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Managing a transition to green energy sources: The perspectives of energy practitioners in the Southern African Development Community region.

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Abstract
The Southern African Development Community (SADC) region has low energy security, exacerbated by electricity power cuts and load-shedding in almost all its member states. Green energy has the potential to contribute to the shortfall in the supply of energy required on the grid network during daily (morning and evening) and seasonal (winter) peak periods. The Statistica 12 program was used to analyse and compare responses between identified groups in the SADC region's Energy sector. Multivariate analysis of variance and analysis of variance were used to examine associations between variables within the identified categories of respondents, and conclusions were made about six hypotheses. The categories of respondents sampled included: people associated with fossil fuel and renewable energy; people with experience of 1-6 years and more than 6 years; researchers and industry practitioners; practitioners based in South Africa and in other SADC countries; and a category based on practitioners' positions (junior managers, middle managers, and senior managers) in their respective organisations.
The study found that energy practitioners generally support a transition to green energy sources and there is consensus that the uptake of green energy will be slow initially, driven by low costs of fossil-based sources, but the uptake will eventually grow exponentially to a point of driving industries in future. The study recommends that SADC countries prioritise mapping of green energy resources to facilitate the selection of suitable green energy options in order to meet local energy needs and environmental protection. Research and development of suitable green energy storage technologies to overcome intermittency of some green energy sources must be expedited in the region.

Keywords: green energy, energy security, greenhouse gases, energy storage, peaking power, environmental pollution

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1. Energy poverty and low-carbon energy solutions

Green energy obtained through the use of low-carbon energy solutions is acknowledged as a solution to energy poverty and climate change around the world (UNEP, 2011). The transformative potential of green energy on socio-economic development and mitigation of environmental pollution could change the well-being and quality of life for citizens of the Southern African Development Community (SADC). Nezhad (2009) identified the driving forces that will shape the future of global energy as economic growth rate, growth rate of energy consumption, investment requirements, demographic changes, carbon dioxide emissions, technology development and innovation, global energy intensity, oil prices, and development of alternative energy sources.

1.1 Greenhouse gases and climate change

The World Energy Council (2012) projected that, by 2035, approximately 60% of electricity will be generated from fossil-fuel sources, with 40% coming from carbon-free sources, and that fossil fuel will continue to play a dominant role for the following two to three decades. Africa possesses immense energy potential in the form of renewable energy sources, even though its energy consumption in general is low and electricity consumption is only approximately 8% of the global total (Sanoh et al., 2014). Sub-Saharan Africa (SSA) is the only region in the world where the number of people living without electricity is increasing, as rapid population growth is outpacing the many positive efforts to provide access (IEA, 2014).

A number of studies have been conducted to project different scenarios that will result from global warming. Marchal et al. (2011) listed some of the regional impacts forecast by the Inter-Governmental Panel on Climate Change to affect Africa by 2020. It is projected that between 75 million and 250 million people will be exposed to increased water stress, yields from rain-fed agriculture could be reduced by up to 50% in some regions by 2020, and agricultural production, including access to food, may be severely compromised. The release of both black carbon particles and other forms of air pollution, e.g., sulphur and nitrogen oxides, photochemical smog precursors and heavy metals, will also have a detrimental effect on public health (United Nations Environment Programme (UNEP), 2011). There is, generally, consensus that global warming is an inevitable result of anthropogenic emission of greenhouse gases that remain in the atmosphere like a blanket, preventing the reflection of heat back into outer space (Arent et al., 2011). Consequently, the average earth temperature has increased by 0.7 °C since the pre-industrialisation period and this rise has resulted in climate change that has caused devastation to ecosystems and sustainable social and economic development in many parts of the world, especially in developing countries (Arent et al., 2011; Lau et al., 2012). Greening the Energy sector can contribute substantially to addressing global warming challenges and energy poverty.

1.2 Historical green energy initiatives

Recognising the imperatives of access to green energy is not a new concept in Africa. In 1981, Africa hosted the first international conference on new and renewable sources of energy in Nairobi. The conference acknowledged the realities facing Africa in terms of access to modern energy and the unprecedented, high prices of petroleum energy (Kammen & Kirubi, 2008). Africa, like other world regions, embraced the strong optimism and vision for making a transition to renewable energy sources. Although important initiatives have since been taken, notably in biomass and solar energy, the promise of renewable energy in Africa remains largely unmet (Kammen & Kirubi, 2008).

Current energy-generation assets are ageing, which leads to decreasing efficiency, increasing maintenance cost, and unexpected outages. The frequent power outages have resulted in the increasing use of emergency power, using liquid fuels, which are expensive (KPMG, 2014). The recent approval by ministers of SADC for the establishment of the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) as a subsidiary organisation is a positive development. Its main objective is stated as being 'to contribute towards increased access to modern energy services and improved energy security across the SADC region by promoting market-based uptake of renewable energy and energy efficient technologies and energy services' (SACREEE, 2013).

