

The background features a stylized graphic of the South African flag. It consists of a red upper section, a green middle section, and a blue lower section, separated by white borders. A large, stylized 'Y' shape is formed by the green and blue sections, with a yellow border and a black center. The text is overlaid on the red and green sections.

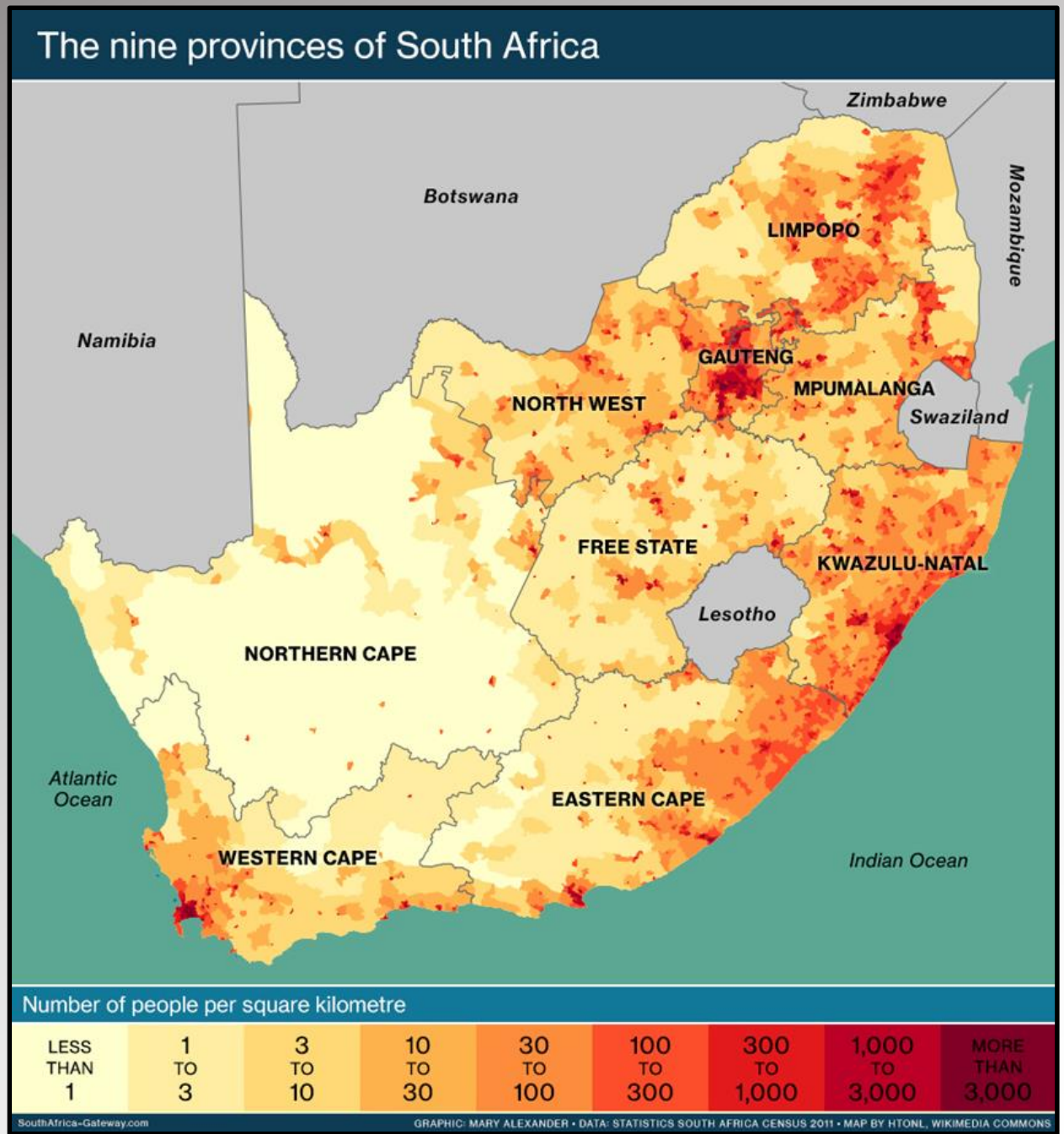
# **Energy Analysis of South Africa**

**Presented by:  
Ericka Boudreau  
Rick Butts**

# Outline

- Overview of South Africa
- Energy Summary
- Energy Policies
- Energy Infrastructure
- Load Shedding
- Overview of Coal
- Future of Coal
- Nuclear Power
- Solar Energy
- References
- World Bank Statistics
- EIA General Info
- EIA South Africa
- CDIAC
- Oil and Natural Gas
- Hydropower in South Africa
- Biomass
- Wave and Wind Energy
- Fun Facts
- References

