

South Africa's performance on renewable energy and its relative position against the OECD countries and the rest of Africa

Amandine Nakumuryango and Roula Inglesi-Lotz¹

Department of Economics, University of Pretoria

Pretoria, South Africa

Abstract

Renewable energy has been a "hot topic" since the increased awareness of the consequences of climate change. Africa is vulnerable to such climate changes and, hence, should be more aware of the impact of fossil fuel generation on the environment although it has coal in abundance. South Africa is among the countries who negatively contributed to the pollution of the environment in recent years especially as nearly 90% of its energy is produced from coal. We position South Africa with regards to renewable energy supply, usage and intensity both among other African countries and among more developed countries, such as the OECD group. The findings show that South Africa is not the best performer regarding renewable energy among African countries, despite its main economic position in the continent. Furthermore, the comparison of South Africa to OECD countries shows that South Africa has a long way to go to achieve a sustainable environment.

Keywords: Renewable energy; renewable energy intensity; OECD; African continent

1. Introduction

The accelerated change of global weather caused by greenhouse gas (GHG) emissions has been one of the most alarming and debated issues over the last few decades. The development of renewable energy use is seen as a reliable and efficient solution to mitigate the impacts of climate change. Europe has been the most active region in the world to put in place renewable energy technologies [1].

South Africa is classified as the seventh largest exporter of coal [2]. Appreciating the contribution of coal-generated energy to the rising issues of global climate change, the South African government

¹ Corresponding author. Email address: roula.inglesi-lotz@up.ac.za. Tukkiewerf building, Department of Economics, University of Pretoria, Main campus, Hatfield 0002 Pretoria, South Africa.

realised the need to achieve a sustainable energy mix by developing renewable energy sources. This resulted in the *White Paper on Renewable Energy* in 2003 [3], the *Integrated Resource Plan (IRP)* in 2010 [4] and recently the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) in 2014 [5]. The objective of the White Paper was mainly to promote renewable energy investment by setting well-structured tariffs and raising public awareness on the use of renewable energy and being energy efficient. The IRP 2010 is a 20-year long-term plan with principal targets, among others, to enlarge energy production from solar and wind sources. The REIPPPP was adopted to replace the feed in tariffs (Fits) system in favor of competitive tender's regime.

In order to assess the success of South Africa's renewable energy policies, a proper monitoring and comparing mechanism should be put in place. Taking the country's current position into consideration, this paper addresses two main issues. The first is to determine South Africa's economic position among the countries of the African continent and its relation to renewable energy performance. The second issue is South Africa's performance with regards to renewable energy compared to the OECD countries. We aim to address these issues by positioning South Africa's renewable energy consumption, supply and intensity of use through the years and comparing this to the OECD countries and the other African countries.

2. Literature review

The urgent need for a clean economy, growing global energy demand and intensified impacts of climate change are all factors that render renewable energy highly important. The development of renewable energy is as valuable in developing as in developed economies. Many developing countries, especially on the African continent, depend on agriculture and firewood (for lighting and cooking) because of poverty.

In 2008, two-thirds of the GHG emissions were emitted by developing countries outside the OECD countries [6]. Furthermore, in 2011, energy consumption was overshadowed by fossil fuels with only a 2% share of renewable energy internationally [7]. Hydroelectricity and wind contributed most of the world's renewable electricity production. However, OECD countries see most of its renewable energy coming from non-hydroelectric sources like wind [8].

Africa has large undeveloped renewable energy sources. However, households lack access to energy. This is a major concern since access to energy touches on all aspects of living, especially nutrition,

health and education. The United Development Program [9] reported that 1.5 billion people in developing countries do not have access to electricity and 3 billion people used solid fuels for lighting and cooking on a daily basis. In Africa, 589 million out of 1 billion people do not have access to electricity and the continent only uses 4% of the global electricity [10, 11]. In sub-Saharan Africa, two-thirds of the population do not have access to electricity [12]. This not only illustrates the African continent's contribution to climate change due to burning fossil fuels, but also the severe possible impact upon the continent's environment.

Furthermore, the high population growth in Africa, the increasing consumption of industrialised countries and highly volatile oil prices only contribute to the prevailing energy crisis situation. For this reason, it is crucial to diversify the energy mix by transitioning the world to a more sustainable energy production by investing heavily in the existing and abundant renewable energy resources. Even though many attribute the situation to the lack of funding for renewable energy projects, it has been found that the loss resulting from the use of the finite fossil fuel amounts to close to \$US3.4 trillion per year [13].

2.1. The road towards the development of renewable energy in South Africa

South Africa has large coal resources and greatly contributes to climate change due to its GHG emissions [14]. In addition, South Africa is among the countries with excellent solar regimes with solar being its most viable renewable energy resource [15]. Despite this, South Africa still depends more on coal for energy production claiming that fossil and nuclear technologies are more affordable than renewable energy (RE) technologies [16]).

A National Integrated Resource Plan (NIRP) was approved by the South African government in 2002. The aim of the NIRP was to set South Africa on a path to reach its electricity requirements with minimum costs using the Renewable Energy Feed-in-Tariff (REFIT) programmes [17]. It was divided into two plans (namely NIRP1 and NIRP2) with the difference being that the NIRP2 is based on average international data to determine the cost and the performance of new power plants.

In 2003, the South African Government, keen to contribute to a sustainable development in the future, approved the *White Paper on renewable energy* which announced a target goal of 10 000 GWh (0.8

Mtoe) of renewable energy production by 2013. To put it in perspective, this target was 4% of total electricity generation from renewable energy [18].

South Africa adopted the REFIT policy in 2009 to promote renewable energy technologies. The REFIT policy targets the prices of renewable electricity and consists of setting up a guaranteed price for a fixed period that covers both the cost of electricity supply and a justifiable profit to attract investment from renewable energy developers [19]. The REFIT policy was adopted and implemented based upon the positive experiences of other countries such as Germany, the United States and Spain which all use the same system in renewable energy markets [20].

Another IRP for the period until 2030, initiated in 2010 aims to reduce the consequences to the environment through the expansion of the renewable energy domestic market, construction of a new fleet of 9.6GW and the enforcement of the Energy Efficiency Demand-Side Management (EEDSM) system [4].

In 2011, South Africa initiated the REIPPPP based on competitive tenders to attract more Independent Power Producers (IPPs). The REIPPPP has been proven to be of great success by providing 3920 MW of renewable energy in 3 years only [21].

South Africa has to improve its energy efficiency to maintain its economic competitiveness according to Fawkes [22]. However, Inglesi-Lotz and Blignaut [23] observed that South Africa's electricity intensity is higher than that of the OECD countries and, therefore, there is a need for a policy to promote electricity efficiency. To illustrate the South African reality with regards to renewable energy usage, Figure 1 shows the total renewable energy consumption in kilotonnes of oil equivalent (ktoe) and its share in the energy mix for the period 1990 to 2010.