2. The theoretical rationale of the study

The theoretical rationale of this study, shown in Figure 1, is premised on an increased demand for energy as a result of population growth leading to a need to meet energy requirements through the increased use of green energy as opposed to fossil-fuel sources. The rationale postulates that increasing access to energy services through green energy will lead to widespread access to modern energy services and an improved quality of life, as opposed to the use of fossil fuels resulting in environmental catastrophes in the long term.

3. The research problem statement and the objective of the study

The continued extensive use of fossil fuels is not addressing energy poverty in Africa and it is likely to lead to environmental damage. Wustenhagen and Menichetti (2012) argued that greenhouse gases

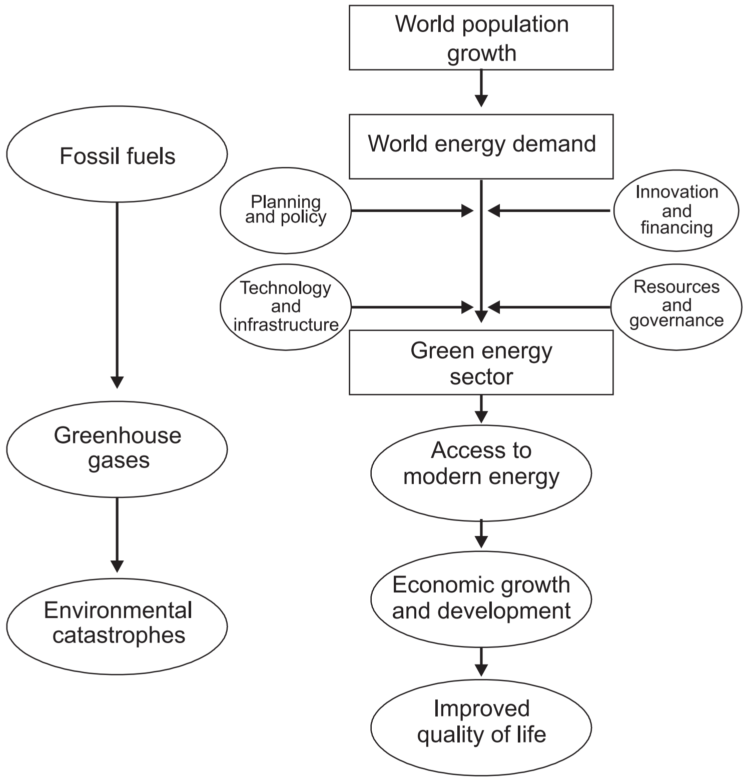

Figure 1: The theoretical rationale of the study.

that result in global warming have the potential to cause extensive devastation in the form of environmental catastrophes in the future if action is not taken to reduce them. Against this background, the research problem is that the continued dependence on fossil fuel energy sources will not address energy poverty in the SADC region; on the contrary, it will have an adverse impact on human health and also increase environmental pollution. This study aims to establish whether there are significant differences of views amongst energy practitioners with regard to a transition to green energy in the SADC region.

4. Green energy battery storage

The need for access to green energy is most evident in rural areas. Energy generated by renewable sources for remote rural areas has many advantages over conventional supplies, but a negative aspect of green energy sources is that some are intermittent. This problem can be addressed by investing in battery storage (Ma et al., 2015). To regularise an intermittent renewable energy output, Ma et al. (2015) advocated for the adoption of an appropriate energy storage component as the solution, with high specific power and high specific energy over periods of minutes or hours. Solomon et al. (2014) argued that the existing grid in developing countries is not yet configured to accommodate very large, variable, renewable energy systems, and that bulk distribution will most likely require the ability to enhance the use of energy from the variable technologies. Cho and Kleit (2015) observed that battery storage technologies have developed to the point that some are mature enough to serve as a generation resource. For example, a photovoltaic (PV) battery energy storage system can potentially solve this problem by storing electrical energy when demand is low and supply stored energy when the demand is high. Energy storage system (ESS) and hybrid energy storage system (HESS) are some of the available options available for use with PV (Cho & Kleit, 2015).

5. Increasing capacity for energy generation in the SADC region

Power shortages have affected most countries in varying degrees. According to the Development Bank of South Africa (DBSA) (2014), the main reasons for the diminishing generation capacity in the SADC region are:

- an increase in electricity demand; unexpected high industrial growth;
- economic expansion;
- high growth in population;
- uneconomic tariffs that do not support the capital and operational cost for investment in power generation; and
- lack of capital injection into new generation projects by both the public and private sectors.

Earth offers many options to exploit sources of green energy, including wind (offshore and onshore), marine (wave, ocean thermal energy conversion, tidal), biomass (biogas, dung, ethanol, gasifiers, crop residue and fuel wood), hydro (pump-dam storage, run-of-river, pump storage),