# Overview of South Africa





# Energy Summary

Energy production  
Mtoe



**158**

↑ 37.39% from 1990

Electricity final consumption  
TWh



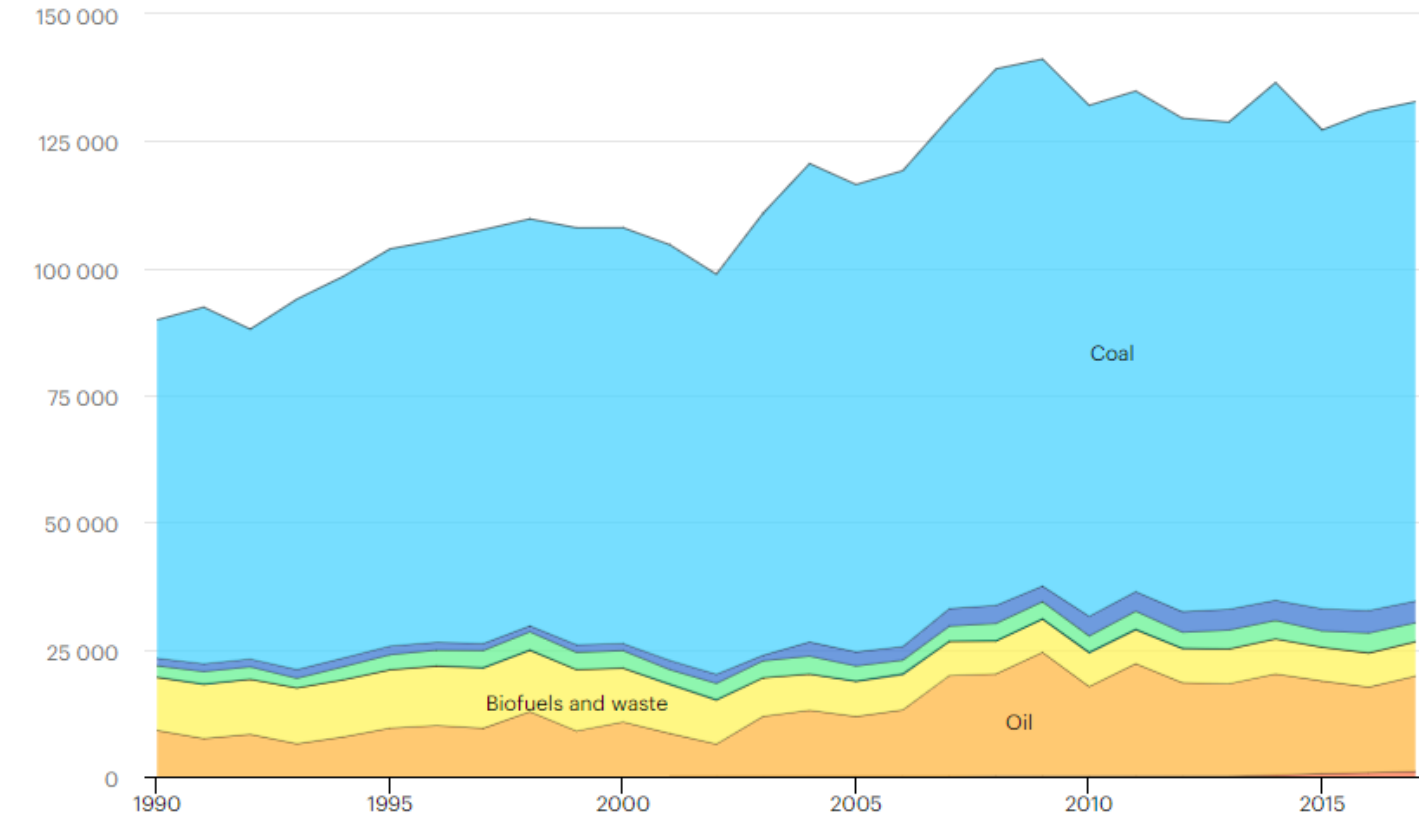
**227**

↑ 45.51% from 1990

Total primary energy supply (TPES) by source, South Africa 1990-2017

ktoe

● Coal ● Natural gas ● Nuclear ● Hydro ● Biofuels and waste ● Oil ● Wind, solar, etc.



- Total domestic electricity generation capacity is 51 GW
- Eskom is the dominant energy provider in South Africa, generating 95% of the country's electricity and supplying 45% of electricity across the African continent.
- Current access to the national power grid is 86% (April 2020 estimates from USAID)
  - With rural areas at 66% and urban areas at 93%
- There are 2.2 million households without power

# Recent Energy Policies



- **South African Carbon Tax 2019** – incentivizes high carbon-emitting businesses to adopt clean energy technology
- **The Integrated Resource Plan 2019** – increasing electricity infrastructure
- **South Africa's Low-Emission Development Strategy 2050** – plan to combat climate change

# Electricity Infrastructure

## Legend

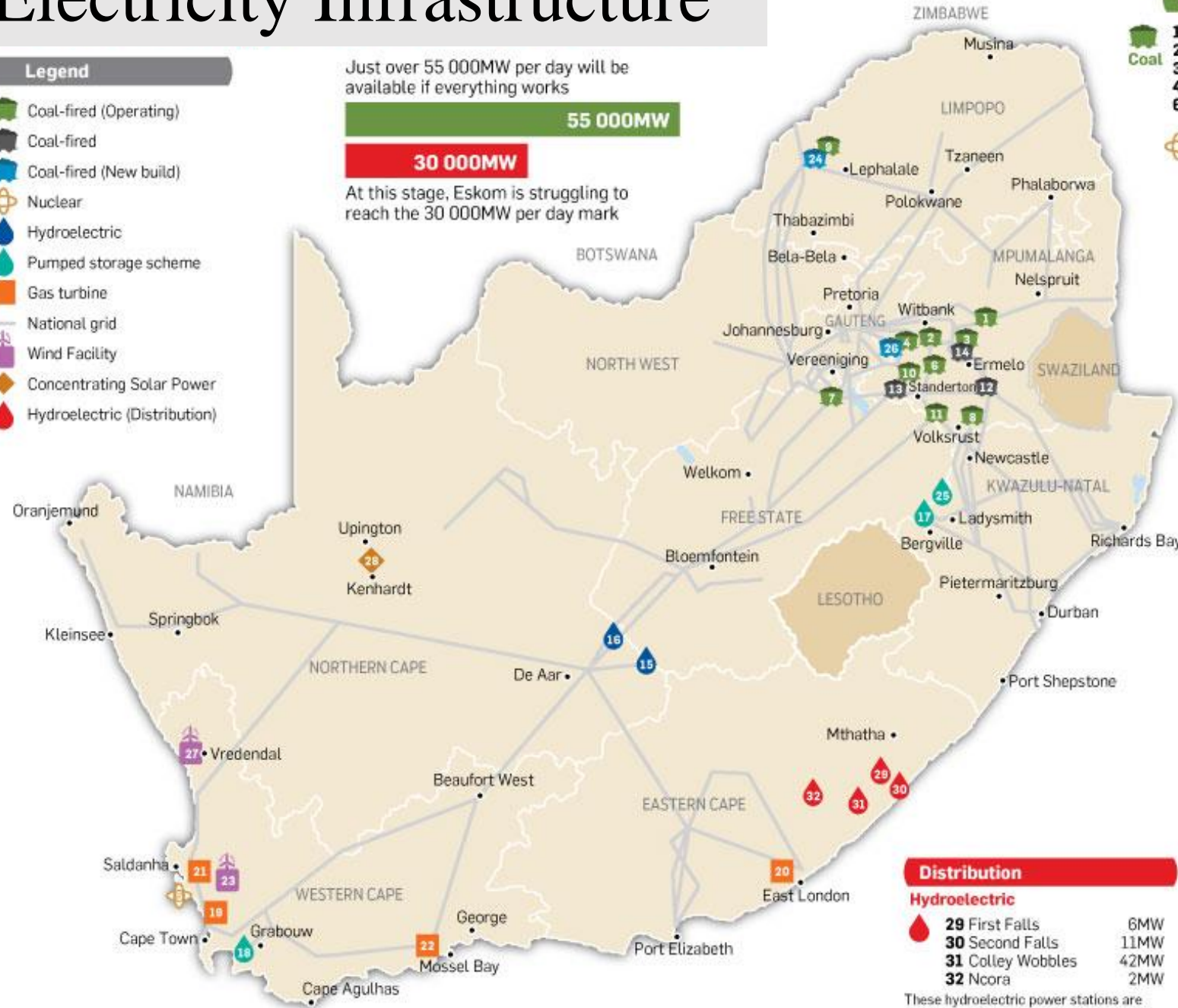
-  Coal-fired (Operating)
-  Coal-fired
-  Coal-fired (New build)
-  Nuclear
-  Hydroelectric
-  Pumped storage scheme
-  Gas turbine
-  National grid
-  Wind Facility
-  Concentrating Solar Power
-  Hydroelectric (Distribution)