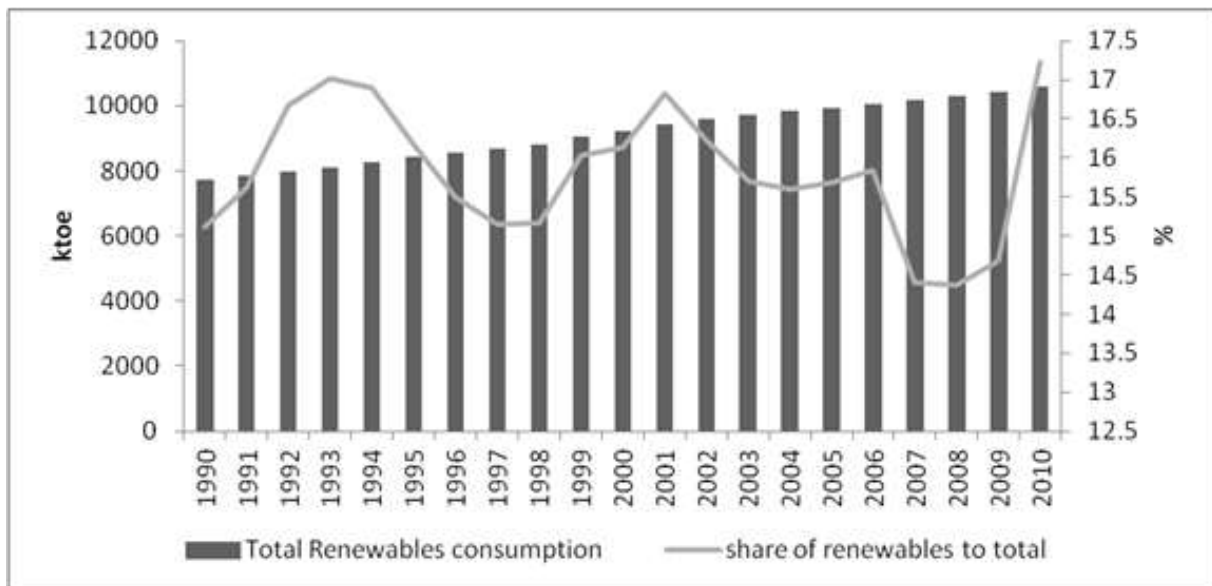


Fig.1. Total renewable energy consumption and its share in the total energy mix, South Africa; 1990–2010

Source: OECD [24]

From Figure 1, it can be seen that the consumption of renewable energy has increased over the period 1990 to 2010. However, its contribution to energy mix has decreased from 16.8% in 2001 to 14.6% in 2009 with a sharp increase in 2010 to 17.2%. This increase can be explained by the adoption of new policies on renewable energy as a result of the IRP 2010 which attracted investment and development in renewable energy. It is also necessary to mention that there was an increase of 78% from 2008 to 2011 in the South African real electricity price [25]. The rise in electricity prices made renewable energy a more cost-effective alternative.

Figure 2 presents the share of the different renewable energy options (i.e. hydro, geothermal, solar, wind, tide, biofuels and renewable waste) as a percentage of the total primary renewable energy supply in South Africa for 2010.

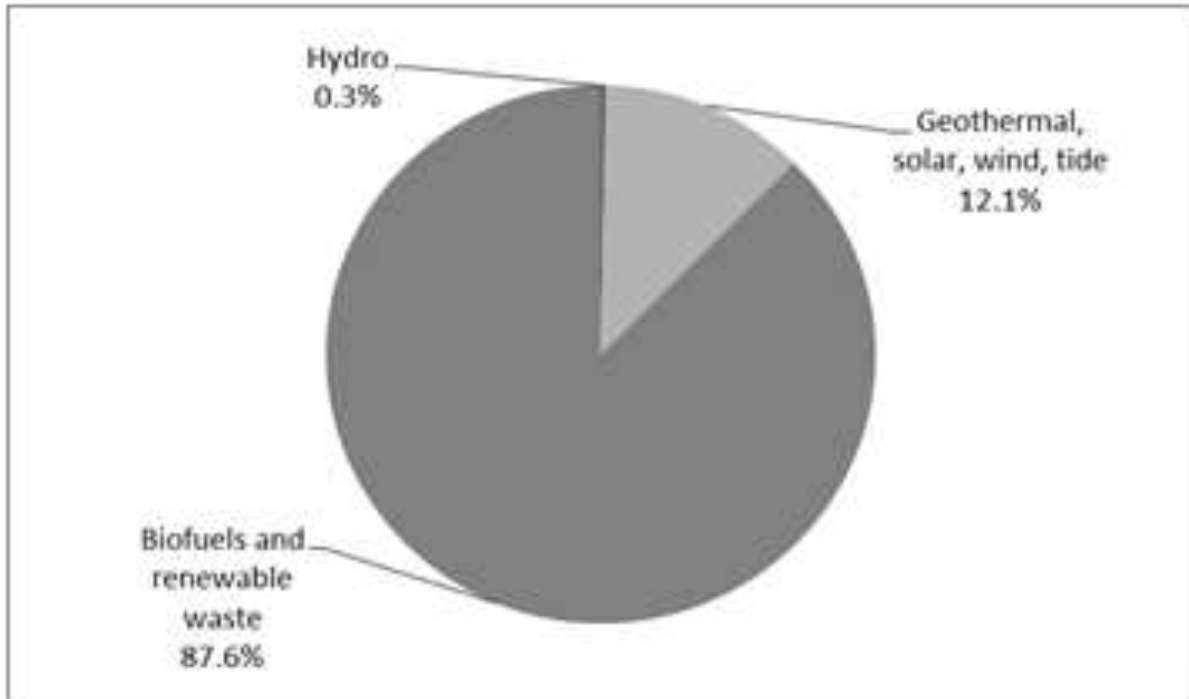


Fig.2. Contribution of different renewable energies to total primary renewable energy supply, South Africa, 2010.

Source: OECD [24]

It can be noted that “Biofuels and renewable waste” was the largest contributor to the total renewable energy with 87.6% of the primary supply. “Geothermal, solar, wind and tide” was the second largest contributor with 12.1%. And according to international standards, South Africa is poorly endowed in hydropower [26]; hence, the low contributions (0.3%) to the energy mix.

Figure 3 represents the trend of renewable energy production (REP) and the share of renewable energy production (SREP) as it relates to the total energy mix of South Africa from 1990 to 2010.

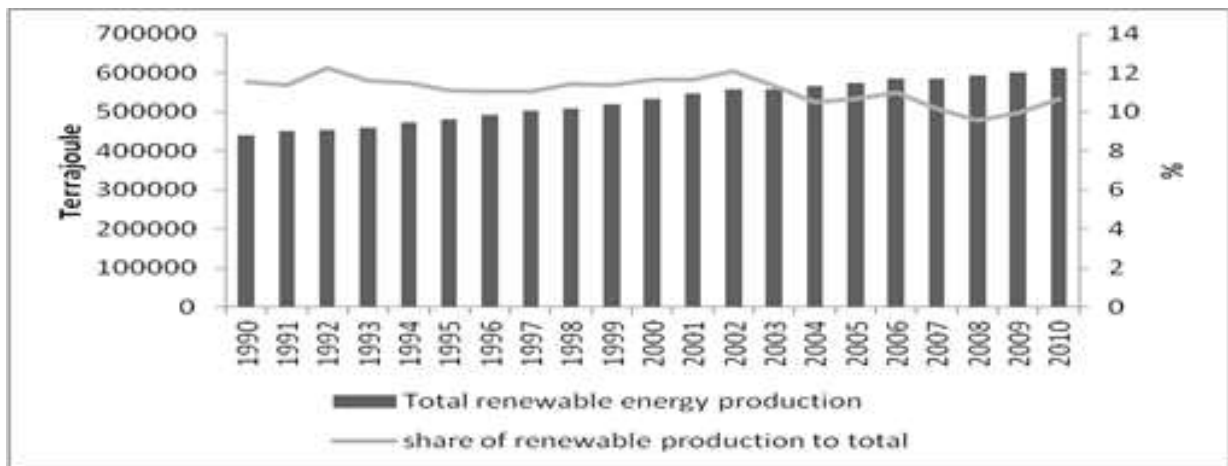


Fig.3. Evolution of renewable energy production in South Africa

Source: OECD [24]