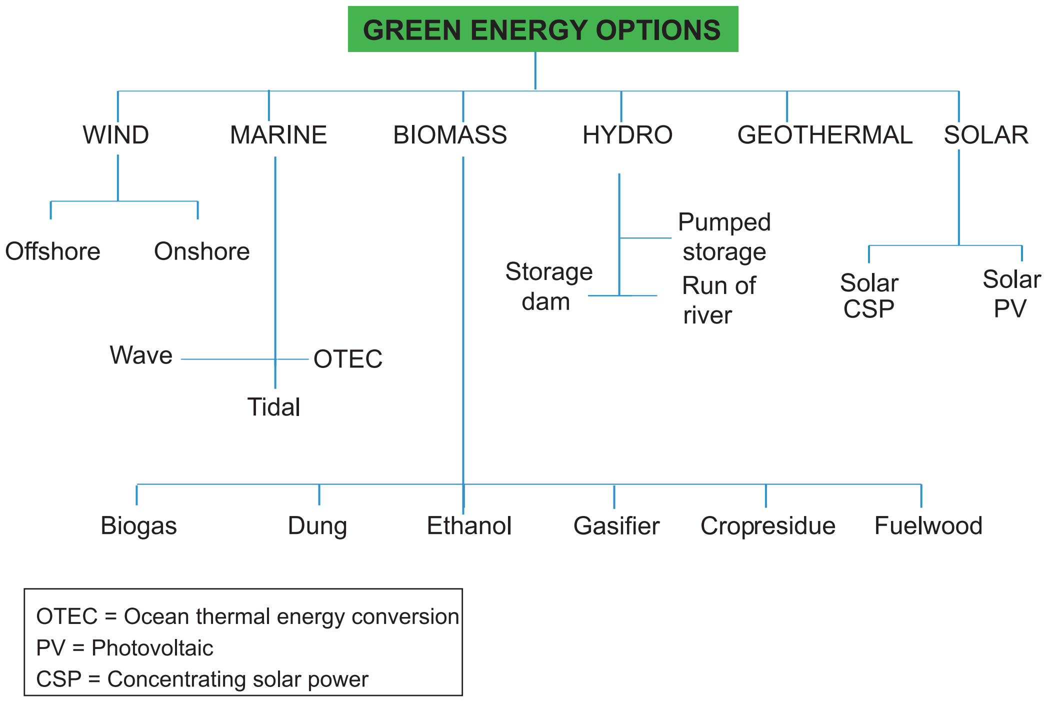

Figure 2: Global green energy options (adapted from Kathirvel and Porkumaran, 2011).

geothermal and solar (PV and concentrating solar power) as shown in Figure 2. Insufficient mapping of renewable energy resources is, however, another challenge that must be addressed urgently. There is still a need for regional resource maps that could be useful in assessing potential for regional projects (SACREEE, 2013).

Barry et al. (2011) observed that the selection of low-carbon energy technology must be based on research in order to achieve the priorities of the local population, as well as governmental social and environmental targets, thereby sustaining the sector. As part of the short-term measures, a number of rehabilitation and generation projects are being undertaken to address the generation supply gap, whereby up to 17000 MW was planned between 2013 and 2016 (Southern African Power Pool (SAPP), 2013). The SAPP (2014) revealed that the region will have sufficient generation capacity after 2017 if all the planned projects were commissioned and energy adequacy achieved in 2018. The generation reserve margin will reach 12.6% in 2016, 17.2% in 2017, and 23.8% in 2018 (SAPP, 2014).

5.1 Biomass energy potential

Biomass is and will remain SSA's dominant source of energy for a foreseeable future. Owen et al. (2013) argued that, in order to realise the full potential of biomass energy for poverty alleviation and the creation of employment and business opportunities, prevailing informal production and distribution of solid biomass must be replaced with economically viable and socially equitable arrangements in a more modern and organised fashion.

5.2 Hydro-electrical power potential

Large-scale hydro is the most inexpensive, efficient and affordable form of renewable energy with vast potential still to be developed in Africa, where there is only 7% development and which is the lowest rate of the world's regions (WEC, 2013b). Africa has a considerable natural advantage in hydro power because of extensive, high-altitude areas on which the water vapour gathered over the Atlantic precipitates. The run-off from this rainfall into the Congo, Niger and Zambezi rivers could support several mega-dams, significant projects on the upper Nile in Ethiopia and Uganda; and numerous smaller schemes (Collier and Venables, 2012). Political obstacles hinder the development of hydro electrical energy in the central parts of Africa. The most notable examples of political obstacles are tribal conflicts and rebellions from political formations in the Democratic Republic of the Congo (DRC), which resulted in weak investments for decades in the Grand Inga hydro-electric project on the Congo River (Sebitosi and Okou, 2010; Collier and Venables, 2012).

5.2.1. The Grand Inga project

Kammen and Kirubi (2008) argued that the DRC can potentially be a huge exporter of electricity. It could be a net exporter almost four times larger than its domestic consumption and continue to supply hydro power through Namibia, Botswana, Zimbabwe, Mozambique, and Lesotho. The Congo River is currently the world's second largest in terms of its flow (Odhiambo, 2010; WEC, 2013a). The first site development studies done in the 1960s recommended a construction of four hydro-electric power stations in two phases (International Development, 2008). Only a fraction of the potential hydro-electric power was, however, developed in the DRC largely because of the political uncertainties that have ravaged the country and scared potential investors over the years. Odhiambo (2010) observed that, in 2003, the DRC had a total generating capacity of about 2568 MW, but only produced 600-700 MW because two-thirds of the turbines were dysfunctional.