Just over 55 000MW per day will be available if everything works

**55 000MW**

**30 000MW**

At this stage, Eskom is struggling to reach the 30 000MW per day mark



## Base load stations



1 Arnot	2 352MW	7 Lethabo	3 708MW
2 Duvha	3 600MW	8 Majuba	4 110MW
3 Hendrina	2 000MW	9 Matimba	3 990MW
4 Kendal	4 116MW	10 Matla	3 600MW
6 Kriel	3 000MW	11 Tutuka	3 654MW



5 Koeberg	1 940MW
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## Return-to-service stations



12 Camden	1 510MW
13 Grootvlei	1 200MW
14 Komati	940MW

## Peak demand stations

### Hydroelectric



15 Gariep	360MW
16 Vanderkloof	240MW

### Pumped storage scheme



17 Drakensberg	1 000MW
18 Palmiet	400MW

### Gas turbine



19 Acacia	171MW
20 Port Rex	171MW
21 Ankerlig	1 338MW
22 Gourikwa	746MW

## Renewable energy

### Wind Facility



23 Klipheuwel Wind Facility	3MW
-----------------------------	-----

## New builds



24 Medupi	4 788MW
26 Kusile	4 800MW

### Pumped storage scheme



25 Ingula	1 332MW
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### Wind Facility



27 Sere Wind Facility	100MW
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### Solar



28 Concentrating Solar Power	100MW
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## Distribution

### Hydroelectric



29 First Falls	6MW
30 Second Falls	11MW
31 Colley Wobbles	42MW
32 Ncora	2MW

These hydroelectric power stations are used to stabilise the distribution network in the Eastern Cape



# Load Shedding

## 02 VOLUNTARY OR CONTRACTED EMERGENCY DEMAND REDUCTION

To help balance the demand and supply of electricity. Demand Response & Emergency Demand Reduction customers are called on to reduce their demand.



## 01 TIGHT SUPPLY

The demand for electricity is high, putting pressure on supply. Emergency resources have been depleted, or there is an unexpected event such as technical issues at power stations or on major power lines.



	TYPE	QUANTITY
STAGE 1	Scheduled; Notified	≤ 1000MW to be shed
STAGE 2	Scheduled; Notified	≤ 2000MW to be shed
STAGE 3	Scheduled; Notified	≤ 3000MW to be shed
STAGE 4	Scheduled; Notified	≤ 4000MW to be shed

## 04 BLACKOUT

If preventative measures, including load shedding, are insufficient - the national grid will collapse. This incident is referred to as a blackout. A blackout is unforeseen and therefore the System Operator will not be able to make an announcement in advance.

A national blackout will have massive implications and every effort is made to avoid this occurrence.



## 05 RECOVERY

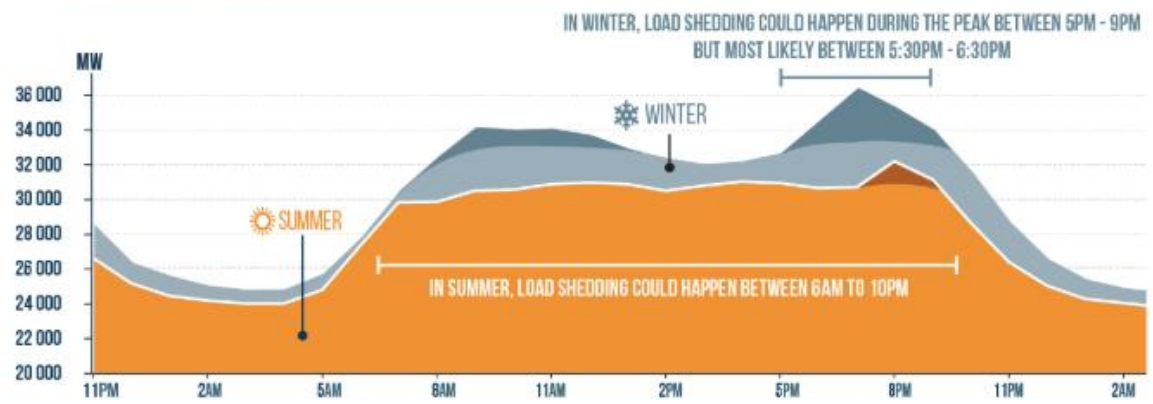
It will take a while to recover from a blackout.



