IEA Bioenergy
Technology Collaboration Programme

# Implementation of bioenergy in South Africa – 2021 update

## Country Reports

IEA Bioenergy: 10 2021

This report was prepared from the 2021 IEA World Energy Balances and Renewables Information, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members[1]. Reference is also made to FAOstat as well as data from national statistics. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report for all country reports.

**Edited by:** Luc Pelkmans, Technical Coordinator IEA Bioenergy

**Contributions:** Dr Karen Surridge (South African National Energy Development Institute - SANEDI) and Prof. Cristina Trois (SARCHI Chair Waste and Climate Change, University of kwaZulu-Natal).

## HIGHLIGHTS

- Renewables make up 6.6% of *total energy supply* in South Africa. The renewable energy share in *final energy consumption* is 10%. Around 85% of renewable energy is from biomass. Biomass is almost exclusively used for heat production (residential and in industry).
- Coal is dominating total energy supply. It provides 92% of electricity in South Africa and 57% of heat.
- The use of biomass for residential applications (mostly traditional use) is going down steadily and is partly compensated by an increasing use of solid biomass as a fuel in industry.
- Biomass plays no notable role in electricity production and there is no reporting of biofuels in transport.
- South Africa has important opportunities to further deploy bioenergy, particularly through the replacement of coal by solid biomass in existing assets, the replacement of traditional bioenergy by more modern (and less polluting) forms of bioenergy or the deployment of transport biofuels based on domestically available residues. There are ample opportunities for (renewable) energy from MSW as part of the development of waste management systems.
- Nonetheless, South Africa still faces mounting service delivery challenges that retard the implementation of energy policies, especially those for the provision of decentralized energy

[1] While data for 2020 are starting to become available at national level, it was decided to consider trends up to 2019 for good comparability and benchmarking between the different IEA Bioenergy member countries. Care should also be taken when using 2020 data for analysing trends as these data are distorted by the COVID19 Pandemic.

services, which are critical towards sustainable development. The past decade has seen the insertion of decentralised waste-to-energy systems been installed in rural, and historically underserviced, South African municipalities, particularly micro-bio-digesters. The implementation of these decentralized energy systems contributes to sustainable development by improving social dynamics, promoting new business opportunities, and preserving natural resources.

# COUNTRY PROFILE

## Population and land use

South Africa is the southernmost country in Africa. It has a total land area of 1.21 million km² and a population of 58.6 million people, which represents a relatively low population density of 48 persons per km².

The interior of South Africa consists of a vast, in most places almost flat, plateau, largely comprising sparsely populated scrubland. 10% of the land area is arable land and 14% forest land. South Africa has a generally temperate climate, but with a great variety of climatic zones (from extreme desert to subtropical climates).

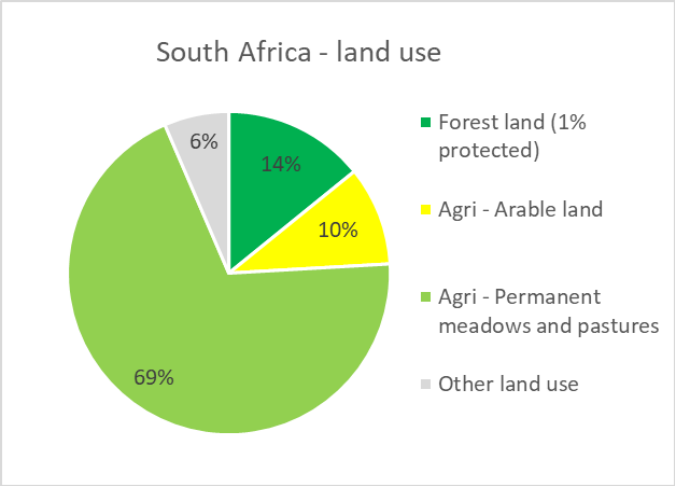


*Figure 1: Land use in South Africa (2018 figures - Source: FAOstat)*

## Final energy consumption

South Africa is a developing country. Overall final energy consumption in South Africa (*also including non-energy use of oil, natural gas, and coal in industry*) comes down to 1.2 tonnes of oil equivalent (toe) per capita, which is less than half of the average of IEA Bioenergy member countries. Industry represents around 40% of final energy consumption; transport and residential/services each represent around 30%.