5.3. Solar energy potential

One of the most promising green energy technologies for Africa is solar power. It suits Africa's natural endowment of strong sunlight distributed evenly throughout the year. Solar energy sources have the potential to improve access to modern energy through PV and CSP because PV technology is ideal for decentralisation and dispersion to rural households of developing countries and, in the long term, a cheaper option than conventional, grid-based electricity (Collier and Venables, 2012; Shukla et al., 2010; Otiti and Soboyebo, 2006). Many national, renewable and rural energy strategies must, consequently, give priority to the dissemination of PV.

5.4 Wind energy potential

Wind energy is an attractive option for countries with an abundance of wind, particularly the coastal areas in the SADC region, as it can be installed quickly in areas where electricity is needed urgently, in many instances, it can be a cost-effective solution if fossil fuel sources were expensive or not readily available (Milborrow, 2011; Sartipipour, 2011). In addition, there are many applications for wind energy in remote regions. It can transform access to energy to supply farms, homes, and other installations on an individual basis (Milborrow, 2011). Wind generation of electricity is, however, hindered by a lack of manufacturing industries in developing countries, skills and spare parts, which should be addressed urgently (IEA, 2012).

5.5 Non-green energy (nuclear energy) potential

The regional infrastructure development Master Plan (2012) concluded that nuclear power is considered to be an important source in the mix of global electricity generation. It is viewed as a solution to climate change, but recent disasters and the constant fear of managing nuclear waste prevents it from being a popular solution. In the SADC region, the share of nuclear power is 1.6% and is only found in South Africa, the country was reluctant to implement further nuclear power stations using its pebble bed technology (RIDMP, 2012). There is strong opposition from the community of non-governmental organisations. The country, however, plans to add nuclear capacity in 2023, perhaps hoping that the option will be more acceptable then.

6. Research methodology

A survey questionnaire with 72 questions linked to a 7-point Likert scale of responses was sent to respondents to test their support for green energy sources and to determine if there were significant differences in support for alternative sources of green energy identified in the questionnaire, amongst energy practitioners in the SADC region. A total of 301 responses were received. The composition of the sample population for the study included energy practitioners from both fossil-fuel and renewable Energy sectors and comprised respondents from energy ministries in the SADC region, non-governmental institutions, private companies; energy researchers; academics; and energy specialists. Respondents were categorised as follows:

- those associated with fossil-fuel and renewable energy;
- those with experience of 1-6 years and more than 6 years;
- researchers and industry practitioners;
- practitioners based in South Africa and other SADC countries; and
- junior, middle, and senior managers.

Different research designs fall into two categories that might be more or less appropriate in different situations, being probability sampling and non-probability sampling (Leedy and Ormrod, 2005). Quota sampling, which is a non-probability sampling technique, was employed for this study. This method of sampling selects respondents randomly in the same proportion that they are found in the general population (Leedy and Ormrod, 2005). The largest quota of respondents was obtained from South Africa. In Africa, the largest percentage of electricity generated from fossil fuel is generated in South Africa. The country has the most advanced power market in Africa and is sometimes referred to as 'the powerhouse of Africa' (KPMG, 2014). Eskom, a parastatal responsible for the supply of electricity in South Africa, is estimated to generate about two-thirds of the total output of electricity for SSA and 80% of the total southern African output (KPMG, 2014).

7. Interpretation of results and discussion

Leedy and Ormrod (2005) observed that, in the analysis of quantitative research, data characteristics are reduced to variables analysed with multivariate and univariate statistical data analysis techniques. Multivariate Anova (MANOVA) and Univariate (ANOVA) statistics were employed to determine whether sufficient evidence existed to make conclusions about the six hypotheses of the study. These hypotheses related to the differences in opinions between categories of respondents. A series of MANOVA analyses were conducted to test for differences between all identified factors, and ANOVAs were conducted on factors individually.

7.1 Multivariate ANOVA statistics (MANOVA)

The MANOVA statistics analysis revealed that there were significant differences in the responses from respondents based on the region in which the respondents are based, being South Africa/other SADC countries (p = 0.001). There were also significant differences in the responses from respondents based on their position, being Junior management/Middle management/Senior management (p = 0.001). There were no significant differences in the responses based on years of experience in the Energy sector (1-6 years and >6 years), Energy sector (fossil fuel/renewable energy) and the role of the energy practitioner (researchers/industry). MANOVA analysis results indicating significant differences of the results are highlighted in bold font. Table 1 shows the MANOVA statistics for variables A to L.

7.2 The ANOVA results of variable A – L

Tables with ANOVA analysis results indicating significant differences of the results are highlighted in bold font. The ANOVA results A and post-hoc results A are shown in Table 2.

The ANOVAs that were conducted on factors individually revealed that there was a significant difference in responses to the independent variable A (strategic planning for green energy) based on the region in which the respondents were based (South Africa and other SADC countries). Univariate ANOVA results B and post-hoc results B are shown in Table 3.

