewable resources are common; the non-renewable resources are less common and are largely found in certain locations.

Whatever functions that resources may render, the truth is that they contribute to sustainability. The idea of sustainable development became popular with the publication of the book *Our Common Future* and has since appeared on the political platform. The most common definition of the concept is provided by the Brundtland Commission:. It says that 'Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future' (Brundtland Commission, 1987)

Before the Brundtland Report, sustainability means 'to keep in existence, maintain, prolong' (Rajovic and Bulatovic, 2017). The concept has now become extremely politicized and hence, sustainability can now be seen as 'a systems approach that incorporates environment, economy and society; (Rajovic and Bulatovic, 2017). The value that resources have are evaluated from three components of sustainable development: environment, social and economic. They play many roles for societies. In achieving these roles. The reciprocal relationship is for the society to ensure that the role of the natural resources in maintaining ecological balance and continuous yield of the said resources are achieved. In terms of the society and the economy, the role of the society is to ensure continuous supply of the resources, equity in harvesting and distribution of the benefits to achieve human wellbeing for the majority of the people. Indeed, sustainable resource use in the current global approach is to ensure that resource use and benefits leave no one behind; that is, inclusive benefit distribution.

Energy resources are part of the natural resources available to man. They form a unique set of resources because the development of energy resources is permissive to the development of other resources and human activities in general. So, energy resources may simply be called 'permissive resources' in view of the role they play in achieving economic development and human wellbeing. They help in creating wealth and improving standard of living (Rosen and Dincer, 2022) The UN Development Goals assigned a goal to energy; Ensure access to affordable, reliable, sustainable and modern energy for all

In addition to the benefits of resources in general to human society, energy serves three broad functions. One, they serve as an exportable commodity to nations and secondly, they provide direct use to the nations for developing energy output that provide a range of services to the people. By energy services, the benefits of energy resources are brought to the people, institutions and businesses. Modern societies are grossly energy dependent and with the growing influence of information technology in almost all activities, the energy-dependency status of the modern economy is growing continually. Therefore, an energy development system that excludes access undermines sustainability. A major issue in a compromised energy access is energy governance.

Energy resources open many development possibilities; economic, political power and international diplomacy. Therefore, the third function of energy resources is largely intangible, consisting of national pride, confidence and enhanced international diplomacy. Energy becomes a tool of negotiation at the international level and sometimes, a tool for national protection. Energy resources allow the development of a modern energy system that allows diversity in energy services. Therefore, the benefits of energy resources are seen through the prism of these modern energy forms, especially electricity. Energy is central to economic and social development and to reduction of poverty (IEA and IRENA, 2017) Chirambo (2016) remarks that 'improved access to energy promotes industrial development, sustainable growth, job creation and poverty alleviation'. Modern energy form, especially electricity, is seen as a necessary prerequisite to long-term economic development (Energy for Growth Hub,2020). According to Blimpo and Cogrove-Davies (2019) analysis of statistical relationship between GDP and electricity shows a positive statistical relationship and R2 of 0.8398. On the reverse side, inadequate access to energy constrains the development of modern economics and negatively impacts life expectancy, and quality of life and undermines adoption of emerging technologies in many aspects of life including education and agriculture (Wilkinson, 2020). Electricity provides a gateway to a modern economy based on digital infrastructure and telecommunications and allows existing and potential companies in traditional industries (GIZ and IRENA, 2020). Energy is a cross-cutting infrastructure critical to the achievement of many SDGs (Blimpo and Cogrove-Davies, 2019) and acts as the link connecting the global poverty agenda and climate change (Africa Energy Panel, 2015). Indeed, Swilling (2016) sees energy as a game-changing dynamics, although less recognized so. Game-changing dynamics is defined as a complex process of change that specific actors invoke to justify their particular set of proposed social and system innovations'(Swlling, 2016).