Although the South African REP has increased over time, its share of the total energy mix started to decrease in 2003. In 2002, REP was 12% of the total energy mix but it dropped to 9.5% in 2008, increasing to 10.6% in 2010. This can be explained by the South Africa's heavy dependence on coal for the generation of energy. It can also be explained by the non-attractive, more costly, market for renewable energy. Investors were reluctant to invest in renewable energy because of the ambiguous policies regarding renewable energy development.

3. METHOD AND DATA

3.1. Method

The comparative studies emphasize both the similarities and differences between groups or units of analysis such as countries, as in this case.

An important aspect of this research design is the selection (or sampling) of the units of analysis and in a country or cultural comparison this is primarily done on theoretical grounds. South Africa's economy is considered to be two-tiered [23]. The first tier includes South Africa's primary sectors (manufacturing, mining and agricultural) and financial sector which are sophisticated, well-developed and competitive with international markets. The second tier, however, is characterised by a third-world economy. South Africa is among the non-member economies with which the OECD has working

relationships. To accommodate South Africa's economic nature and for more holistic comparative purposes, the OECD group is separated into two smaller sub-groups, namely developing countries and developed countries. It is helpful to position South Africa among developed countries to compare and contrast the differences, gaps and potential of the consumption and supply of renewable energies. This is done in an effort to improve the country's performance according to international standards, and also to position the country within a group of, countries with different socioeconomic characteristics as those on the African continent.

3.2 Data

Data on total renewable energy use, supply and its share in relation to the total energy mix is used to create a holistic picture for the comparative exercise. For this study, summed up total energy consumption data from hydropower, nuclear, geothermal and solar power, biomass and waste electricity, and hydroelectricity was used. The data used on energy from renewable sources is derived from the OECD databases such as the OECD Energy Balances for OECD countries, OECD Energy Balances for non-OECD countries [24,26] and Renewable Information (IEA, 2012a). The data is expressed in ktoe or TJ. The period under study is from 1990 to 2010.

The GDP data in current prices is obtained from the World Development Indicator Database [27]. The GDP data was adjusted using the purchasing power parity (PPP). This method is suitable for African countries because it eliminates the possible effects of the difference between strong currencies such as the Euro and US Dollar versus the rest of the African countries' currencies and South Africa's Rand (ZAR). The PPP-equivalent GDP is obtained by dividing a country's nominal GDP in its own currency by its PPP relative to the US Dollar [28].

4. COMPARATIVE ANALYSIS

4.1. South Africa vs. OECD Countries

4.1.1. Renewable energy consumption

The use of renewable energy in OECD countries has been increasing over the years, reducing dependency on energy sources from outside the countries and lowering environmental deterioration. Apergis and Payne [29] show that an increase of 1% in renewable energy consumption (REC)

increases real GDP by 0.76% in OECD countries. Also, a recent study by Inglesi-Lotz [30], using 31 OECD countries as the study population, showed that a 1% increase in REC leads to a 0.22% rise in GDP and a 0.033% increase in GDP per capita.

Figure 4 shows that the OECD developing countries (Hungary, Mexico, Poland and Turkey) increased their REC from 4 494.9ktoe to 4 960.3ktoe (approximately 10.3%) from 1990 to 2010 while South Africa increased its REC by 37% during the same time period. The overall average OECD country almost doubled its REC from 3 081.2ktoe in 1990 to 5 444.7ktoe in 2010 (an increase of approximately 76%). It is clear that South Africa made remarkable progress compared to the OECD developing countries but not as much compared to the average of all the OECD economies.

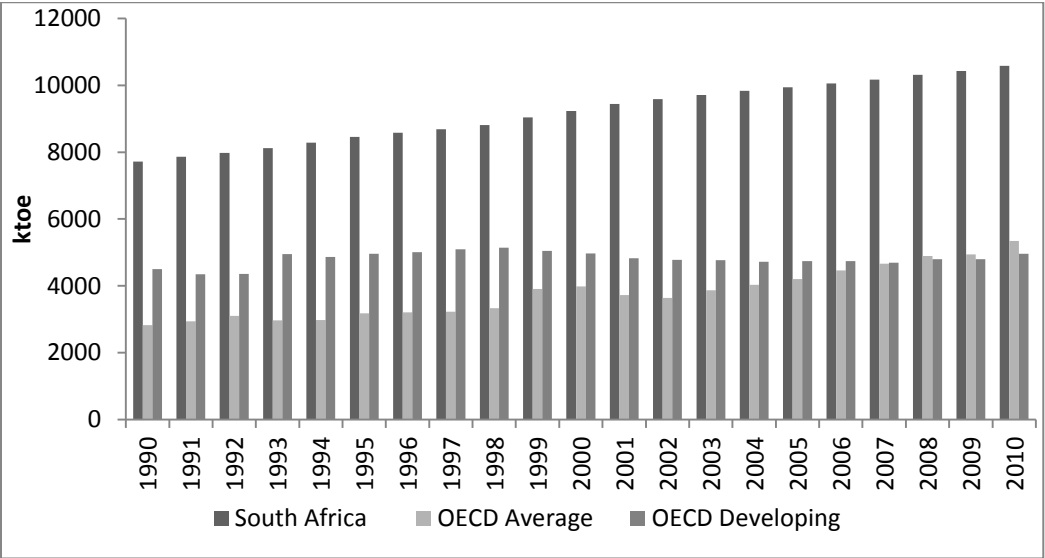


Fig.4. Total final energy consumption from renewable sources, 1990–2010

Source: Authors calculations from OECD [24,26]

Another interesting conclusion from Figure 4 is that South African consumption of renewable energy is substantially higher than both the average of all OECD countries or the OECD developing countries. A reason for this can be that one part of the South African economy is still considered primitive and traditional owing to specific conditions. Hence, biomass and waste is used for heating and cooking purposes in a higher scale than in more industrialised economies.

While the percentage change in REC over the period 1990 to 2010 is shown in Figure 4, Figure 5 presents a comparison of each OECD-member country to South Africa.