Post-hoc results show that p = 0.002. ANOVA analysis for the independent variable B (economic augmentation from green energy) indicates that there was a significant difference between responses in terms of the region and positions of respondents (Senior management/Middle management/Junior management). The post-hoc results of Middle management/Junior management give p = 0.004. Univariate ANOVA results C and post-hoc results C are shown in Table 4.

The ANOVA results represent a significant difference in responses to the independent variable C (mitigation of environmental pollution) in terms of position and region. Post-hoc results yield p = 0.036 for the differences based on the region; p = 0.001 for Senior management/Junior management

Table 1: Multivariate ANOVA statistics - variables A to L.

Effect	F	D.F.	p
Intercept	802.93	12; 232	<0.0005
Years. Cat	0.39	12; 232	0.968
Energy sector	1.23	12; 232	0.265
Researcher. Industry	1.47	12; 232	0.136
Region	2.96	12; 232	0.001
Position	2.14	24; 464	0.001

Table 2: Univariate ANOVA results A and post-hoc results A.

Univariate ANOVA results – A

Effect	*F-value*	*D.F.*	*p*
Intercept	1380.534	1; 249	<0.0005
Years. Cat	0.009	1; 249	0.926
Energy sector	0.15	1; 249	0.699
Researcher. Industry	3.904	1; 249	0.049
Region	9.636	1; 249	0.002
Position	2.416	2; 249	0.091

Post-hoc results – A

Effect	*Level 1*	*Level 2*	*M_1*	*M_2*	*p**	*Cohen's d*
Intercept	-	-	4.51	-	<0.0005	4.03
Years. Cat	<= Median 6	> Median 6	4.52	4.49	0.926	0.02
Energy sector	Fossil Fuel	Renewables	4.50	4.51	0.699	0.01
Researcher. Industry	Researchers	Industry	4.34	4.54	0.049	0.17
Region	South Africa	Other SADC	4.42	4.85	0.002	0.39
Position	Junior management	Middle management	4.82	4.37	0.176	0.47
	Junior management	Senior management	4.82	4.55	0.521	0.22
	Middle management	Senior management	4.37	4.55	0.466	0.16

** Scheffé Test if 3+ Levels, else t-Test*

Table 3: Univariate ANOVA results B and post-hoc results B.

Univariate ANOVA results – B			
Effect	***F-value***	***D.F.***	***p***
Intercept	2371.092	1; 249	<0.0005
Years. Cat	0.674	1; 249	0.413
Energy sector	1.905	1; 249	0.169
Researcher. Industry	0.411	1; 249	0.522
Region	12.856	1; 249	<0.0005
Position	3.142	2; 249	0.045

Post-hoc results • B						
Effect	***Level 1***	***Level 2***	M_1	M_2	***p****	***Cohen's d***
Intercept	-	-	5.00	-	<0.0005	5.08
Years. Cat	<= Median 6	> Median 6	5.01	4.99	0.413	0.02
Energy sector	Fossil Fuel	Renewables	4.80	5.21	0.169	0.36
Researcher. Industry	Researchers	Industry	5.23	4.96	0.522	0.24
Region	South Africa	Other SADC	4.87	5.54	<0.0005	0.61
Position	Junior management	Middle management	5.03	4.76	0.423	0.28
	Junior management	Senior management	5.03	5.18	0.758	0.12
	Middle management	Senior management	4.76	5.18	0.004	0.38

** Scheffé Test if 3+ Levels, else t-Test*

Table 4: Univariate ANOVA results C and post-hoc results C.

Univariate ANOVA results – C			
Effect	***F-value***	***D.F.***	***p***
Intercept	1392.323	1; 249	<0.0005
Years. Cat	0.114	1; 249	0.736
Energy sector	0.172	1; 249	0.679
Researcher. Industry	1.191	1; 249	0.276
Region	4.425	1; 249	0.036
Position	5.013	2; 249	0.007

Post-hoc results • C						
Effect	***Level 1***	***Level 2***	M_1	M_2	***p****	***Cohen's d***
Intercept	-	-	5.68	-	<0.0005	4.18
Years. Cat	<= Median 6	> Median 6	5.56	5.80	0.736	0.22
Energy sector	Fossil Fuel	Renewables	5.48	5.89	0.679	0.37
Researcher. Industry	Researchers	Industry	5.84	5.66	0.276	0.17
Region	South Africa	Other SADC	5.57	6.16	0.036	0.54
Position	Junior management	Middle management	4.96	5.47	0.218	0.52
	Junior management	Senior management	4.96	6.00	0.001	0.85
	Middle management	Senior management	5.47	6.00	0.012	0.48

** Scheffé Test if 3+ Levels, else t-Test*

and p = 0.012 for Middle management/Senior management. Univariate ANOVA results D and post-hoc results D are shown in Table 5.

The ANOVA results present a significant difference in responses to the independent variable D (governance of green energy). There was a difference in terms of the Energy sector with which the respondents were associated (fossil-fuel/renewable energy) and their position. Post-hoc results indicate that: in terms of the Energy sector, p = 0.043; in terms of position, Junior management/Middle management, p = 0.001; and Junior management/ Senior management, p = 0.001. Univariate ANOVA results E and post-hoc results E are shown in Table 6.