Southern Africa like the other subregions in Africa is endowed with both renewable and non renewable energy resources. It is however faced with the challenge of underdevelopment of these resources with the consequences of low energy production, low energy consumption and unacceptable energy deprivation by households, institutions and businesses. Removing these challenges or reducing them significantly lies with the sustainable development of these resources. Generally, the appalling state of energy situation in Africa has been adduced by many analysts (IRENA, 2019, Chirambo, 2016, and Sanusi and Spahn, 2019). The poor state of energy is seen in the comparison between France and Africa where Africa with over a billion population has the same installed electricity capacity as France with 80 million population (Swilling, 2016). Except for the North African countries, the African countries seem to have similar energy problems in the midst of the large energy resources that abound in the continent.. While attempts are being made to undertake energy reforms, align with international energy/climate governance protocols, little gains have been made. This study is focusing on the energy resources in Southern Africa. It intends to profile the reserves non-renewable energy resources; explore the potentials of renewable energy resources and draw the implications of the resources for energy delivery in the Southern African subregion. The paper intends to examine the present status of energy consumption, explore the energy potentials of Southern Africa and understand the governance activities being undertaken to resolve the sub-region's energy challenges.

2.0 Methodology

Southern Africa as considered in this study consists of 12 countries. These are Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia. Sao Tome, South Africa, Swaziland (Eswatini), Zambia and Zimbabwe (Figure 1).

Data types and sources: The study relied on published data in all the energy resources considered. Four types of non-renewable energy resources and renewable resources each have been considered. The non-renewable resources are natural oil, natural gas, coal and uranium while the renewable resources are wind, solar, hydropower and geothermal. Data on the non-renewable resources, hydropower and geothermal are available in the directly usable form at the country level. In respect of wind and solar energy, two parameters each are considered to evaluate the respective potentials. Secondly, country level data is not directly available.

Figure 1: Countries of Southern Africa

Solar potential is measured by global horizontal irradiation (GHI) and practical solar potential. The GHI is the theoretical potential of solar energy which sums up the direct and diffuse irradiation components received by a horizontal surface, measured in kWh/m2. It is the shortwave solar radiation received by a horizontal surface and it is the most important parameter for energy yield (ESMAP, 2020).

The practical solar potential is defined by practical solar PV potential which is the power output achievable by a typical PV system (PVOUT). The PVOUT simulates the conversion of the available solar resource to electric power considering the constraints available at the specific location. These constraints are impact of air temperature, terrain horizon, and albedo, as well as module tilt, configuration, shading, soiling, and other factors affecting the system performance. It is 'the amount of power generated per unit of installed PV capacity over the long term (the specific yield), measured in kilowatt hours per installed kilowatt peak (kWh/kWp); (ESMAP, 2020)

Wind energy potential is measured by wind density and wind speed. Wind (power) density is defined as a 'comprehensive index in evaluating the wind resource at a particular site. It is the available wind power in airflow through a perpendicular cross-sectional unit area in a unit time period' (Tong, 2010). Similarly, wind speed is one of the most critical characteristics in wind power generation. It varies in time and space and is determined by many factors such as geographic and weather conditions (Tong, 2010).

Data for solar energy was derived from Global Solar Atlas and that of the wind was also derived from Global Wind Atlas. Both the Solar Atlas and Wind Atlas are online resources provided through multilateral cooperation coordinated by the Energy Sector Management Assistance Program (ESMAP) of the World Bank and International Finance Corporation. The country data for wind potentials are available in the Wind Atlas. However, in the case of solar energy potential, country level data are not available. So, attempts were made to collect the GHI and PVOUT for three locations in 8 countries (Angola, Botswana, Malawi, Namibia, Mozambique, South Africa, Zambia and Zimbabwe), two locations in 3 countries (Lesotho, Swaziland and Mauritius) and one location in Sao Tome. and the average derived to get country level potentials.