*Table 1: Distribution of the final consumption of energy carriers by sector in South Africa (2019 figures - Source: IEA (2021) World Energy Balances and Renewables Information)*

| Final consumption energy carriers | Toe/capita (2019) | % of total | *Median* (toe/capita)* |
|---|---|---|---|
| **Industry (energy use)** | 0.41 | 35% | *0.67* |
| **Industry (non-energy use)** | 0.08 | 6% | *0.21* |
| **Transport** | 0.33 | 28% | *0.69* |
| **Residential** | 0.21 | 18% | *0.57* |
| **Commercial & public services** | 0.09 | 8% | *0.34* |
| **other** | 0.06 | 5% | |
| **Total** | 1.18 | | *2.34* |

** Median of the 25 member countries of IEA Bioenergy*[2]

[2] Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

# NATIONAL POLICY FRAMEWORK IN SOUTH AFRICA

## TARGETS AND STRATEGIES

South Africa's National Development Plan (NDP) 2030 offers a long-term plan for the country. It defines a desired destination where inequality and unemployment are reduced and poverty is eliminated so that all South Africans can attain a decent standard of living. Electricity for all is one of the core elements for a decent standard of living. The NDP envisages that, by 2030, South Africa will have an energy sector that provides a reliable and efficient energy service at competitive rates, that is socially equitable through expanded access to energy at affordable tariffs and that is environmentally sustainable through reduced pollution. In formulating this vision for the energy sector, the NDP took as a point of reference the Integrated Resource Plan (IRP) 2010–2030, which was promulgated in March 2011.

The Integrated Resource Plan (IRP) is an electricity infrastructure development plan based on the least-cost electricity supply and demand balance, considering security of supply and the environment (minimize negative emissions and water usage). A total 6,422 MW under the Renewable Energy Independent Power Producers Programme (REIPPP) has been procured, with 3,876 MW operational and made available to the grid. In total, 18,000 MW of new generation capacity has been committed.

Figure 2 and Table 2 highlight the IRP 2019 energy mix committed in 2019 and the progressive 2030 targets. This figure clearly highlights the strong commitment of the South African government towards a net decrease of reliance to coal and fossil fuels (40%) and a net increase of renewables such as wind (21%) and PV (10%). The low investment towards biomass, landfill gas and co-generation systems, as evident from Table 2, is rather alarming and should be monitored carefully.

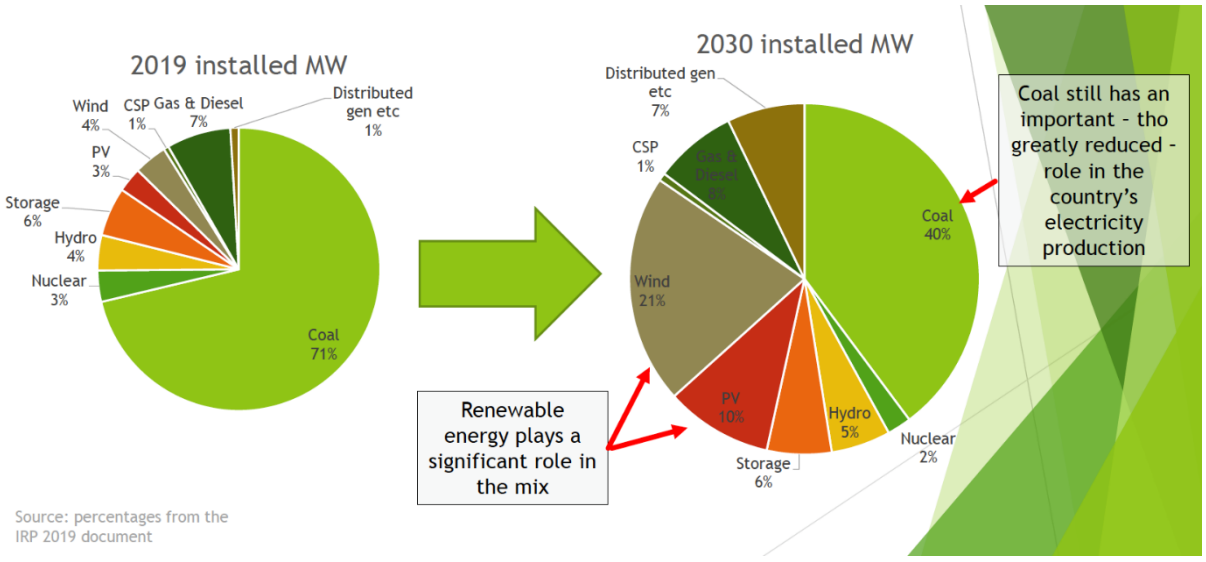


***Figure 2**: Integrated Resource Plan (IRP) generation mix installed electrical capacity (Source IRP 2019)*

*Table 2: Installed new power capacity targets as per the IRP 2019 in South Africa (Source IRP 2019).*