The ANOVA results show that there was a significant difference in responses to the independent variable E (innovation in green energy technology)

Table 5: Univariate ANOVA result D and post-hoc results D.

Univariate ANOVA results – D

Effect	F-value	D.F.	p
Intercept	1637.435	1; 249	<0.0005
Years. Cat	0.027	1; 249	0.869
Energy sector	4.125	1; 249	0.043
Researcher. Industry	0.467	1; 249	0.495
Region	1.621	1; 249	0.204
Position	4.664	2; 249	0.010

Post-hoc results - D

Effect	Level 1	Level 2	M_1	M_2	p*	Cohen's d
Intercept	-	-	3.50	-	<0.0005	4.28
Years. Cat	<= Median 6	> Median 6	3.54	3.46	0.869	0.07
Energy sector	Fossil Fuel	Renewables	3.65	3.35	0.043	0.27
Researcher. Industry	Researchers	Industry	3.32	3.53	0.495	0.20
Region	South Africa	Other SADC	3.51	3.48	0.204	0.02
Position	Junior management	Middle management	4.04	3.51	0.011	0.55
	Junior management	Senior management	4.04	3.39	0.001	0.54
	Middle management	Senior management	3.51	3.39	0.520	0.11

** Scheffé Test if 3+ Levels, else t-Test*

Table 6: Univariate ANOVA results E and post-hoc results E.

Univariate ANOVA results – E

Effect	F-value	D.F.	p
Intercept	286.765	1; 249	<0.0005
Years. Cat	0.2289	1; 249	0.633
Energy sector	2.3537	1; 249	0.126
Researcher. Industry	0.3992	1; 249	0.528
Region	1.8456	1; 249	0.176
Position	4.4982	2; 249	0.012

Post-hoc results - E

Effect	Level 1	Level 2	M_1	M_2	p*	Cohen's d
Intercept	-	-	2.92	-	<0.0005	1.77
Years. Cat	<= Median 6	> Median 6	3.06	2.78	0.633	0.25
Energy sector	Fossil Fuel	Renewables	2.91	2.93	0.126	0.02
Researcher. Industry	Researchers	Industry	2.89	2.92	0.528	0.02
Region	South Africa	Other SADC	2.99	2.64	0.176	0.31
Position	Junior management	Middle management	3.69	3.02	0.174	0.69
	Junior management	Senior management	3.69	2.67	0.016	0.84
	Middle management	*Senior management*	*3.02*	*2.67*	*0.288*	*0.31*

** Scheffé Test if 3+ Levels, else t-Test*

in terms of position and region. Post-hoc results shown that: in terms of position, Junior management/Senior management, p = 0.016. Univariate ANOVA results F and post-hoc results post-hoc results F are shown in Table 7.

There was no significant difference in terms of independent variable F (alignment of green energy policy). Univariate ANOVA results G and post-hoc results G are shown in Table 8.

The ANOVA results revealed that there was a significant difference in responses to the independent variable G (financing of green energy projects) in terms of region. Post-hoc results indicated that: in terms of the region, p = 0.001. Univariate ANOVA results H and post-hoc results H are shown in Table 9.

There were also significant differences in terms of the region for independent variable H (develop-

Table 7: Univariate ANOVA results F and post-hoc results F.

Univariate ANOVA results – F

Effect	*F-value*	*D.F.*	*p*
Intercept	1391.993	1; 249	<0.0005
Years. Cat	0.002	1; 249	0.965
Energy sector	0.090	1; 249	0.764
Researcher. Industry	1.050	1; 249	0.307
Region	0.164	1; 249	0.686
Position	1.093	2; 249	0.337

Post-hoc results – F

Effect	*Level 1*	*Level 2*	M_1	M_2	*p**	*Cohen's d*
Intercept	–	–	3.75	–	<0.00055	4.23
Years. Cat	<= Median 6	> Median 6	3.77	3.74	0.965	0.02
Energy sector	Fossil Fuel	Renewables	3.79	3.72	0.764	0.06
Researcher. Industry	Researchers	Industry	3.61	3.78	0.307	0.15
Region	South Africa	Other SADC	3.76	3.74	0.686	0.02
Position	Junior management	Middle management	3.99	3.70	0.343	0.30
	Junior management	Senior management	3.99	3.74	0.451	0.20
	Middle management	Senior management	3.70	3.74	0.930	0.04

** Scheffé Test if 3+ Levels, else t-Test*

Table 8: Univariate ANOVA results G and post-hoc results G.