3.0 Results and Discussion

3.1: Non-renewable energy:

The non-renewable energy resources considered are natural oil, natural gas, coal and uranium. Southern African countries are not generally oil sub-region. Only Angola features among the 12 major oil countries of Africa. Angola is the fourth largest oil country in Africa, following Libya, Nigeria and Algeria. Records show that Angola has 11.6 billion barrels of oil reserves representing about 9% of Africa's total reserves of 128 bbl (Hafner, Tagilipietra and de Strasser, 2018). Recent oil discoveries are changing the oil landscape and hence brought in Mozambique as an emerging oil power. Major oil discoveries by Reconnaissance Africa put the Mozambique oil reserves at 120 billion barrels (Energy Capital and Power, September 16, 2021). These reserves clearly put Mozambique ahead of all other African countries; the amount representing almost 100% of the previous total reserves of 128 bbl for the African continent.

In terms of natural gas reserves, Southern Africa has been least represented in Africa. However, recent discoveries have also put Southern African countries on natural gas maps and even global maps. Reports by Energy Capital and Power, July 16, 2021 indicate that Angola's fossil fuel position has been strengthened with gas reserves of 13.5 trillion cubic feet (tcf) (373.8 billion cubic metres) while Mozambique has gas reserves totaling 77.2tcf (2.2 trillion cubic metres). In addition are the discoveries of shale gas in South Africa. Records show that South Africa is the fifth shale gas reserve country in the world. With 2013 estimates of 390tcf (11 tcm) and potential power generation of 40 854 TWh, it follows China, USA, Argentina and Mexico in that order (van Niekerk ,Petrie, Fakir and Clark, 2021).

Unlike the other fossil fuels, coal is common in Southern Africa. Seven of the 12 countries have coal reserves. Coal reserves in Africa are dominated by South Africa. Its 2019 total reserves are estimated as 10 905 standard million tones (Table 1). South Africa is followed by Zimbabwe with 553 million tonnes, Mozambique with 1975 standard tonnes and Botswana with 1830 million tonnes (Table 3). The least reserves of 2.2 million tonnes are found in Malawi and Zambia with 50 million tonnes. The large deposit of coal is evident in its contribution to electricity generation in South Africa in particular and in the sub-region in general.

Table 1 : Coal reserves in Southern Africa, 2019

Country	Reserves (million tonnes)
Botswana	1830
Malawi	2.2
Mozambique	1975
South Africa	10 905
Swaziland	159
Zambia	50
Zimbabwe	553

Source: US Energy Information Administration 2022
https://www.eia.gov/international/data/world/coal-and-coke/coal-

Uranium is another non-renewable resource with considerable presence of Southern African countries. Six of them are uranium reserve holders. The largest deposit is found in Namibia with 320 000 tonnes (Table 2). It is followed by South Africa with 258 000 tonnes. Other countries have far less than the leading countries. The reserves are as low as 1400 tonnes in Zimbabwe and 12 800 tonnes in Zambia. Namibia and South Africa control about 93% of the total Southern African uranium reserves. Although uranium is a non-renewable energy resource, it is clean and loaded with so much energy that only a small quantity provides substantial power.

Table 2: Reasonably assured recoverable Uranium resources 1 (January, 2019), tones U, rounded nearest 100 tonnes.

Country	USD260/kg U
Botswana	20400
Malawi	9700
Namibia	320000
South Africa	258000
Zambia	12800
Zimbabwe	1400
	4 723 700

Source: OECD, 2020.

3.2 **Renewable energ**y resources

Unlike the non-renewable energy resources which are less universally distributed, renewable energy resources are available in all the countries and hold promises for improved energy delivery in Africa. Renewable resources of wind, solar and hydropower are available in varying volumes in all the countries. The implication is that countries can use a combination of these resources to achieve desired energy mix. In addition to near-even distribution is the fact that renewable resources provide clean energy and therefore are capable of helping African countries to contribute to achieving the Paris Agreement of 2.5 degree carbon emission seal.