| | Coal | Nuclear | Hydro | Storage (Pumped Storage) | PV | Wind | CSP | Gas / Diesel | Other (CoGen, Biomass, Landfill) | Embedded Generation |
|---|---|---|---|---|---|---|---|---|---|---|
| 2018 | 39 126 | 1 860 | 2 196 | 2 912 | 1 474 | 1 980 | 300 | 3 830 | 499 | Unknown |
| 2019 | 2 155 | | | | | 244 | 300 | | | 200 |
| 2020 | 1 433 | | | | 114 | 300 | | | | 200 |
| 2021 | 1 433 | | | | 300 | 818 | | | | 200 |
| 2022 | 711 | | | | 400 | | | | | 200 |
| 2023 | 500 | | | | | | | | | 200 |
| 2024 | 500 | | | | | | | | | 200 |
| 2025 | | | | | 670 | 200 | | | | 200 |
| 2026 | | | | | 1 000 | 1 500 | | 2 250 | | 200 |
| 2027 | | | | | 1 000 | 1 600 | | 1 200 | | 200 |
| 2028 | | | | | 1 000 | 1 600 | | 1 800 | | 200 |
| 2029 | | | | | 1 000 | 1 600 | | 2 850 | | 200 |
| 2030 | | | 2 500 | | 1 000 | 1 600 | | | | 200 |
| TOTAL INSTALLED | 33 847 | 1 860 | 4 696 | 2 912 | 7 958 | 11 442 | 600 | 11 930 | 499 | 2600 |
| Installed Capacity Mix (%) | 44.6 | 2.5 | 6.2 | 3.8 | 10.5 | 15.1 | 0.9 | 15.7 | 0.7 | |

Installed Capacity
Committed / Already Contracted Capacity
New Additional Capacity (IRP Update)

Within the frame of the Biomass Action Plan for Electricity Production in South Africa (BAPEPSA) in 2016/2017 it was concluded that it was not economically viable to replace coal with biomass at existing coal power stations, so at present this is not something the South African government is considering. However, with the announcement at COP26 in November 2021 that France, Germany, the UK, the US and the European Union would provide 8.5 billion US$ to support South Africa in its transition away from coal, it may become a possibility to explore.

A description of renewable energy and climate policies and measures in South Africa is available at the IEA's Policies and Measures Database:
https://www.iea.org/policies?qs=south&country=SouthAfrica%2CSouth%20Africa

Specific policies related to renewable electricity, renewable heat and transport biofuels will be highlighted in the chapters about the role of bioenergy in different sectors.

# THE CONTRIBUTION OF BIOENERGY IN NATIONAL ENERGY SUPPLY

## TOTAL ENERGY SUPPLY

The total energy supply (TES) of South Africa in 2019 amounted to 5,867 petajoule (PJ) with fossil fuels (coal, oil, gas) contributing more than 90%. Coal (4,250 PJ) is the dominant fuel, representing 72% of total energy supply. Oil products (938 PJ) represents another 16% and natural gas around 3% (167 PJ). Nuclear energy has a TES share of 2.5% at 145 PJ. Renewable energy sources represent 6.6% of total energy supply (together 386 PJ), around 85% of it being bioenergy.