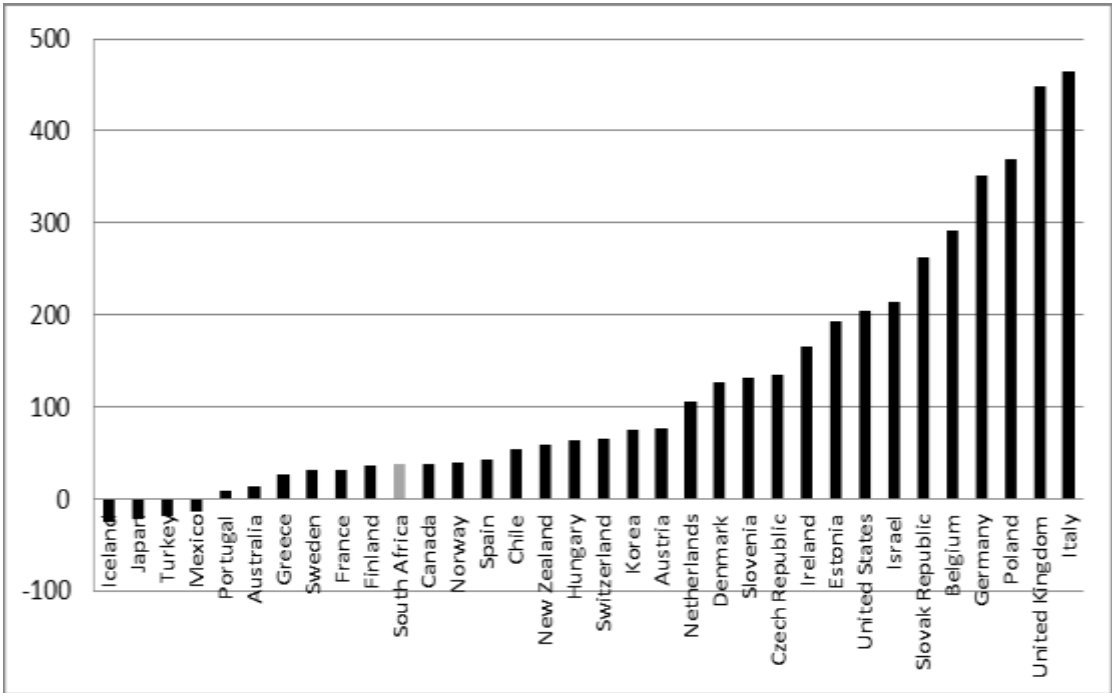


Fig.5. Percentage change of total renewable energy consumption for South Africa and OECD countries: 1990–2010

Source: Authors calculations from OECD [24,26]

South Africa has not made significant progress regarding its renewable energy use over the period 1990–2010. This could be due to the lack of renewable energy technologies. It can also be attributed to the fact that the country had relatively high consumption of renewable energy (biomass and waste used for cooking and heating) at the beginning of the period. In general, the OECD countries made positive progress. While some countries like Italy and the United Kingdom had substantial increases of 465.26% and 448.66% respectively, other countries like Mexico and Switzerland performed worse over the period 1990 to 2010 decreasing their renewable energy consumption by -24.8% and -21.5%, respectively.

4.1.2 Renewable energy supply

Figure 6 presents the contribution of renewable energy supply to total supply mix in South African as well as OECD countries for the years 2001 and 2010. Also, it shows the change in renewable energy supply for the period 2001 to 2010. Although South Africa's renewable energy supply increased by almost 15%, its contribution to the total energy supply mix decreased over the same period. This can be explained by the non-competitive market for renewable energy development whereby the costs of renewable energy technologies and its maintenance are still higher than the cost of using coal and natural gas technologies [31]. This implies that South Africa still favours traditional sources of energy generation (such as coal burning) over renewable energy.

Both the OECD average and OECD developing economies' share to the total supply mix as well as the consumption in absolute values increased. This can be explained by the increasing demand of renewable energy in the OECD-member economies characterised by a population working actively towards the reduction of GHG emissions.

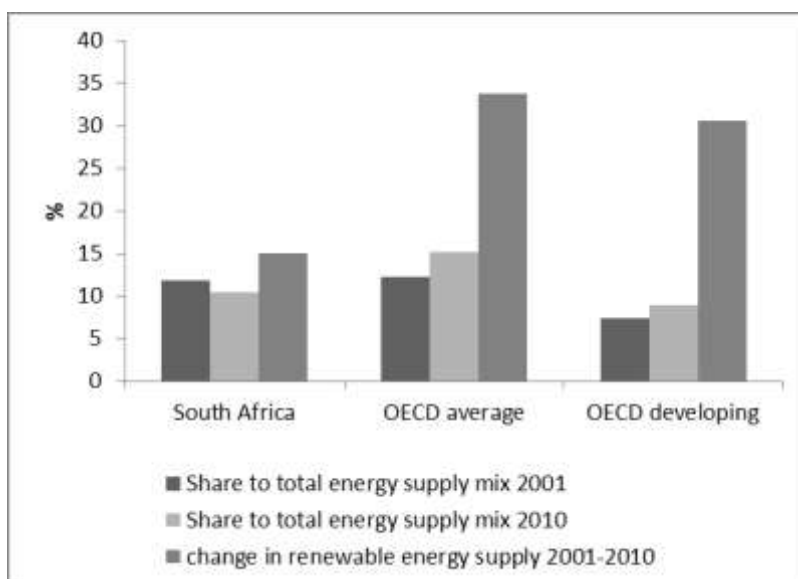


Fig.6. Renewable energy share to total energy supply mix (2001 and 2010) and the change in renewable energy supply (2001 to 2010): South Africa, OECD average and OECD developing

Source: Authors calculations from OECD [24,26]

In contrast to the OECD countries, South Africa’s renewable energy production has declined from a share of 11.7% of the total energy supply mix in 2001 to 10.3% in 2010. This can possibly be explained by the South African government's struggle to provide affordable tariffs for renewable energy development and also the constraints of limited markets for renewable energy. The OECD developing countries’ change in renewable energy supply (30.6%) over the period 2001 to 2010 is twice as big as that of South Africa (15%) over the same period. This suggests that South Africa needs more appropriate policies to boost its renewable energy supply.

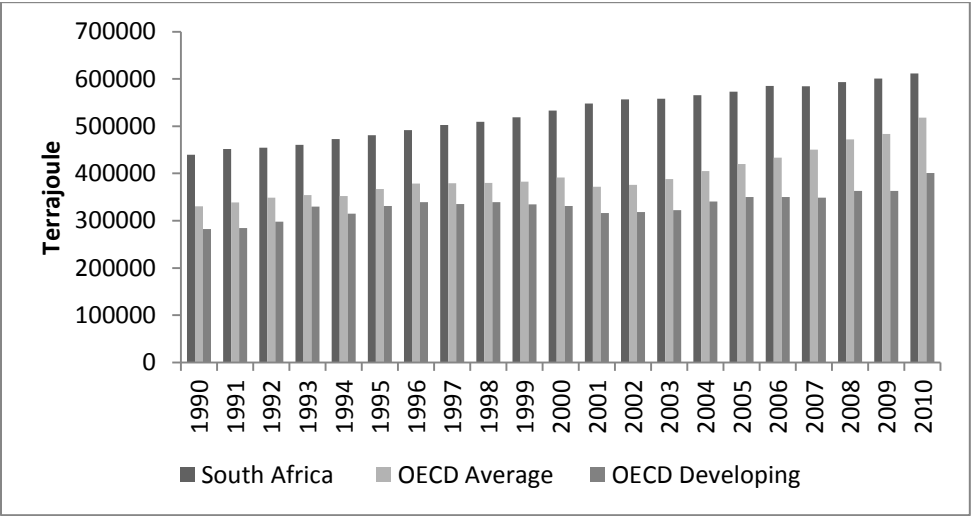


Fig.7. Renewable energy production (REP): South Africa and OECD average 1990–2010

Source: OECD [24,26]

From Figure 7, it can be seen that, although South Africa’s renewable energy production is higher than the OECD average and the OECD developing countries', it follows similar increasing trends. South Africa’s REP increased from 439 559.94TJ in 1990 to 611 667.2TJ in 2010 (a 39.15% increase). The OECD developing countries increased their REP by approximately 42% while the OECD-member countries' average REP increased by 57% over the same period.