Produced by BDO Cons

## WINTER AND SUMMER ELECTRICITY PROFILE

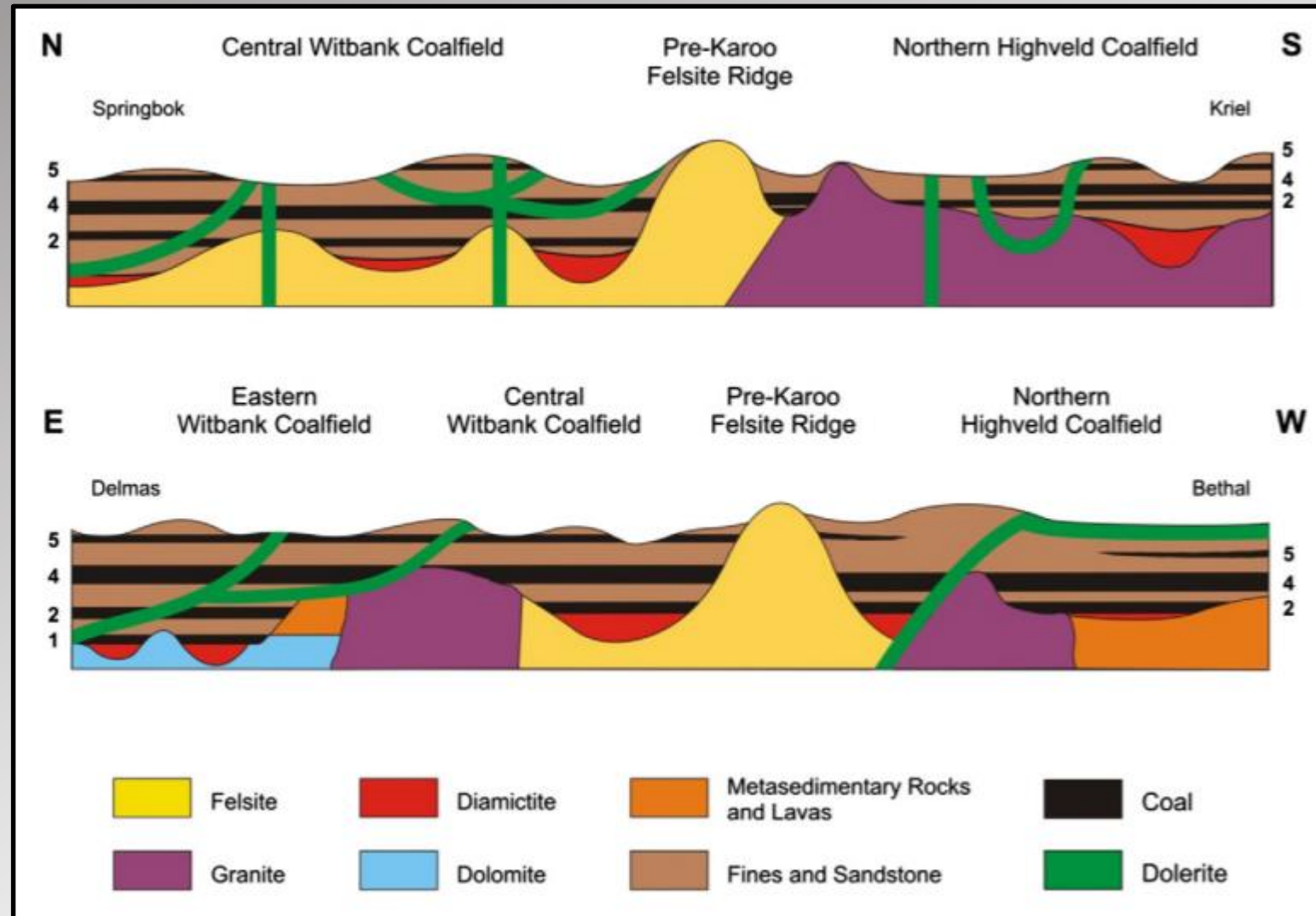
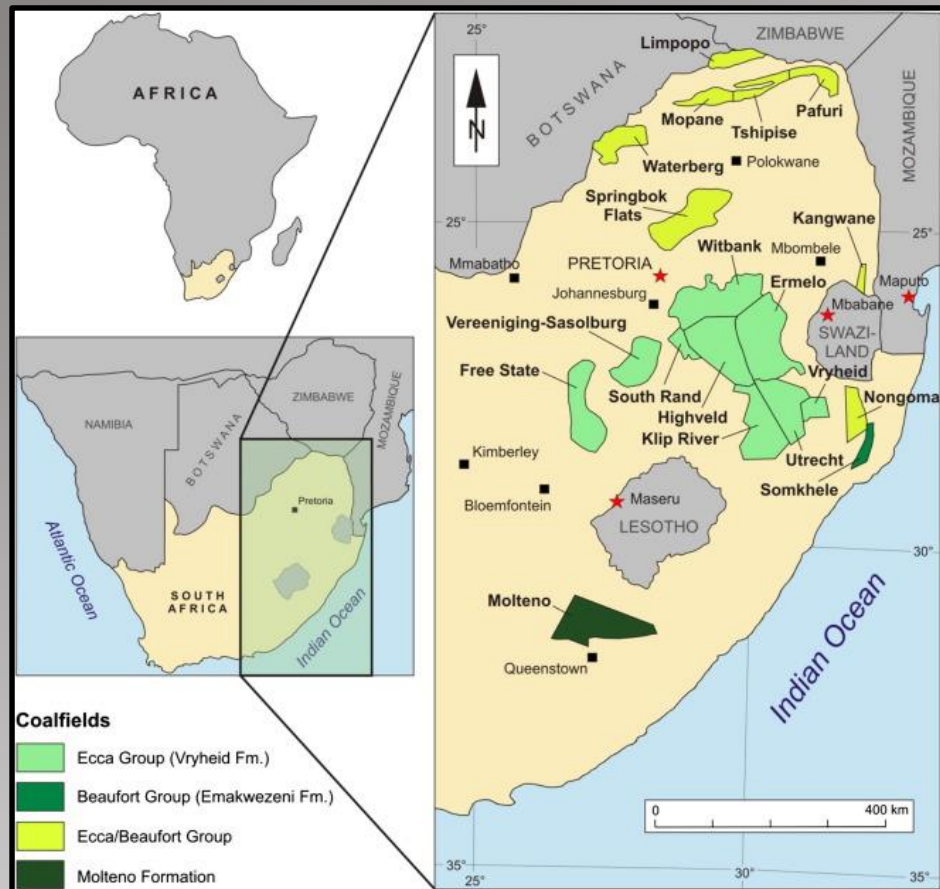
The load profile for summer and winter is different. This means that the national power system will be particularly strained during the evening peak between 5pm and 9pm in winter, and any time of the day in the summer months.



- Occurs more frequently in the summer months in order to protect critical loads
  - Drinking water supply, sewage systems, emergency services, airports, public transportation and telecommunications are all examples of critical loads.
- Situations that could cause load shedding: availability of coal, generation problems, demand prediction error, weather related issues, and supply line faults.

# Overview of Coal

(Hancox, 2014)