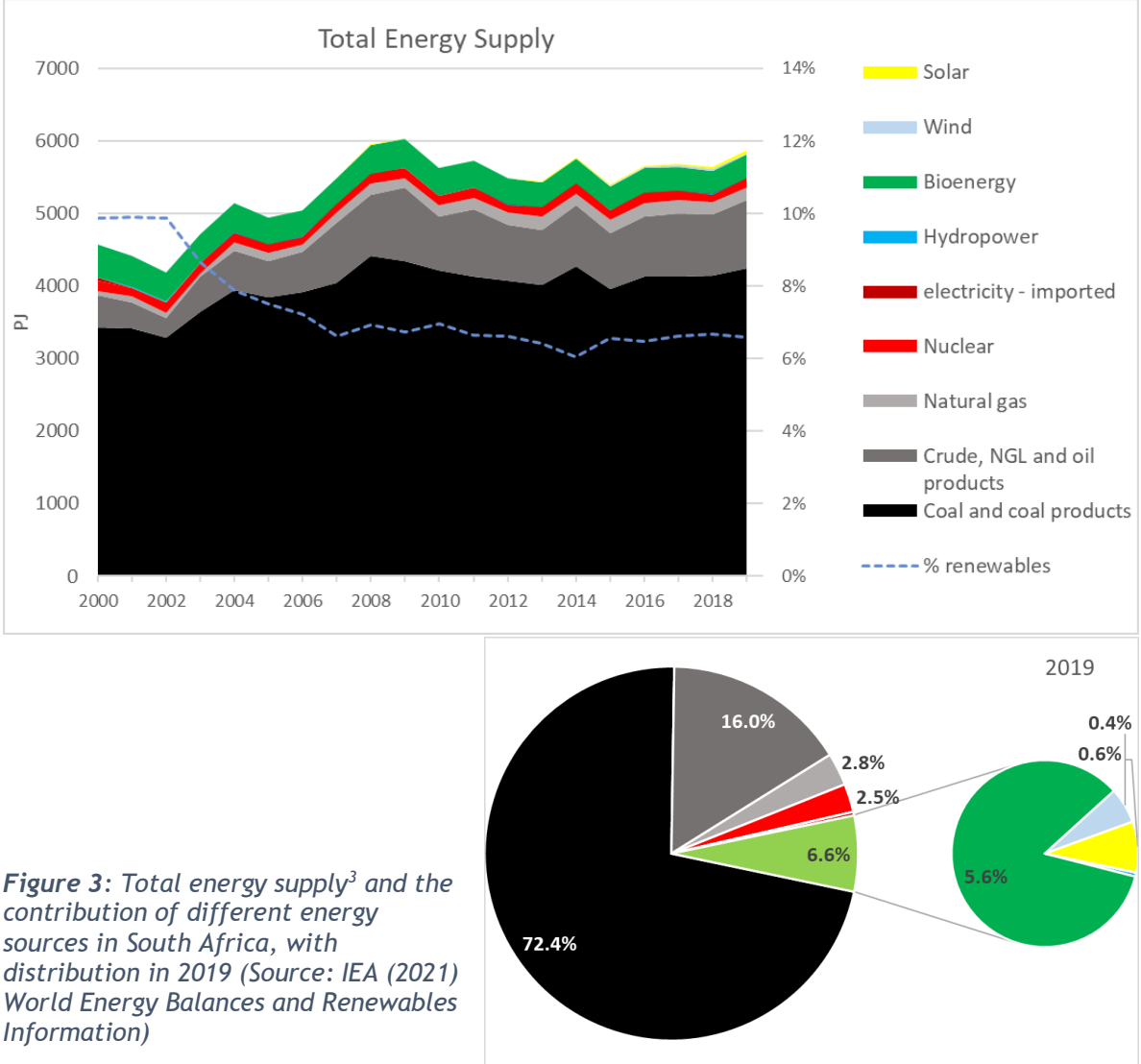


***Figure 3**: Total energy supply[3] and the contribution of different energy sources in South Africa, with distribution in 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Total energy supply in South Africa increased up to 2008 and has stabilized around 5,700 PJ since. The contributions of the different energy sources have also been fairly stable in the past decade: coal fluctuated between 4000 and 4300 PJ, representing almost three quarters of TES in South

[3] Total energy supply refers to the use of resources. In terms of the role in the energy system this distribution overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear plants).

Africa; the contribution of oil products fluctuated around 15% (750-1000 PJ); gas fluctuated between 160 and 180 PJ (3% of TES).

The contribution of renewable energy in TES went down from 10% in the early 2000s to a level of 6-7% since 2006. There is a growing level of solar and wind power, albeit at quite modest levels, now contributing around 1% of TES.

Overall, bioenergy steadily went down from 450 PJ in 2000 to 330 PJ in the past years. These are almost exclusively solid biofuels, divided between residential applications (which are steadily decreasing), industry use of biomass (which is slightly increasing) and transformation processes (mainly to charcoal, of which 30% is exported). There is no reporting of liquid biofuels or biogas.