4.2. South Africa vs. other African Countries

4.2.1. Renewable energy consumption

South Africans' life expectancy keeps increasing while the population growth in South Africa is lower than in any other African country [32]. This can imply that the increased energy use per person is balanced by the slow population growth and the switch to renewable energy can therefore help to deal with climate change issues while increasing REC may possibly induce growth in the economic welfare [30]. The ever-increasing population growth in Africa makes the reaching a sustainable environment difficult because of high poverty levels in the region and increasing energy demand [34]. Most of the population in Africa use firewood for cooking and lighting.

Figure 8 presents the renewable energy trends for South Africa compared to the African countries' average over the period 1990–2010.

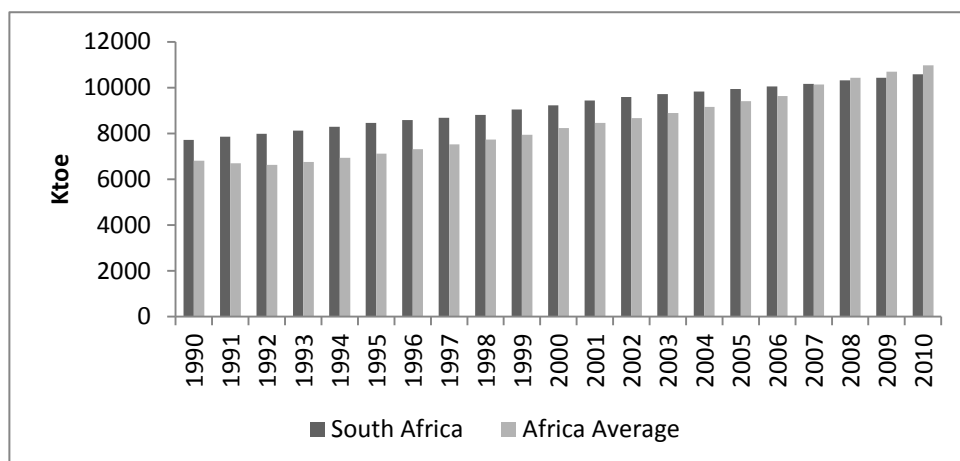


Fig.8. REC: South Africa and Africa Average, 1990–2010

Source: OECD [24]

From Figure 8, it is can be seen that REC for both South Africa and the other African countries has been increasing at a slower rate over the past decade. South Africa's REC increased from 9 232.5ktoe to 10 578ktoe (14.5%) for the period 2000 to 2010 while the average African country's REC rose from 8 232ktoe to 10 966.5ktoe (33.2%) for the same period. Much must still be done for a complete transition to a more sustainable South Africa. However, despite South Africa being among the largest

economy in Africa, Figure 8 indicates that the average African country surpassed South Africa in REC from 2008 to 2010. The average African REC increased from 10 427.4ktoe in 2008 to 10 966.5ktoe (5.1%) while South Africa’s REC increased from 10 310.5ktoe in 2008 to 10 578ktoes in 2010 (2.6%).

Figure 9 presents the share of REC for both South Africa and African average for the period 1990 to 2010.

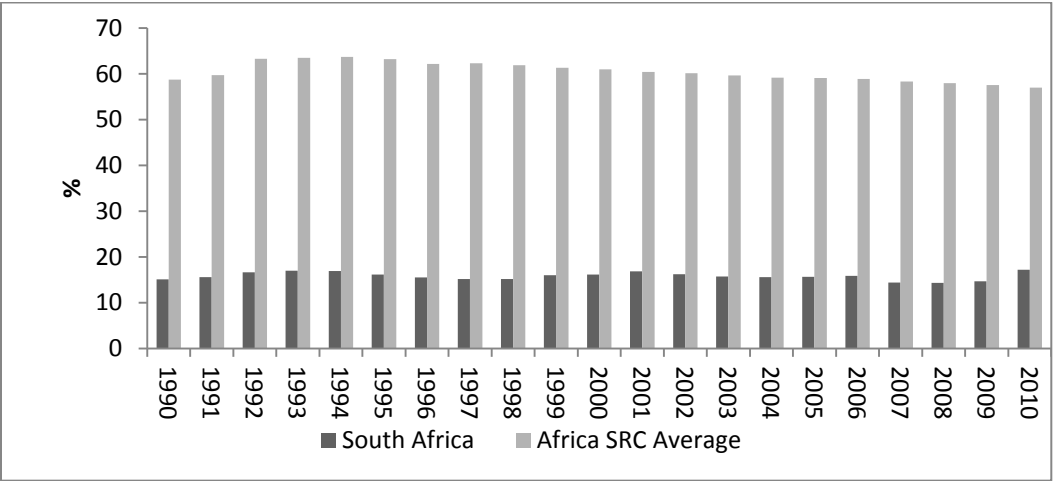


Fig.9. Share of REC: South Africa and African average 1990–2010

Source: OECD [24]

Figure 9 shows that African countries are doing much better as they are striving to increase energy access especially in rural areas. In 2010, South Africa’s share of REC was 17.2% compared to the African countries' average of 57%. Edkins et al. [20] argue that there is no clear interaction between the renewable energy development policy and implementation in South Africa and also that the adoption of REFIT has not been successful. The little progress, compared to the rest of Africa, is also due to the fact that South Africa is much dependent on the cheap coal to generate electricity.

Figure 10 presents the 2010 REC of each of the African countries, including South Africa, and their relative change in the share of REC over the period 1990 to 2010.