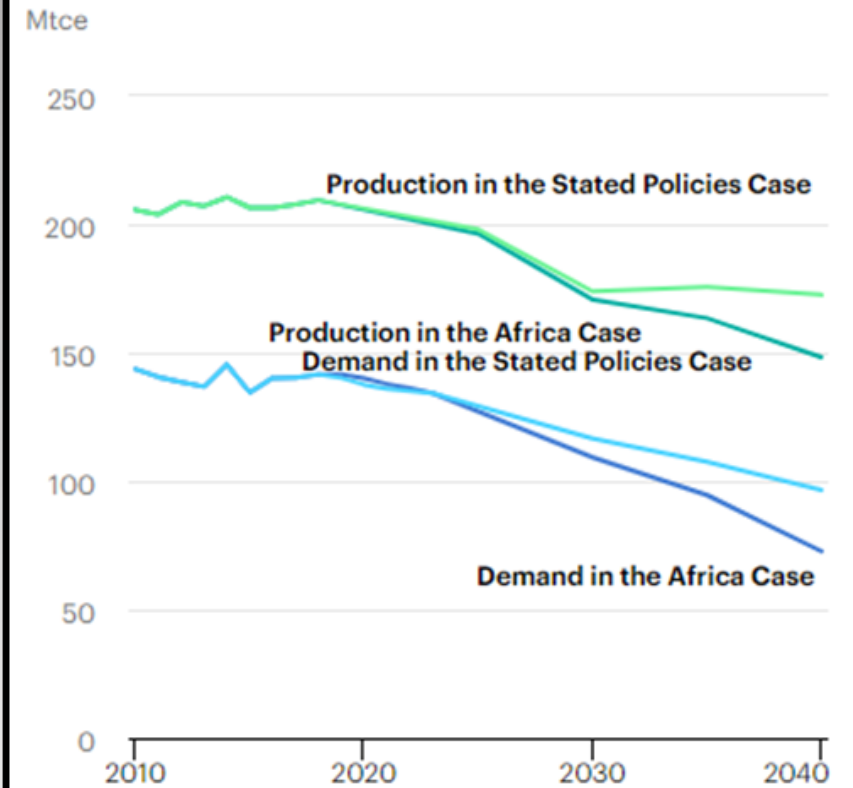
# Future of Coal

- Coal will continue to heavily contribute to energy generation, but under climate and environmental policies.
- Two new coal fired power plants are under construction and are expected to be functional by 2022.
- Use of underground coal gasification and carbon capture and storage methods to mitigate CO2 emissions.



South Africa coal demand and production by scenario, 2010-2040

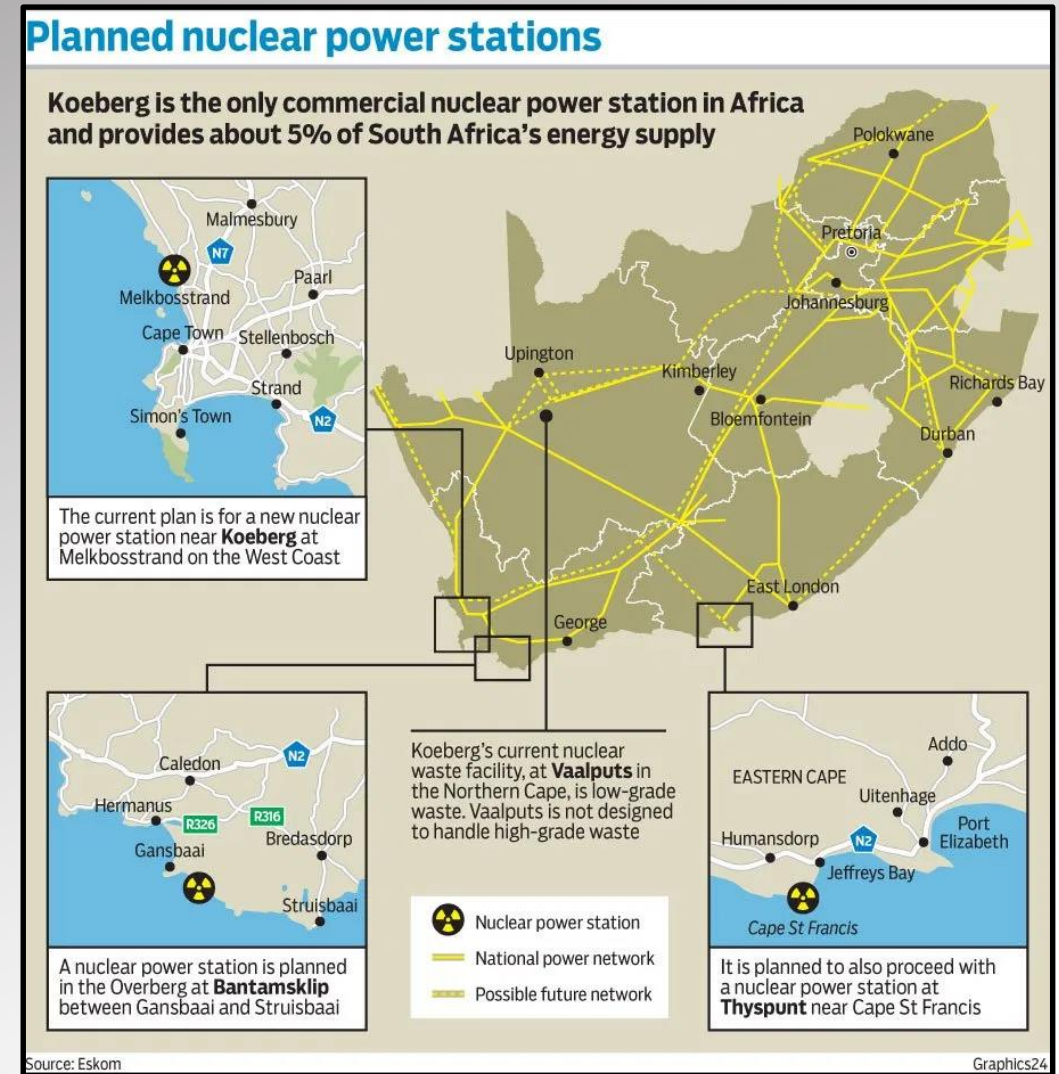
Open 



- Demand in the Stated Policies Case
- Demand in the Africa Case
- Production in the Stated Policies Case
- Production in the Africa Case