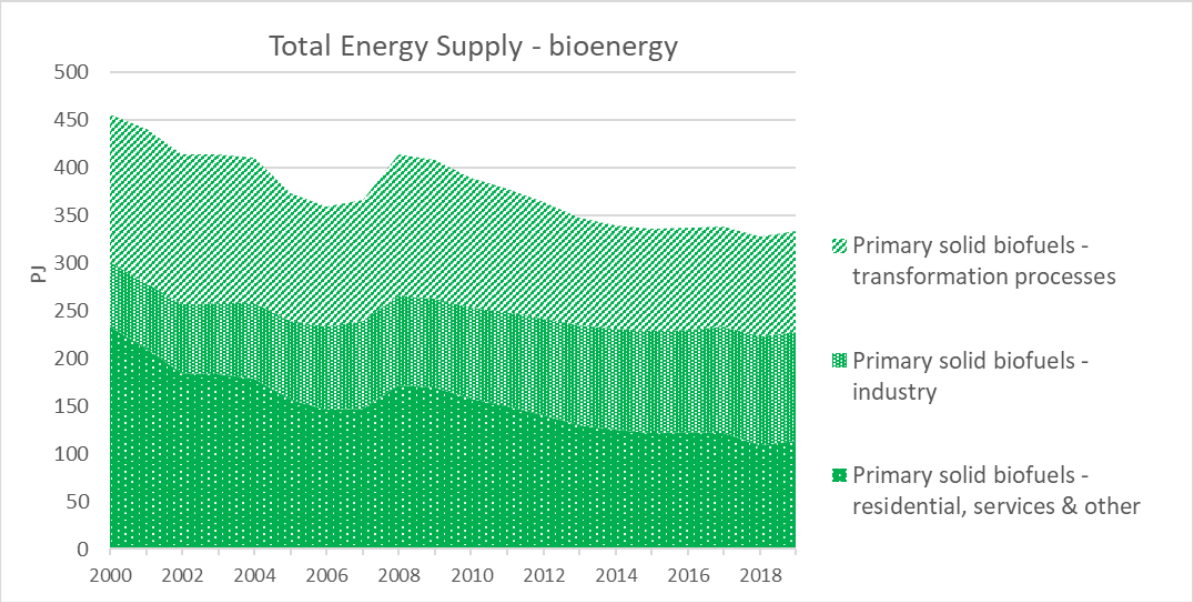


***Figure 4**: Development of total energy supply from bioenergy in South Africa 2000 – 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Table 3 displays the 2019 total bioenergy supply values on a per capita basis. Compared to the other 24 member countries of IEA Bioenergy (expressed per capita), South Africa ranks at the lower end for solid biofuels and very low for biogas, liquid biofuels and renewable MSW.

***Table 3**: Total energy supply per capita in 2019 for different bioenergy carriers*

| | Supply per capita | *Median IEA Bioenergy members* |
|---|---|---|
| **Bioenergy** | 5.7 GJ/cap | *10.6* |
| **Solid biofuels** | 5.7 GJ/cap | *7.0* |
| **Renewable MSW** | 0.0 GJ/cap | *0.8* |
| **Biogas** | 0.0 GJ/cap | *0.7* |
| **Liquid biofuels** | 0.0 GJ/cap | *1.5* |

*Source: IEA (2021) World Energy Balances and Renewables Information*

Table 4 indicates the amounts of the different bioenergy carriers compared to some relevant reference points, namely the amount of forest in the country (for solid biomass), the amount of generated MSW (for renewable MSW used for energy), the amount of natural gas consumed in the country (for biogas) and the amount of fossil oil products consumed (for liquid biofuels).

***Table 4**: Comparison of the supply of different bioenergy carriers in 2019 to specific reference points*

| | Compared to reference points | | | *Median** |
|---|---|---|---|---|
| **Bioenergy** | 5.6 | % | of total energy supply | *7.2 %* |
| **Solid biofuels** | 19.7 | GJ/ha_forest | compared to the domestic hectares of forest land (excl. protected) | *21.3 GJ/ha_forest* |
| **Renewable MSW** | 0.00 | GJ/ton_MSW | compared to the total generated MSW in the country | *1.4 GJ/ton_MSW* |
| **Biogas** | 0.000 | GJ/GJ_NG | compared to natural gas supply | *0.023 GJ/GJ_NG* |
| **Liquid biofuels** | 0.000 | GJ/GJ_oil | compared to oil products supply | *0.028 GJ/GJ_oil* |

*Source: energy data from IEA (2021) World Energy Balances and Renewables Information; forest figures from FAOStat; waste figures from World Bank*
** Median of the 25 member countries of IEA Bioenergy*[4]

Specific comments in relation to the reference points:

- The use of solid biofuels compared to the domestic forest area is modest (~1 tons_dry mass of wood per hectare[5]). Mind that solid biofuels are not only woody biomass sourced from forests, but also wood harvested from shrubs.
- Energy production from (the renewable share of) MSW has not been substantially developed yet, so major steps can be taken there.
- Liquid biofuels also have not been substantially developed, so these also have high growth potential. The same applies for biogas.

[4] Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.
[5] Counted with a typical calorific value of wood (dry mass) of 19 GJ/ton$_{\text{dry mass}}$

# ROLE OF BIOENERGY IN DIFFERENT SECTORS

## OVERVIEW

The overall 2019 share of renewables in **final energy consumption** among electricity, transportation and heat sectors is 10%, with bioenergy making up 8.5% of the energy share (Table 5). It is to note that these figures are higher than the shares in total energy supply (where unused waste heat, e.g., in fossil or nuclear power production, is also included).

***Table 5:*** *Role of bioenergy and renewable energy in electricity, transport energy and fuel/heat consumption in 2019*

| Sector | Share of bioenergy | Share of renewable energy | Overall consumption |
|---|---|---|---|
| **Electricity**[6] | 0.2% | 4.6% | 241 TWh (867 PJ) |
| **Transport energy (final consumption)** | 0.0% | 0.1% | 804 PJ |
| **Overall fuel and heat consumption**[7] | Direct biomass: 19.7% | 20.1% | 1241 PJ |
| **TOTAL FINAL ENERGY CONSUMPTION** | **8.5%** | **10.0%** | **2902 PJ** |

*Source: IEA (2021) World Energy Balances and Renewables Information*

The following paragraphs will consider the evolutions in the different sectors.