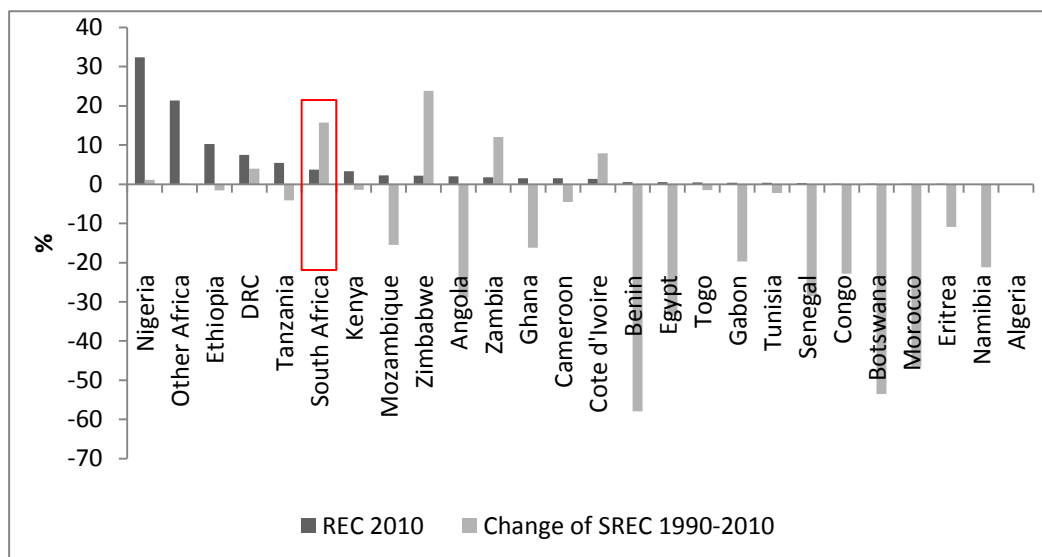


Fig.10. South Africa and African countries' REC (2010) and change of share of REC (1990–2010)

Source: OECD [24]

Nigeria has consumed the most renewable energy in 2010 (32.4%) but its associated change for the time period is just 1.1%. Other countries like Tunisia, Senegal, Botswana, Morocco, Eritrea, Namibia and Algeria practically have no renewable energy plan in place. South Africa's renewable energy consumption in 2010 is 3.7%, which is low compared to REC in Tanzania (5.4%), Democratic Republic of Congo (7.4%) and Ethiopia (10.2%). However, South Africa's change in their share of REC is quite significant (15.7%), just lower than Zimbabwe (23.8%). This implies, therefore, that although South Africa's REC was not high in 2010 compared to some other African countries like Tanzania and Ethiopia, it has been increasing its consumption over the years which explains its high change in the share of REC over the period 1990–2010.

Figure 10 proves that South Africa, despite its high economic position on the African continent, does not perform well in renewable energy compared to other African countries. However, Africa overall made little progress in developing renewable energy and biomass energy is still the most utilised source of energy in Africa. An estimated 80% of the total energy consumption in Africa comes from biomass energy [34]. For example, 94% of the population in Burundi and 68% of the population in Kenya use biomass and waste energy to meet its energy needs [35]. There is great potential for hydropower in Africa but it still unexploited due to lack of not only proper policies but also funds [36].

However, some countries like Rwanda, Kenya, Tanzania, Malawi, Mozambique and Zimbabwe have started putting in place small hydropower projects [38].

4.2.2 Renewable energy production

It is estimated that 57% of the population in Africa lack access to electricity and if appropriate measures of increasing renewable energy were not taken, 42% of the population will still be without access to electricity in 2030 [38].

Figure 11 presents the renewable energy production of South Africa compared to that of the African average.

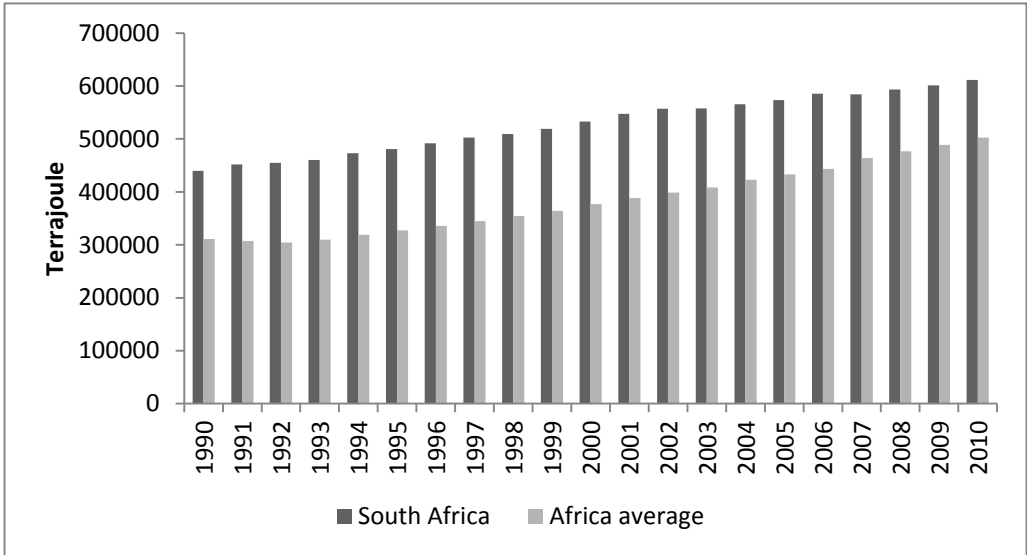


Fig.11. REP: South Africa and African average (1990–2010)

Source: OECD [24]

It can be clearly seen from Figure 11 that REP in South Africa is higher than in the other African countries for the period 1990 to 2010. In 2010, REP was 611 667.1TJ for South Africa and 502 537.5TJ for the African average (21.7% higher). A possible reason for this is South Africa has more developed technologies available; however, the high demand of the South African economy requires substantially higher absolute amounts of energy. The South African policies and their targets might have contributed to that.

Figure 12 presents the share of REP for South Africa compared to the African average over the period 1990 to 2010.

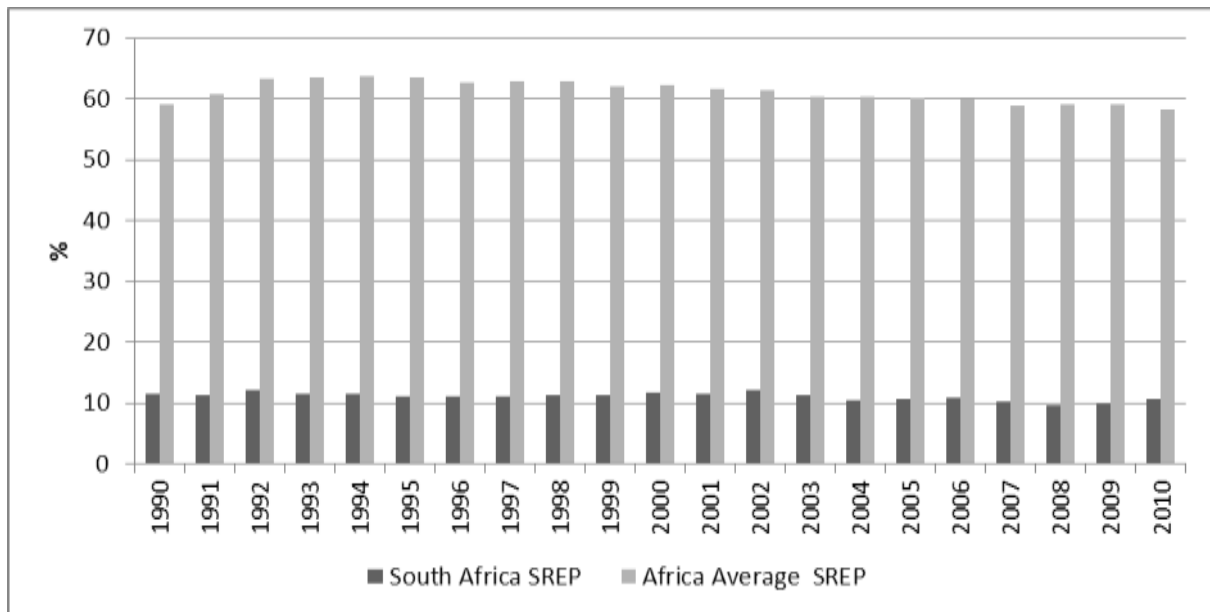


Figure 12 Share of REP: South Africa and African average (1990–2010)

Source: OECD [24]

The share of REP for the African countries is much greater than that of South Africa over the study period. The African share of REP decreased slightly from 59.03% in 1990 to 58.22% in 2010 (-0.81%). South Africa's share of REP decreased from 11.54% in 1990 to 10.67% in 2010 (-0.87%). The difference can be attributed to greater use of hydropower in the African countries. In 2008, energy production from hydropower was 55% in Sudan, 63.4% in Madagascar, 99% in Malawi and 35.4% in Nigeria, while only 1.2% of energy is produced from hydropower in South Africa [39].