4.2.2.1: Wind energy resources: although there are many parametres to determine energy resourcefulness of wind; density and speed are quite critical and have been used here to examine the wind energy potential of the Southern African countries. Southern Africa is part of the sub-regions with high wind energy potential (Greenomics World, 2018). It competes only with North Africa and the northern part of West Africa. Table 3 shows the distribution of the wind density and wind speed at 100 m above the ground. In terms of wind density, the wind resource varies from 97 w/m^2 and 936 w/m^2. The highest wind density of 936 w/m^2 is found in Lesotho (Table 5). It is followed by South Africa with 559w/m^2. The sub-regional wind density is 376.43w/m^2 . Eight of the countries have wind density below the sub-regional average while three (Lesotho, Namibia and South Africa) have above the sub-regional average wind density. Wind speed is fairly less differentiated. While the minimum wind speed is 6.65m/s. The highest found in Lesotho is 9.26m/s. Lesotho is followed by South Africa, 7.73 m/s and Namibia, 7.41 m/s. Malawi also has wind speed above 7.0 (7.48m/s). The mean wind speed for the sub-region is 6.98 m/s. This is above the African average of 6.47m/s and the minimum wind speed of 6.0m/s required for utility scale wind power plants **(UNDP, 2018).**

Table 3: Wind energy potentials of Southern Africa

Country	Wind density w/m^2	Wind speed m/s
Angola	195	5.88
Botswana	277	6.85
Lesotho	936	9.26
Malawi	356	7.48
Mauritius	551	8.51
Mozambique	258	6.4
Namibia	461	7.41
Sao Tome	97	4.65
South Africa	559	7.73
Swaziland	322	6.58
Zambia	233	6.42
Zimbabwe	266	6.55

Source: Global wind Atlas, 2022,

4.2.2.2: **Solar Energy**

Two parameters of solar energy potential are used to examine the energy resourcefulness of solar in the sub-region. These are global horizontal irradiation and the practical solar potential, also called solar photovoltaic specific power output (PVOUT).

The GHI data shows that it varies from 1540 KWh/m2 in Angola to 2367KWh/m2 per year in Namibia. In addition to Namibia, the other top countries in GHI are Botswana (2220KWH/m2 per year, Zimbabwe (2192.2KWh/m2/year), Zambia (2131.5 KWh/m2/year). In general, only five countries (Swaziland, Sao Tome, Mozambique, Mauritius and Angola) fall below the sub-regional average of 1993.11kWh/m2/year (Figure 2). The GHI is complemented with PVOUT.

Source: Data from Global Solar Atlas, 2022.

This varies from 1235.33 KWh/kwp per year in Angola to 1985.03 KWh/kwp/year in Namibia. Namibia is followed by Lesotho (1893.85 KWh/kwp/year) and Botswana (1882.45 KWh/kwp/year. The sub-regional average is 1687.28 KWh/kwp/year. Six of the 12 countries (Swaziland, Sao Tome, Mozambique, Mauritius, Malawi and Angola) (Figure 3).

Source: Data from Global Solar Atlas, 2022.

4.2.2.3: Hydropower resources:

Table 4 **s**hows the hydropower potential of Southern Africa compared with Africa in general. The Table shows that the hydropower potential of the sub-region is 303 715 GWh. This is 19.6% of the continental total of 1 546 314 GWh. The sub-region generates 43 348GWh, representing 14.3% of the total potential. There is still a large margin to fill in its hydropower potential; although its existing capacity of 14.5% is more than the continental development capacity of 6.8% of total hydropower potentials. In addition to the big hydro potential is small hydropower potential. The advantages of small hydropower are that it is less threatening to the environment, less disruptive of social fabric since it is associated with very limited displacement of communities, low investment per power plant and less sophisticated technology.