## ELECTRICITY

Power production in South Africa is dominated by coal, which produces more than 90% of electricity (220-230 TWh). Nuclear power had a share of 5-6% (11-15 TWh) in the past decade. Renewable electricity had a share of 4.5% in 2019. Since 2014 there has been a steady growth of wind and solar power, together representing 4% of electricity consumption in 2019. The contribution of biomass-based electricity is marginal (0.2%).

[6] Renewable electricity production compared to final consumption. Potential renewable shares of imported electricity are not included.

[7] This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.
Electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported.

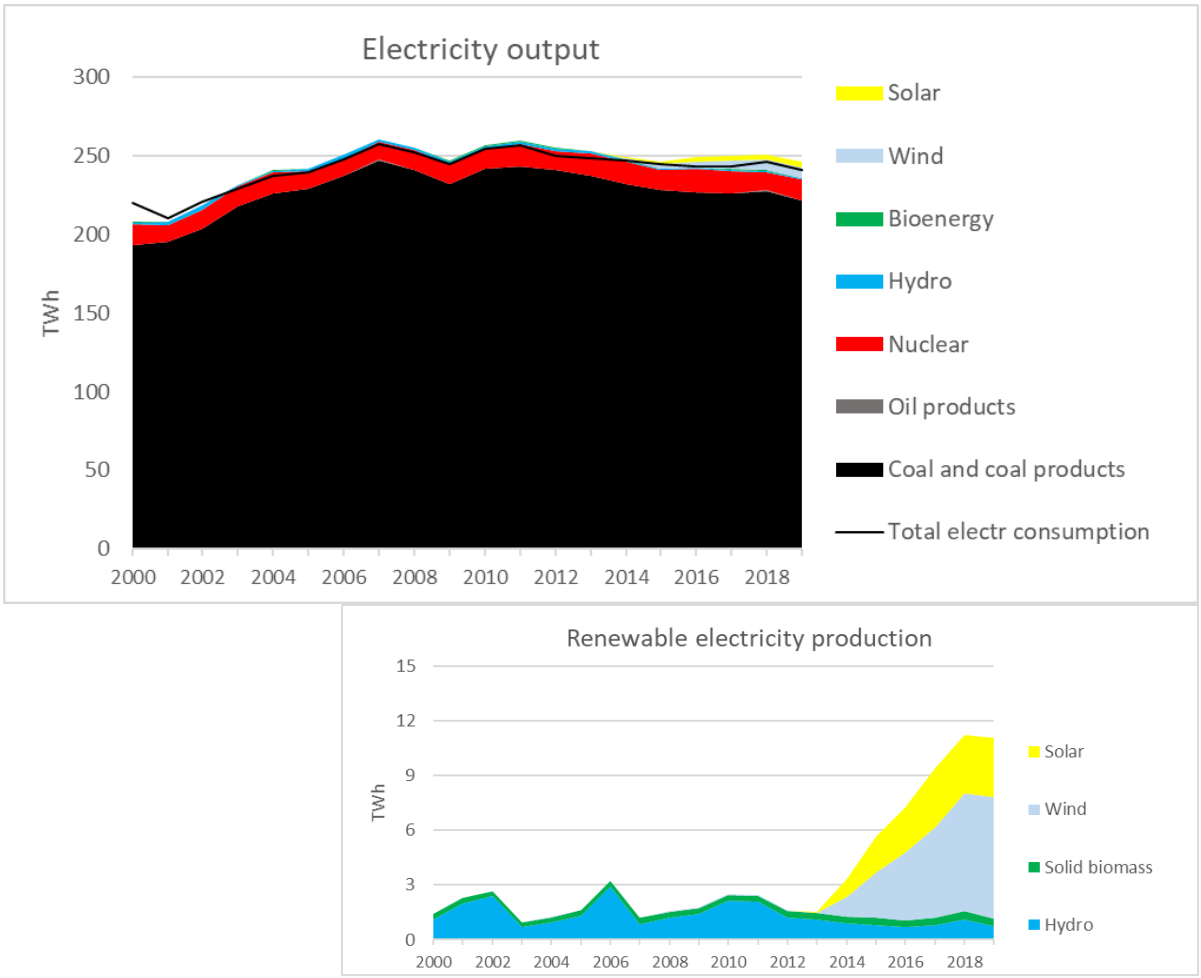


*Figure 5: Evolution of the electricity mix in South Africa 2000 – 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

**Policy framework**

The main relevant policy instruments behind these evolutions are:

- National Environmental Management Act 107 of 1998
- National Energy Act 34 of 2008
- Gas Act 48 of 2001
- National Energy Regulator Act 40 of 2004 (amendment for three states: less than 100MW does not require a NERSA generation license)
- Electricity Regulation Act, 2006
- National policy on thermal treatment of general and hazardous waste, 2009
- Department of Minerals and Energy (2003): White Paper on Renewable Energy
- National Energy Regulator of South Africa: South Africa renewable energy feed-in tariff (refit), 2009
- Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)

## HEAT/FUELS

Figure 6 shows the role of different fuels/energy carriers for providing heat in different sectors (industry, residential sector, commercial and public services and other). Fuel use by energy producing industries for transformation and for own use is excluded. Mind that electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported in the IEA database.