Univariate ANOVA results – G

Effect	*F-value*	*D.F.*	*p*
Intercept	458.1015	1; 249	<0.0005
Years. Cat	0.8622	1; 249	0.354
Energy sector	0.2473	1; 249	0.619
Researcher. Industry	2.8295	1; 249	0.094
Region	10.3606	1; 249	0.001
Position	0.5229	2; 249	0.593

Post-hoc results – G

Effect	*Level 1*	*Level 2*	M_1	M_2	*p**	*Cohen's d*
Intercept	–	–	2.47	–	<0.0005	2.41
Years. Cat	<= Median 6	> Median 6	2.54	2.39	0.354	0.13
Energy sector	Fossil Fuel	Renewables	2.57	2.36	0.619	0.19
Researcher. Industry	Researchers	Industry	2.46	2.47	0.094	0.01
Region	South Africa	Other SADC	2.57	2.04	0.001	0.48
Position	Junior management	Middle management	2.62	2.58	0.986	0.04
	Junior management	Senior management	2.62	2.35	0.463	0.22
	Middle management	Senior management	2.58	2.35	0.232	0.21

** Scheffé Test if 3+ Levels, else t-Test*

ment of human capacity in green energy). Post-hoc results shown that: in terms of the region, p = 0.017. Univariate ANOVA results I and post-hoc results I are shown in Table 10.

The ANOVA results demonstrated that there was a significant difference in post-hoc results for the independent variable I (development of green energy infrastructure) in terms of position. Junior management/Senior management = 0.029. Middle management/Senior management, p= 0.010. Univariate ANOVA results J and post-hoc results J are shown in Table 11.

There was no significant difference in terms of dependent variable J (development of local market

Table 9: Univariate ANOVA results H and post-hoc results H.

	Univariate ANOVA results – H			
	Effect	***F-value***	***D.F.***	***p***
	Intercept	373.3094	1; 249	<0.0005
	Years. Cat	0.8281	1; 249	0.364
	Energy sector	0.6055	1; 249	0.437
	Researcher. Industry	0.092	1; 249	0.762
	Region	5.8141	1; 249	0.017
	Position	1.2528	2; 249	0.288

Post-hoc results – H

Effect	***Level 1***	***Level 2***	M_1	M_2	***p****	***Cohen's d***
Intercept	–	–	2.81	–	<0.0005	2.40
Years. Cat	<= Median 6	> Median 6	2.86	2.76	0.364	0.08
Energy sector	Fossil Fuel	Renewables	2.79	2.83	0.437	0.04
Researcher. Industry	Researchers	Industry	2.66	2.83	0.762	0.15
Region	South Africa	Other SADC	2.89	2.49	0.017	0.37
Position	Junior management	Middle management	2.53	2.84	0.471	0.33
	Junior management	Senior management	2.53	2.84	0.466	0.25
	Middle management	Senior management	2.84	2.84	0.999	0.00

** Scheffé Test if 3+ Levels, else t-Test*

Table 10: Univariate ANOVA results I and post-hoc results I.

	Univariate ANOVA results – I			
	Effect	***F-value***	***D.F.***	***p***
	Intercept	635.5565	1; 249	<0.0005
	Years. Cat	0.3417	1; 249	0.559
	Energy sector	0.7439	1; 249	0.389
	Researcher. Industry	0.7768	1; 249	0.379
	Region	0.8079	1; 249	0.370
Position	2.155	2; 249	0.118	

Post-hoc results – I

Effect	***Level 1***	***Level 2***	M_1	M_2	***p****	***Cohen's d***
Intercept	–	–	2.63	–	<0.0005	2.82
Years. Cat	<= Median 6	> Median 6	2.73	2.53	0.559	0.18
Energy sector	Fossil Fuel	Renewables	2.79	2.46	0.389	0.30
Researcher. Industry	Researchers	Industry	2.28	2.69	0.379	0.36
Region	South Africa	Other SADC	2.69	2.37	0.370	0.29
Position	Junior management	Middle management	2.95	2.80	0.752	0.16
	Junior management	Senior management	2.95	2.43	0.029	0.43
	Middle management	Senior management	2.80	2.43	0.010	0.34

** Scheffé Test if 3+ Levels, else t-Test*

for green energy). Univariate ANOVA results K and post-hoc results K are shown in Table 12.

The ANOVA results revealed that there was a significant difference in responses to the dependent variable K (perceived success in widespread access to green energy) in terms of region and position. Post-hoc results indicated that: in terms of the region, $p < 0.0005$; and in terms of position (Junior management/Senior management), $p = 0.042$. Univariate ANOVA results L and post-hoc results L are shown in Table 13.

The post-hoc results for the independent variable L (viability of various sources of green energy) shown that: in terms of position (Junior manage-

Table 11: Univariate ANOVA results J and post-hoc results J.

Univariate ANOVA Results – J			
Effect	***F-value***	***D.F.***	***p***
Intercept	1432.773	1; 249	<0.0005
Years. Cat	0.153	1; 249	0.696
Energy sector	0.499	1; 249	0.481
Researcher. Industry	0.257	1; 249	0.613
Region	0.526	1; 249	0.469
Position	1.100	2; 249	0.334

Post-hoc results – J

Effect	***Level 1***	***Level 2***	***M_1***	***M_2***	***p****	***Cohen's d***
Intercept	–	–	3.40	-	<0.0005	4.20
Years. Cat	<= Median 6	> Median 6	3.36	3.43	0.696	0.07
Energy sector	Fossil Fuel	Renewables	3.39	3.40	0.481	0.00
Researcher. Industry	Researchers	Industry	3.51	3.38	0.613	0.12
Region	South Africa	Other SADC	3.38	3.48	0.469	0.10
Position	Junior management	Middle management	3.49	3.30	0.542	0.20
	Junior management	Senior management	3.49	3.45	0.974	0.03
	Middle management	Senior management	3.30	3.45	0.350	0.14

** Scheffé Test if 3+ Levels, else t-Test*

Table 12: Univariate ANOVA results K and post-hoc results K.