Table A in Appendix, shows the REP for 2010 and the change of share of REP over the period 1990 to 2010.

From the Table 1, Libya has the highest change in the share of REP (8.12%) followed by Tunisia (0.5%). South Africa has the lowest change in the share of REP (-5.7%). Nigeria had the highest REP (28.16%) in 2010 and South Africa came in 7th position (4.3%).

4.3 Renewable energy intensity

This section focuses only on South Africa and other African countries since they share the primary objective of increasing access to energy on the continent. The OECD countries' ultimate goal is to attain a cleaner environment.

Renewable energy intensity is defined as renewable energy consumption over gross domestic product (GDP) at constant prices. Chefurka [40] defines energy intensity as “the amount of energy it takes to produce a dollar’s worth of economic output”. It therefore implies that renewable energy intensity will indicate how effective the energy is used. Figure 14 presents South Africa and other African countries' REC intensity for the period 1990 to 2010.

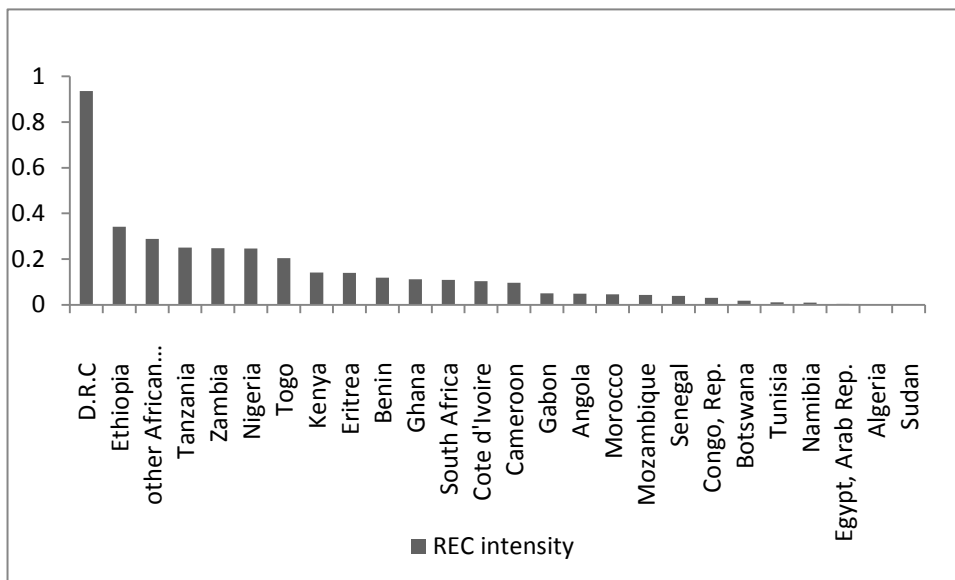


Figure 14 South Africa–African countries' REC intensity (1990–2010) in Terrajoule/US dollars

Source: OECD [24] & World bank [27]

Figure 14 shows that South Africa is in the middle of the ranking for the REC intensity in 2010. South Africa's REC intensity was 0.1% in 2010. The Democratic Republic of Congo (DRC) had the highest REC in 2010 (0.9%).

5. CONCLUSION

During the last few decades, global environmental concerns have been increasing at an alarming rate. The contribution of each country, from the smallest to the largest, is imperative towards a path of future sustainable development. Clean energy is also considered to be an assurance of energy security in the future. This study aimed to trace the evolution of renewable energy in South Africa through the years and assess the country's position among the both OECD countries and the rest of Africa regarding renewable energy. Three components of renewable energy development were evaluated through the comparative analysis process.

The first component examines the renewable energy consumption in South Africa, other African countries and the OECD countries. There has been a significant increase of 37% in South Africa's renewable energy consumption over the period 1990–2010. The share of renewable energy consumption was higher in other African countries compared to South Africa in 2010. Furthermore, compared to the OECD countries, South Africa still has much room for improvement regarding its renewable energy consumption. The share of South Africa's renewable energy consumption to the total energy mix has been decreasing over the years, which shows that the fossil fuels are still the major source of energy consumption. But more importantly, it indicates that there is a need to revise the policies regarding renewable energy developments.

Production of renewable energy was investigated next. The findings show that South Africa's renewable energy production has been increasing with a noticeable increase of 15% from 2001 to 2010. South Africa's REP is also higher than in other African countries over the past 20 years. The reason may be existing incentives regarding renewable energy in South Africa, while such incentives are almost non-existent in some African countries like Senegal, Botswana, Eritrea and Namibia. The share of renewable energy to the total supply mix has been decreasing over the years for all African countries. This illustrates the importance of the abundance of fossil fuels, especially coal, to the African continent. Compared to OECD countries, the results show that South Africa's REP is much lower compared to both the OECD developing and developed countries.

The last component that was evaluated was the renewable energy intensity. This component is particularly important as it shows how effective the energy is used in a specific country. The country's growth and development status is considered similar to that of the developing economies on the

African continent. Hence, an indicator including information on GDP was preferred for comparison only with the rest of the continent. The results show South Africa is in the middle of the ranking with the Democratic Republic of Congo at the top.

The results from the comparison of South Africa to other African countries were not as expected. Despite South Africa having one of the strongest economies on the African continent, it is not performing better regarding renewable energy. Possible reasons for this is that i) large amounts of coal exist in South Africa, making fossil fuel power generation much more cost-effective and ii) many African economies base their energy generation on hydropower facilities, taking advantage of their natural resources.

South Africa is not positioned high in the use and supply of renewable energy compared to OECD countries and Africa, and there is room for improvement according to the specific targets set by the South African government.

This study aims to help policy-makers in South Africa to determine the current position of the country within the renewable energy sector. All in all it was found that South Africa can still improve by promoting various renewable energies also as a way to find potential solutions to each current energy crisis.

Future research in South Africa could be extended to investigate the impact of renewable energy on economic growth apart from the obvious positive environmental effects. Also, researching the effect of policies on the evolution of renewable energy in the past will allow policy-makers to better understand better the renewable energy market. Moreover, learning from successful renewable energy policies internationally will assist with the improvement of the sector.