Table 4: Southern Africa hydropower potential

region	Installed capacity (MW)	On-going construction (MW)	Current generation (GWh)	Technicall feasible potential (GWh)	Installed/ potential (%)
Southern Africa	10 051	3 921	43 348	303 715	14.3
Africa	32853	13327	104602	1546314	6.8

Source: Hydropower News (2022): https://www.andritz.com/hydro-en/hydronews/hydropower-africa

Global small hydropower (SHP) report (UNIDO, 2019) shows that Africa has a total potential of 10 240 MW. Southern African countries have a total SHP potential of 2272.9MW (Table 6). Table 6 shows that total capacity development of SHP is 122.33 MW representing 5.4% of the sub-regional potential. Large potential is held by Mozambique with 1000 MW, Angola, 600 MW and South Africa, 247 MW. The three leading countries account for 77% of the total sub-regional total. Mauritius and Zimbabwe have developed substantial part of their potential; 98% in Mauritius and 89.4% in Zimbabwe. Mozambique, Namibia and even Botswana have developed less than 1% of their existing SHP potential (Table 5). In spite of the advantages of SHP, there are many barriers against their sustainable development in Southern Africa (UNIDO< 2019). For example, in Angola, sustainable development of SHP is prevented by limited long term financing models for private investors; limited access to appropriate technologies in mini, micro and pico hydropower categories and limited infrastructure for manufacturing, installation and operation of small hydropower plants while in South Africa the barriers are, complicated and lengthy processes of EIA process and obtaining licenses and permits, and problems associated with access to crossing private or state land. Community awareness and fear of possible negative impacts of developing the SHP are the barriers found in Malawi and Namibia. (UNIDO, 2019).

Table 5: SHP potential in Southern Africa

Country	Installed capacity (<10 MW)	SHP potential (<10 MW)	Proportion of potential developed
Angola	13.18	600	2.4
Botswana	0.0	1.0	0.0
Lesotho	3.8	38.2	9.9
Malawi	5.6	150.0	3.7
Mauritius	19.3	19.7	98
Mozambique	3.4	1000	0.34
Namibia	0.05	120.0	0.04
Sao Tome	2.7	63.8	4.2
South Africa	38	247.0	15.4
Swaziland	8.2	16.2	50.6
Zambia	12.9	120,0	10.8
Zimbabwe	15.2	17.0	89.4
Regional total	122.33	2272.9	5.4

Source: UNIDO (2019)

4.2.2.4: Geothermal:

Two Southern African countries have geothermal resources; Zambia and Malawi (Omenda (2020).these are Kapisya with more than 80 occurrences of hot springs and Kafue which lies at the intersection of the Zambezi mobile belt. Similarly, in Malawi, geothermal system is due to deep circulation along structures giving rise to medium to low temperature geothermal resources (Omenda, 2020).

3.3. Implications for energy development and delivery.

There is no doubt that the Southern African subregion is endowed with a large amount of energy resources. However, it is also a fact that energy access in the sub-region is also low.

Relating the resources to access to electricity by the people show a large disparity between energy resource endowment and access to energy. Records from Africa energy portal (2021) show that on the average, about 54% of the people in the region have access to electricity. The leading countries in electricity access are Mauritius (100%), South Africa (85%). Swaziland (77%) Sao Tome (72.2%) and Botswana, (70.1%). However, apart from South Africa, the other leading countries in electricity access are low population countries. The implication is that for most of the countries, a substantial part of the national population suffers energy deprivation; thus, raising concern about resource curse. That is, a situation where resource rich countries fail to derive the full benefits from their natural resources and where governments fail to respond to public welfare needs (Natural Resource Governance Initiative, 2015).