# Nuclear Power

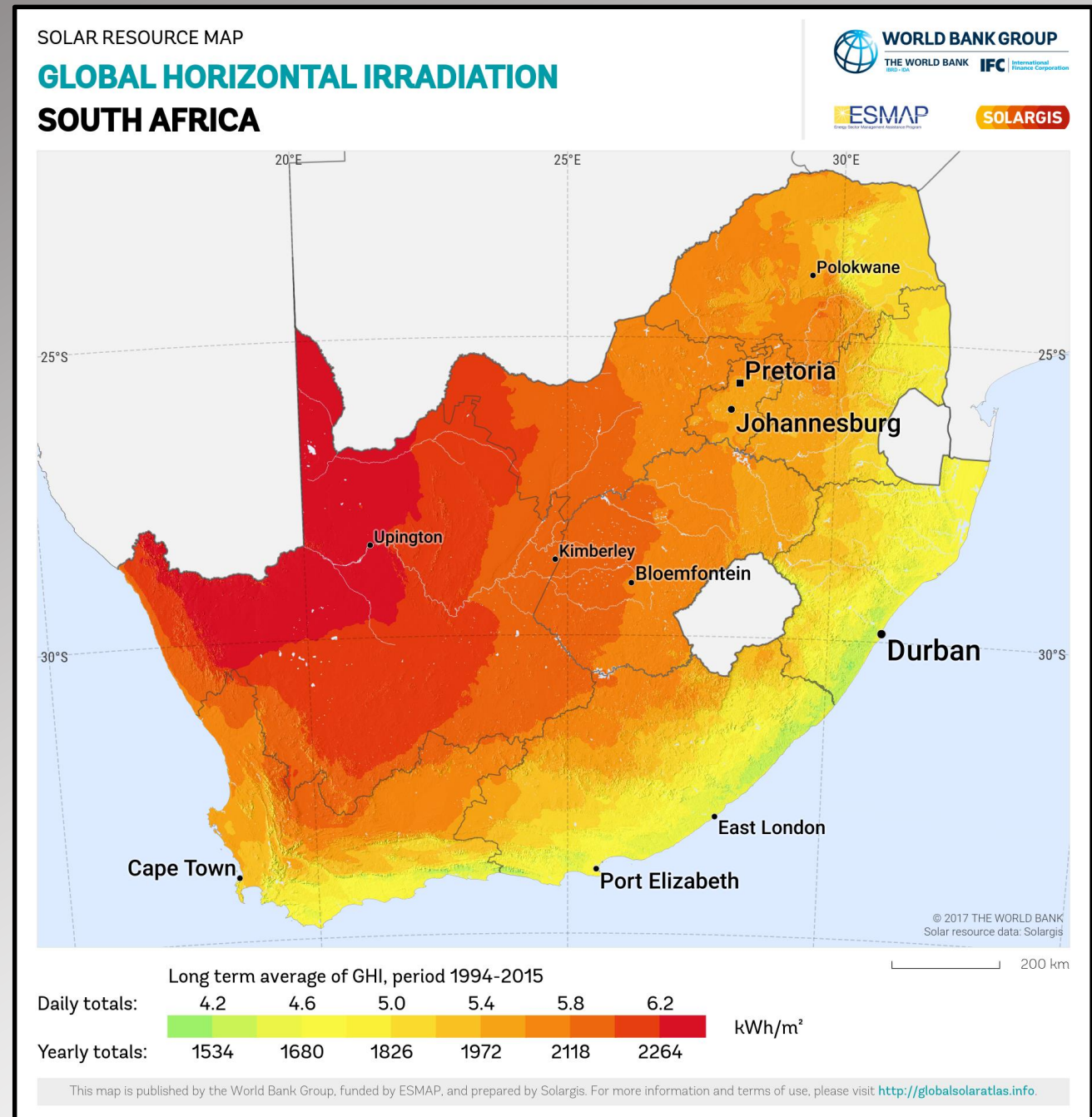
- Koeberg Nuclear Power Plant was built in the 1980's and contains 2 pressurized water reactors that each have a generation capacity of 900MW.
- In 2017, Koeberg generated 14,193 GWh for transmission to the national electrical grid.
- Plans to extend Koeberg's operating timeline and construct a new 1GW power plant will mitigate reliance on coal fire-power plants.





# Solar Energy

- In 2017, solar energy generated 2,634 GWh of electricity using PV technology.
- Construction of a concentrating solar power plant in the Northern Cape near Upington is currently underway.
- Solar PV and CSP usage will diversify grid and simultaneously stimulate the economy via new industry and job creation.
- Small roof solar panels are used instead of gasoline powered generators, in remote areas where there are no power grid connections





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- **Slide 11 –**
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  - <https://www.iea.org/articles/south-africa-energy-outlook>

Break Slide

# World Bank Statistics about South Africa

## GDP (current US\$) - South Africa

World Bank national accounts data, and OECD National Accounts data files.

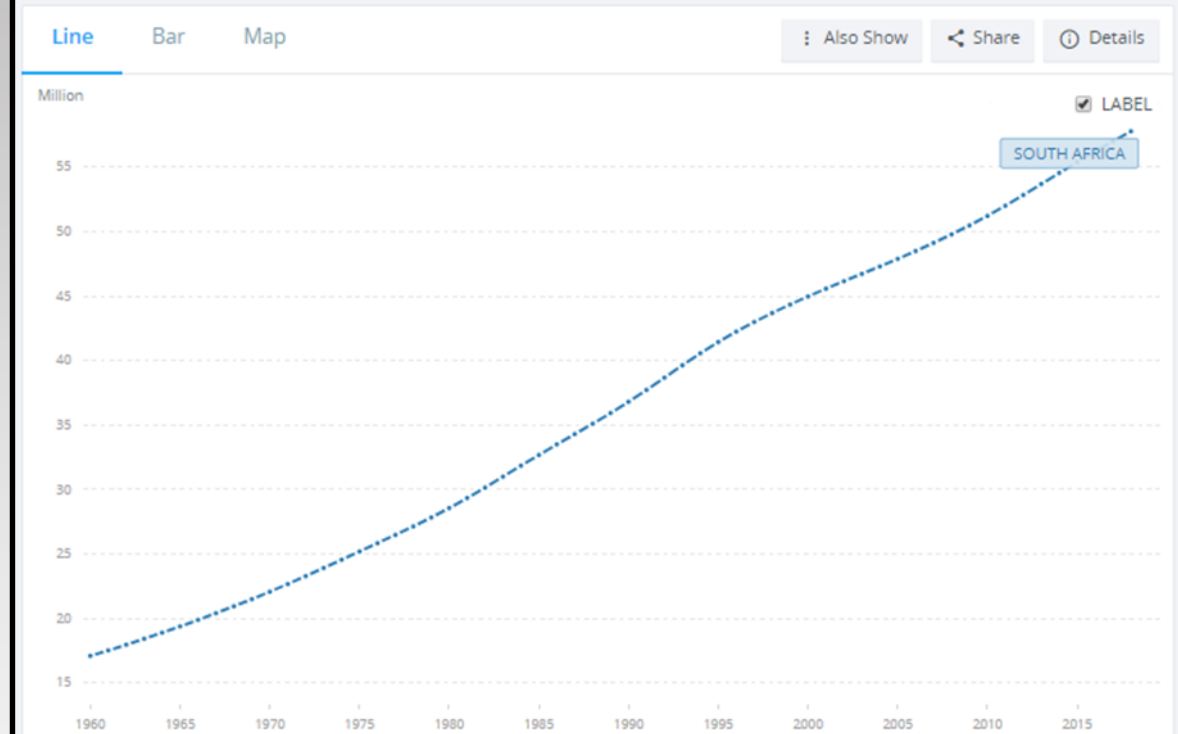
License : CC BY-4.0 [🔗](#)



## Population, total - South Africa

( 1 ) United Nations Population Division. World Population Prospects: 2019 Revision. ( 2 ) Census reports and other statistical publications from national statistical offices, ( 3 ) Eurostat: Demographic Statistics, ( 4 ) United Nations Statistical Division. Population and Vital Statistics Reprot ( various years ), ( 5 ) U.S. Census Bureau: International Database, and ( 6 ) Secretariat of the Pacific Community: Statistics and Demography Programme.