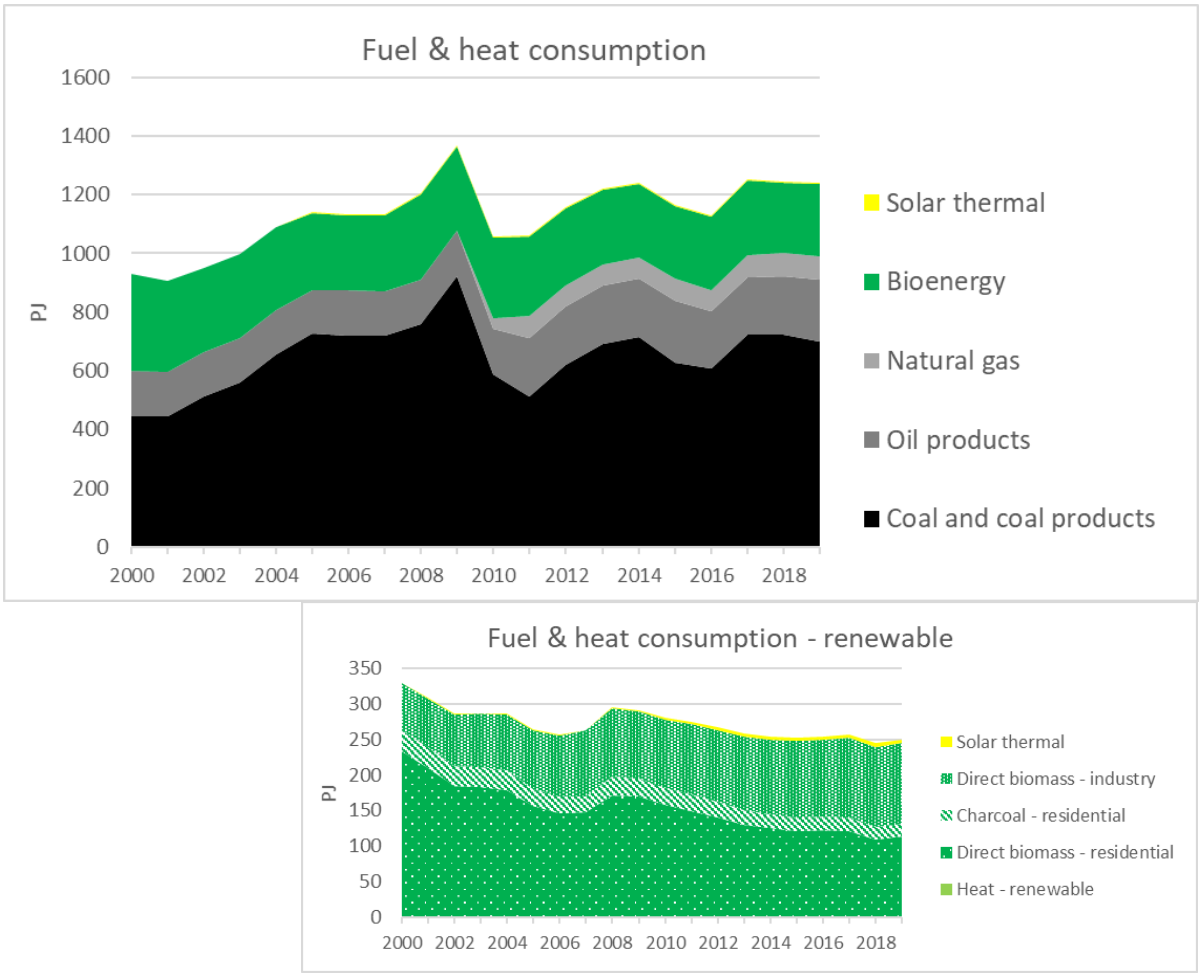


***Figure 6**: Evolution of fuel and heat consumption in South Africa 2000 – 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

The provision of heat is largely fossil fuel based, with a dominant role of coal (56%) and some oil (17%) and gas (6%). Bioenergy represents around 20% of heat provision. The use of biomass and charcoal for residential applications (mostly traditional use) is going down steadily and is partly compensated by a slightly increasing use of solid biomass as a fuel in industry. The use of biomass as a fuel is now almost equally split between industry and residential use.