Increasing discovery of fossil fuels in the sub-region will provide opportunities for export and earning of foreign exchange and provide employment. In Sub-Saharan Africa, nearly 50% of export value is derived from fossil fuels (PwC, 2021).). In general, developing fossil fuels for energy undermines sustainability through high carbon emission. For example, PwC (2021) shows that South Africa is among the five leading carbon emission countries in Africa, the five countries contributing 67% of Africa's 1.6 million tonnes annual carbon emission. Dependence on fossil fuels could tempt countries to disregard the benefits of a more diversified energy generation and remain entrenched in fossil fuels (PwC, 2021). It is safe to say that such dependence could lead to fossil fuel traps. While shale gas discoveries will enhance energy access, its exploitation is faced with environmental concerns (Hamda and Singh, 2018). Conventional natural gas has some advantages as it is cleaner than the other types of fossil fuels (Gounari and Georgoa, 2014). Natural gas will be important for reducing the dependence on unclean cooking energy technologies by the people of Southern African countries. It will also boost the sub-regional energy trade through the development of regional gas pipelines. However, attention should be drawn to problems of gas for energy delivery. Gas requires expensive delivery systems (pipeline or liquified natural gas infrastructure) that are relatively expensive, inflexible; and expensive receiving terminals (Khatib, 2000). Aside from natural gas, the presence of uranium in six of the 12 countries offers opportunities for energy development and even for trade in energy resources. Nuclear energy is clean as it does not emit carbon dioxide and other greenhouse gasses; it has low operating cost and it has improved capacity factors as well as improved safety records (Rosen and Dicer, 2022), However, nuclear energy is associated with concerns for the disposal of radioactive waste, non-proliferation of nuclear material, sufficiency of reserves of uranium for present and future nuclear plants, the problem of mining and refining low grade uranium ore, and the cumbersome process and the long time required for licensing plants and obtaining all approvals and consents (Rosen and Dicer, 2022). The threat of non-renewability in fossil fuel is already rearing its ugly head in Angola. In 2017, Angola total oil reserves stood at 8389 billion barrels. This declined to 2516 billion barrels in 2021 (OPEC, 2022). In addition, only a few of the countries have fossil fuel resources. That, in itself, undermines energy security. Energy security is ' the continuous availability of energy in varied forms, in sufficient quantities, and at reasonable prices' (Khatib,) and often associated with 4 As; availability, affordability, accessibility and acceptability (Cherp and Jewell, 2014).

The even distribution of renewable energy resources put all the nations nn equal footing for the struggle for energy development and delivery. Every nation has one renewable energy resource or the other to claim. Renewable energy resources stand at the forefront of energy security. Renewable energy has the potential to curb the rising GHG emissions, create improved jobs and greater access to affordable electricity for Africa's population and help the African countries to fulfill their declared commitment to net-zero emissions (PwC, 2021). The renewable energy report (REN21, 2021) shows that 10 of the 12 countries have submitted Nationally Determined Contributions, which is the national policy tool for implementing the Paris Agreement, Developing renewable energy resources of the subregion is to shield the countries from global warming and climate change and prevent associated health problems associated with carbon emission; Ebola, Lassa fever, respiratory and cardiovascular disease (Gongsine, Jackson and Sambo, 2016) and to satisfy the fact that Africa remains the last global frontier for transformative clean energy investments (UN, 2020). Renewable energy will also help to achieve the necessary renewable energy mix. Most of the countries have an imbalanced energy mix presently. For example, in South Africa total primary energy supply, that is energy supply from indigenous production and imported sources less export is dominated by coal. In 2018, coal provided 65% of the primary energy supply. followed by crude oil with 18%, renewables with 11% and natural gas with 3% and nuclear with 2% (Department of Mineral Resources & Energy, 2021). In total, fossil fuels provide 86% of the energy supply, a clearly an imbalanced energy mix.

Conclusion

Energy resources offer many possibilities for economic development and in particular, for providing universal access to energy and power the economy. It is seen that the Southern African countries are energy resource rich countries. They have an advantage in coal and uranium energy resources. Although there is increasing hope for natural oil and gas discoveries, only few countries can be said to be fossil fuel powers. All the countries have the advantage of renewable resources. The subregion has high potential for wind and solar energy. All the renewable energy resources provide the possibilities for sustainable energy mix not only to achieve energy security for the countries but also to contribute to meeting the Paris Agreement of keeping the rise in global temperature below 1.5^0C below the pre-industrial level. The implications of the resources in the face of under-electrification of the subregion is that attention should be turned to sustainable utilisation of these resources in order to close the energy gap. The clean non-renewable resources of uranium and the natural gas should be mobilised to provide the broad base source of energy that can feed the national grid while the more widespread renewables should be mobilised to provide decentralised energy system that will adequately serve the people, institutions and businesses at the points of demand.

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