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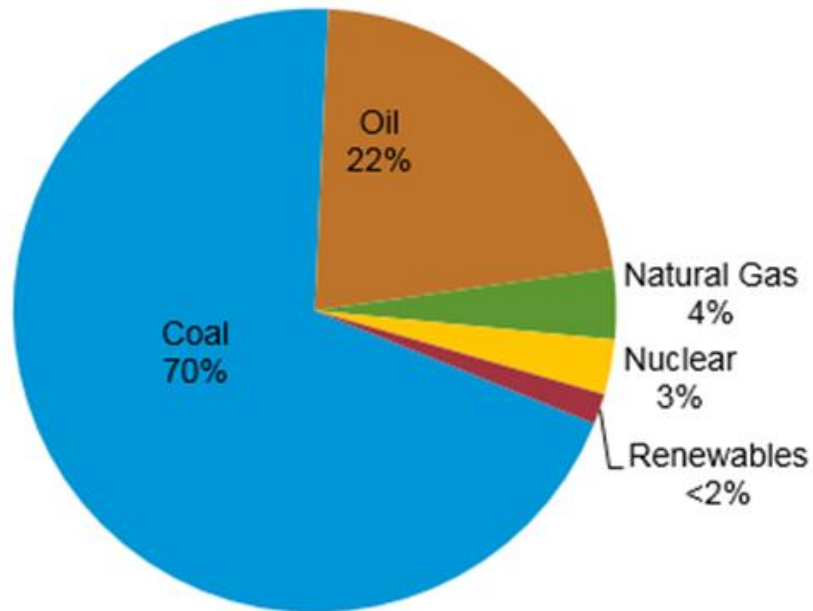




# EIA general information on South Africa's energy use through time

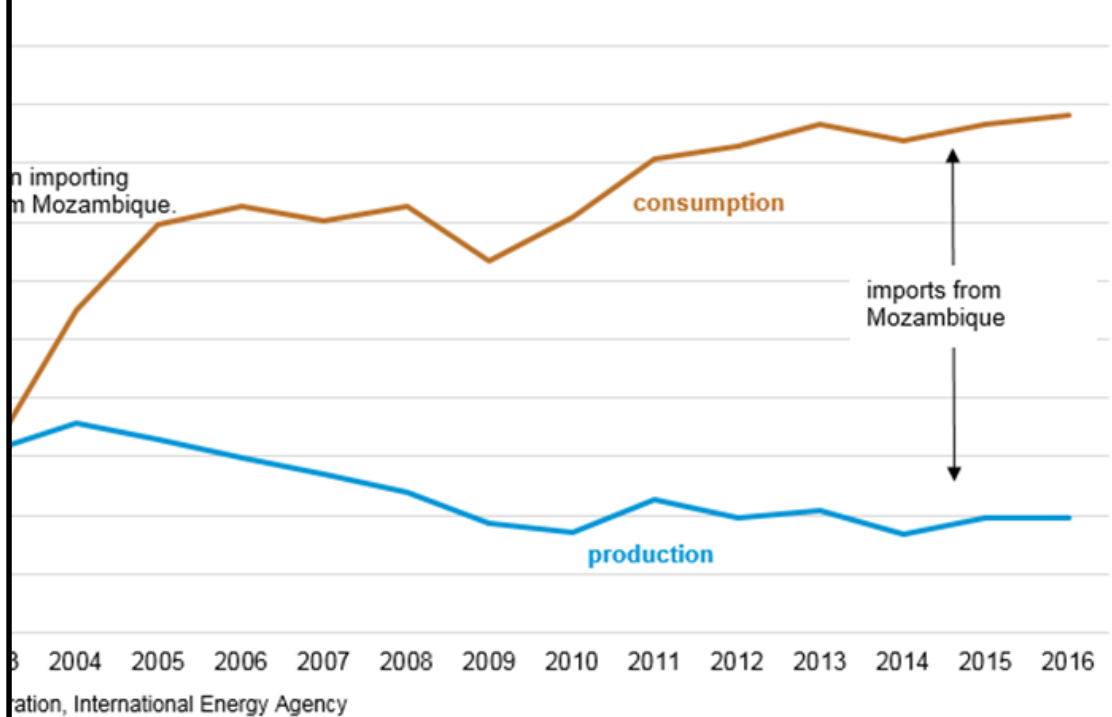
- South Africa plans on using more natural gas and renewable energy

Figure 2. Total primary energy consumption in South Africa, 2016



Note: Traditional solid biomass and waste is not included in the total.  
Source: BP Statistical Review of World Energy 2017

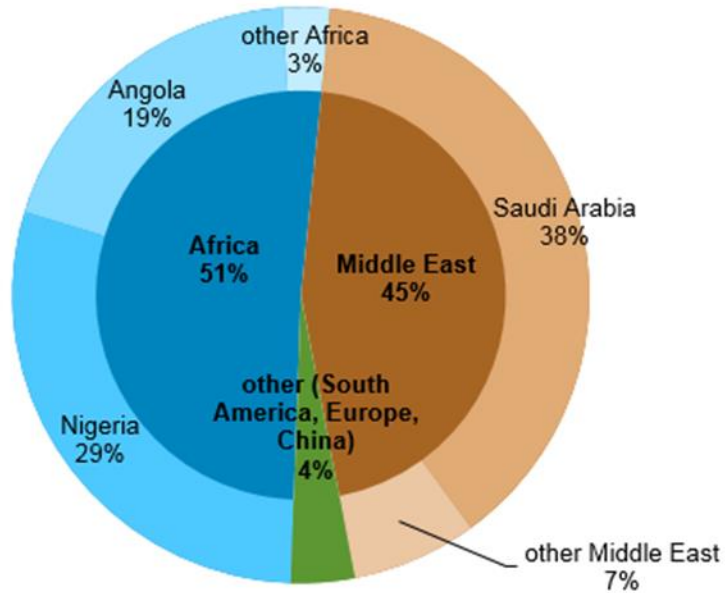
South Africa's natural gas production and consumption