APPENDICES

Table A South Africa–Africa countries REP 2010 and change of the share of REP for 1990–2010

Country	REP 2010 (in %)	Change of the share of REP 1990–2010 (in %)
Algeria	0.02	0
Libyan Arab Jamahiriya	0.05	8.1
Namibia	0.09	-2.2
Botswana	0.14	-2.0
Eritrea	0.17	-0.0
Congo	0.23	-0.8
Morocco	0.24	-0.3
Gabon	0.35	-0.7
Tunisia	0.40	0.5
Senegal	0.46	-0.8
Benin	0.60	-2.4
Togo	0.65	0.0
Egypt	0.83	-1.9
Cameroon	1.41	-0.8
Ghana	1.93	-0.7
Zimbabwe	1.95	1.1
Cote d'Ivoire	2.18	-0.0
Zambia	2.20	0.3
Angola	2.35	-1.1
Mozambique	2.87	0.1
Sudan	3.37	-0.7
South Africa	4.31	-5.7
Kenya	4.65	-0.0
United Republic of Tanzania	5.30	-0.1
Democratic Republic of Congo	6.75	0.4

Ethiopia	9.28	0.0
Other Africa	18.93	-0.0
Nigeria	28.16	0.2

Source: OECD [24]

References

- [1] UNDP. 2011. United Nations Environment Programme 2011: Emerging issues in our global environment. UNEP. Nairobi, Kenya.
- [2] Steyn, M. & Minitt, R.C.A. 2010. Thermal coal products in South Africa. *The Journal of the Southern African Institute of Mining and Metallurgy*, 110:593–599.
- [3] Republic of South Africa. 2003. *White paper on renewable energy*. Pretoria: Department of Minerals and Energy.
- [4] Republic of South Africa. 2010. *Integrated resource plan for electricity 2010-2030*. Pretoria: Department of Minerals and Energy.
- [5] Eberhard, A., Kolker, J., Leigland, J. 2014. South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons. Washington, DC: Public-Private Infrastructure Development Group.
- [6] Holm, D. & Arch, D. 2008. *Renewable Energy Future for the Developing World. White Paper*. Freiburg: International Solar Energy Society. Available at: <http://whitepaper.ises.org/ISES-WP-600DV.pdf>.
- [7] BP. 2012. *BP Statistical Review of World Energy June 2012*. London: BP. Available at http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf
- [8] EIA (Energy Information Administration). 2013. *International Energy outlook 2013*. Washington: EIA.
- [9] UNDP. 2009. *The Energy Access Situation in Developing Countries: A Review Focusing on Least Developing Countries and Sub-Saharan Africa*. New York: UNDP.
- [10] Belward, A., Bisselink, B., Bódis, K., Brink, A., Dallemand, J., de Roo, F., Huld, A., et al. 2011. *Renewable Energies in Africa. Current Knowledge*. Luxembourg: Publications Office of the European Union/JRC European Commission.
- [11] Nair, M. 2009. *Renewable Energy For Africa*. The Hague: The Institute for Environmental Security.

- [12]WEO/IEA.2014. Energy in sub-Saharan Africa today. World energy outlook 2014.
- [13]Kroll, M. 2013. *The Monetary Cost of the Non-Use of Renewable Energies*. Johannesburg: World Future Council.
- [14]Pegels, A. 2009. *Prospects for renewable energy in South Africa: Mobilizing the private sector*. Discussion paper, Deutsches Institut für Entwicklungspolitik.
- [15]Van Niekerk, W. 2012. Why should South Africa invest in the development of renewable energy sources? Stellenbosch: Centre for renewable and sustainable energy studies, University of Stellenbosch.
- [16]Gets, A. 2013. *Powering the future: Renewable energy roll-out in South Africa*. Johannesburg: Greenpeace Africa.
- [17]Republic of South Africa. 2010. Determination regarding the Integrated Resource Plan and new generation capacity. *Government gazette (No.32898)*. Pretoria: Government Printer.
- [18]Republic of South Africa. 2003. *Integrated energy plan for the Republic of South Africa*. Pretoria: Department of Minerals and Energy.
- [19]Odeku, O., Meyer, E., Mireku, O. & Letsoalo, J.L.H. 2012. Implementing a renewable energy feed in tariff in South Africa: The beginning of a new dawn. *Sustainable Development Law and Policy*, 11:44–49.
- [20]Edkins, M., Marquard, A. & Winkler, H. 2010. *South Africa's renewable energy policy roadmaps*. Cape Town: Energy research center.
- [21]Papapetrou,P.2014. Enabling Renewable Energy in South Africa: Assessing the Renewable Energy Independent Power Producer Procurement Programme. WWF.2014
- [22]Fawkes, H. 2005. Energy efficiency in South African industry. *Journal of Energy in Southern Africa*, 16:18–25.
- [23]Inglesi-Lotz, R. & Blignaut, J.N. 2012. Electricity intensities of the OECD and South Africa: A comparison. *Renewable and Sustainable Energy Reviews*, 16:4491–4499.
- [24]OECD. 2012. *Energy Balances for non-OECD Countries*. Paris: OECD.
- [25]Deloitte. 2011. *The economic Impact of electricity price increases on various sectors of the South African economy*. Johannesburg: Deloitte.
- [26]OECD. 2012. *Energy Balances for OECD Countries*. Paris: OECD.
- [27]World Bank. 2011. *World Development Indicators database*. Washington: World Bank.
- [28]Silver, M. 2010. *IMF Applications of Purchasing Power Parity Estimates*. IMF WP/08/253. Washington: IMF.
- [29]Apergis, N. & Payne, J. 2010. Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy*, 38:656–660.
- [30]Inglesi-Lotz, R. 2015. The Impact of Renewable Energy Consumption to Economic Welfare: A Panel Data Application. *Energy Economics*, Forthcoming.

- [31] Musango, J.K., Amigun, B. & Brent, A.C. 2011. Sustainable electricity generation technologies in South Africa: Initiatives, challenges and policy implication. *Energy and Environment research*, 1:124–138.
- [32] National Planning Commission for South Africa. 2011. National Development Plan Vision for 2030. Pretoria: Government Printer.
- [33] Mutunga, C., Zuke, E. & De Souza, R.M. 2012. *Population dynamics, climate change and sustainable development in Africa*. Washington & Kenya: Population Action International and African Institute for Development Policy.
- [34] Denruyter, J., Roberntz, P., Sosovele, H., Randriantiana, I., Máthé L. & Ogorzalek, K. 2010. Bioenergy in Africa – Time for a Shift? *Sud Sciences & Technologies*, 19&20:145–158.
- [35] EuropeAid. 2009. The ACP-EU energy facility and biomass. *EuropeAid Energy facility newsletter*, 35:1-5.
- [36] Klunne, W.J. 2009. Small hydropower for rural electrification in South Africa - using experiences from other African countries. Johannesburg: ISES.
- [37] Klunne, W.J. 2012. Current status and future developments of small and micro hydro in southern Africa. Hydroenergia 2012 conference, Wroclaw, Poland.
- [38] IRENA. 2013. Africa's Renewable Future: Path to Sustainable Growth. Abu Dhabi: IRENA.
- [39] Intpow. 2009. *World hydro potential and development*. Available at: <http://www.intpow.com/index.php?id=487&download=1>
- [40] Chefurka, P. 2007. *Energy Intensity and GDP in 2050: To Have or Have Not*. Available at: http://www.paulchefurka.ca/WEAP2/Energy_Intensity_GDP_2050.html.