There is no reporting of heat sales in South Africa.

## TRANSPORT

Figure 7 shows an overview of the energy used in transport in South Africa, split up by different fuels/energy carriers.

In the past decades transport energy steadily increased from 500 to 800 PJ. Gasoline used to be the dominant fuel, but its level was relatively stable between 320 and 380 PJ. On the other hand, diesel consumption has continued to grow from 150 PJ in 2000 to 425 PJ recently, and now represents more than 50% of transport fuels in South Africa. Other oil-based fuels (mainly jetfuel) are also relevant at 6%.

There is no reporting of biofuel use for transport.

Electricity represents a share of 1.3% of total transport energy use. This is mostly in rail – electricity use in road vehicles is still marginal at 0.02% of transport energy use.

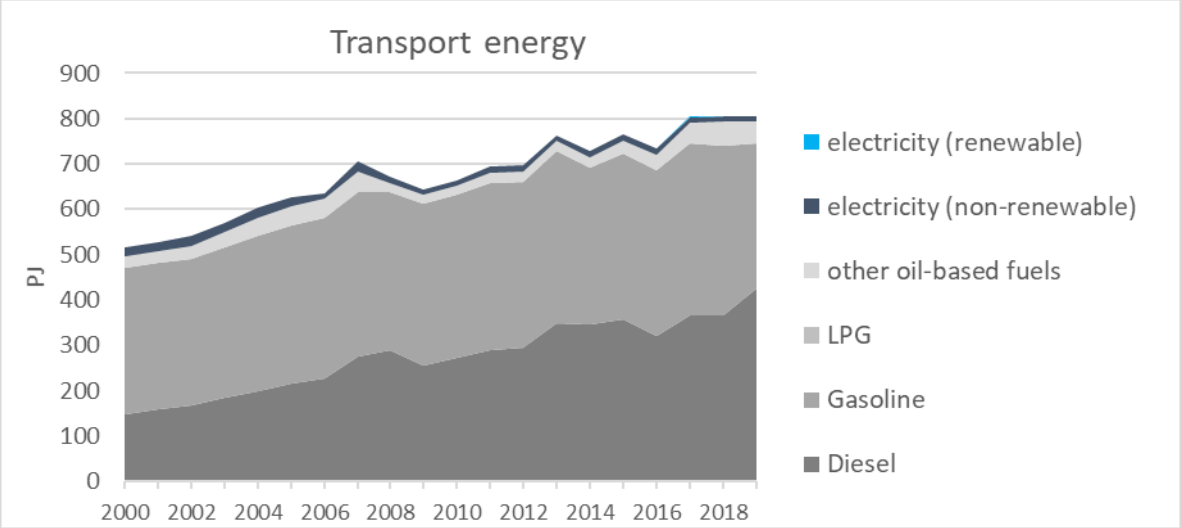


***Figure 7**: Evolution of transport fuels in South Africa 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

## RESEARCH FOCUS RELATED TO BIOENERGY

There is copious research being done at the University of KwaZulu-Natal focusing on bioenergy supported by SANEDI. Other sectors include the Council for Scientific and Industrial Research (CSIR) with the Energy Research Centre and GreenCape through the City of Cape Town.

## LINKS TO SOURCES OF INFORMATION


National Development Plan 2030: https://www.gov.za/issues/national-development-plan-2030

Department of Minerals and Energy. (2003). White Paper on Renewable Energy. Republic of South Africa. Pp.1-59. http://www.energy.gov.za/files/renewables_frame.html

Integrated Resource Plan (IRP2019): http://www.energy.gov.za/IRP/2019/IRP-2019.pdf

National Energy Regulator of South Africa. (2021). NERSA publications. Retrieved from: https://www.nersa.org.za/. (Accessed: 15 June 2021).

Department of Environmental Affairs. 2009. National Environmental Management: Waste Act: National policy on thermal treatment of general and hazardous waste. Department of Environmental Affairs, Pretoria, South Africa. https://www.groundwork.org.za/Documents/AirQuality/nemwa_national%20policy%20on%20thermal%20treatment%20of%20general%20and%20hazardous%20wast....pdf

RSA (Republic of South Africa). 1998. National Environmental Management Act, 1998 (Act 107 of 1998). Government Gazette 19519 Government Notice 1540 of 2 November of 1998. https://www.gov.za/documents/national-environmental-management-act#:~:text=to%20provide%20for%20co%2Doperative,by%20organs%20of%20stite%3B%20and

Renewable Energy Independent Power Producer Procurement Programme (REIPPPP): https://www.ipp-renewables.co.za/