Univariate ANOVA results – K			
Effect	***F-value***	***D.F.***	***p***
Intercept	1345.239	1; 249	<0.0005
Years. Cat	0.019	1; 249	0.889
Energy sector	0.169	1; 249	0.681
Researcher. Industry	0.140	1; 249	0.709
Region	12.511	1; 249	<0.0005
Position	1.593	2; 249	0.205

Post-hoc results – K

Effect	***Level 1***	***Level 2***	***M_1***	***M_2***	***p****	***Cohen's d***
Intercept	–	–	5.11	–	<0.0005	3.92
Years. Cat	<= Median 6	> Median 6	5.04	5.19	0.889	0.13
Energy sector	Fossil Fuel	Renewables	4.91	5.33	0.681	0.37
Researcher. Industry	Researchers	Industry	5.43	5.05	0.709	0.34
Region	South Africa	Other SADC	4.94	5.81	<0.0005	0.79
Position	Junior management	Middle management	4.65	4.94	0.591	0.29
	Junior management	Senior management	4.65	5.34	0.042	0.56
	Middle management	Senior management	4.94	5.34	0.062	0.36

** Scheffé Test if 3+ Levels, else t-Test*

ment/Senior management), p = 0.012. Table 14 shows tested hypotheses 1-6, where H represents hypothesis.

8. Conclusions

The different categories of respondents (1-6 years and >6 years)' (fossil fuel and renewable energy), (researchers and industry practitioners) shared the same views about the prospects of a successful transition to green energy sources. Divergent views were noted from practitioners based in South Africa and practitioners in the rest of the SADC countries. Different views were also recorded from practitioners in support for green energy based on the position held (senior managers; middle managers and senior managers).

Table 13: Univariate ANOVA results L and post-hoc results L.

Univariate ANOVA results – L

Effect	*F-value*	*D.F.*	*p*
Intercept	1448.886	1; 249	<0.0005
Years. Cat	0.803	1; 249	0.371
Energy sector	0.486	1; 249	0.486
Researcher. Industry	0.822	1; 249	0.365
Region	0.214	1; 249	0.644
Position	2.500	2; 249	0.084

Post-hoc results – L

Effect	*Level 1*	*Level 2*	M_1	M_2	*p**	*Cohen's d*
Intercept	–	–	3.91	-	<0.0005	4.23
Years. Cat	<= Median 6	> Median 6	4.01	3.82	0.371	0.17
Energy sector	Fossil Fuel	Renewables	4.02	3.80	0.486	0.20
Researcher. Industry	Researchers	Industry	3.65	3.96	0.365	0.28
Region	South Africa	Other SADC	3.96	3.74	0.644	0.19
Position	Junior management	Middle management	4.40	3.91	0.056	0.50
	Junior management	Senior management	4.40	3.81	0.012	0.48
	Middle management	Senior management	3.91	3.81	0.703	0.09

** Scheffé Test if 3+ Levels, else t-Test*

Table 14: Tested hypotheses 1-6.

Hypotheses	*Hypothesis accepted or rejcted*
H1. There is a significant difference in support for green energy based on years of experience (1- 6 years and >6 years).	Rejected
H2. There is a significant difference in support for green energy based on the energy sector base (fossil-fuel and renewable energy).	Rejected
H3. There is a significant difference in support for green energy based on the role in the sector (researchers and industry practitioners).	Rejected
H4. There is a significant difference in support for green energy based on a location that serves as a base country (South Africa and other SADC countries).	Accepted
H5. There is a significant difference in support for green energy based on the position held (senior managers; middle managers and senior manager).	Accepted
H6. There is a significant difference in support for viability of various sources of green energy amongst different groups in the SADC region: (1-6 years and > 6 years); (fossil fuel and renewable energy); (researchers and industry practitioners); (South Africa and other SADC countries) and (senior manager, middle manager and junior manager).	Rejected

The significant positive support of South Africans for green energy as shown by the results can be explained by evidence that indicate the country's current upsurge in investment into green energy. Senior managers in the whole region are also more optimistic about the transition compared to respondents in the middle and junior positions. The study found that energy practitioners in SADC region generally support a transition to green energy sources and there is consensus that the uptake of green energy will be slow initially, driven by low costs of fossil-based sources, but the uptake will eventually grow and contribute to the mitigation of greenhouse gases and global warming challenges.

Access to modern energy for rural communities could be a catalyst for economic development to dismantle the frontier of poverty that confronts both urban and rural citizens in the SADC region. In order to enhance the energy situation adequately in the SADC region, energy demand and supply constraints must be identified with specific programmes that are oriented towards rural and urban communities separately. At a national level, clear targets must be defined for green energy penetration into the energy market. Interaction between public and private sector is imperative in order to identify viable sources of green energy that must be prioritised in a specific locality in the SADC region.

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