International Energy Agency

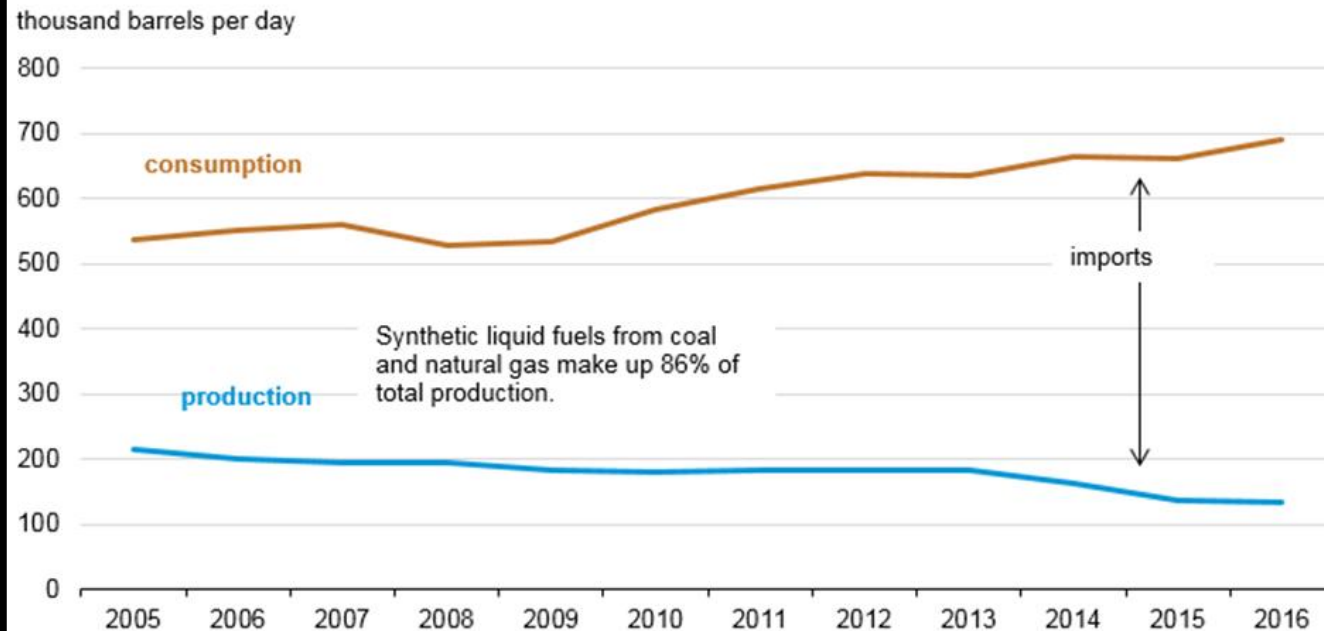
# EIA South African energy projections continued

**Figure 7. South Africa's crude oil and condensate imports, by country of origin, 2016**



Note: Total crude oil and condensate imports were 416,000 barrels per day.  
Source: Global Trade Tracker

**Figure 6. Petroleum and other liquids production and consumption in South Africa**



Source: U.S. Energy Information Administration, *Short-term Energy Outlook*, September 2017

# Carbon Dioxide Information Analysis Center (CDIAC)

Ranking of the world's countries by 2014 total CO2 emissions from fossil-fuel burning, cement production, and gas flaring. Emissions (CO2\_TOT) are expressed in thousand metric tons of carbon (not CO2).

Source: Tom Boden and Bob Andres  
Carbon Dioxide Information Analysis Center  
Oak Ridge National Laboratory

Gregg Marland  
Research Institute for Environment, Energy and Economics  
Appalachian State University

doi 10.3334/CDIAC/00001\_V2017

RANK	NATION	CO2_TOT
1	CHINA (MAINLAND)	2806634
2	UNITED STATES OF AMERICA	1432855
3	INDIA	610411
4	RUSSIAN FEDERATION	465052
5	JAPAN	331074
6	GERMANY	196314
7	ISLAMIC REPUBLIC OF IRAN	177115
8	SAUDI ARABIA	163907
9	REPUBLIC OF KOREA	160119
10	CANADA	146494
11	BRAZIL	144480
12	SOUTH AFRICA	133562

Ranking of the world's countries by 2014 per capita fossil-fuel CO2 emission rates. National per capita estimates (CO2\_CAP) are expressed in metric tons of carbon (not CO2).

Source: Tom Boden and Bob Andres  
Carbon Dioxide Information Analysis Center  
Oak Ridge National Laboratory

Gregg Marland  
Research Institute for Environment, Energy and Economics  
Appalachian State University

doi 10.3334/CDIAC/00001\_V2017

RANK	NATION	CO2_CAP
1	QATAR	13.54
2	CURACAO	10.30
3	TRINIDAD AND TOBAGO	9.32
4	KUWAIT	6.93
5	UNITED ARAB EMIRATES	6.34
6	BAHRAIN	6.28
7	BRUNEI (DARUSSALAM)	5.95
8	SAINT MARTIN (DUTCH PORTION)	5.31
9	SAUDI ARABIA	5.31
10	FALKLAND ISLANDS (MALVINAS)	5.16
11	LUXEMBOURG	4.73
12	NEW CALEDONIA	4.50
13	GIBRALTAR	4.50
14	UNITED STATES OF AMERICA	4.43
15	AUSTRALIA	4.17
16	CANADA	4.12
17	ESTONIA	4.04
18	OMAN	3.94
19	KAZAKHSTAN	3.90
20	BONAIRE, SAINT EUSTATIUS, AND SABA	3.62
21	TURKMENISTAN	3.52
22	FAEROE ISLANDS	3.39
23	PALAU	3.37
24	ST. PIERRE & MIQUELON	3.33
25	RUSSIAN FEDERATION	3.24
26	REPUBLIC OF KOREA	3.20
27	TAIWAN	3.08
28	SINGAPORE	2.79
29	NETHERLANDS	2.70
30	ANGUILLA	2.66
31	MONTSERRAT	2.63
32	JAPAN	2.61
33	NORWAY	2.52
34	BERMUDA	2.51
35	CAYMAN ISLANDS	2.50
36	CZECH REPUBLIC	2.50
37	LIBYAN ARAB JAMAHIRIYAH	2.48
38	SOUTH AFRICA	2.47



# Oil and Natural Gas

Economist.com has an article about new oil and gas exploration in South Africa.

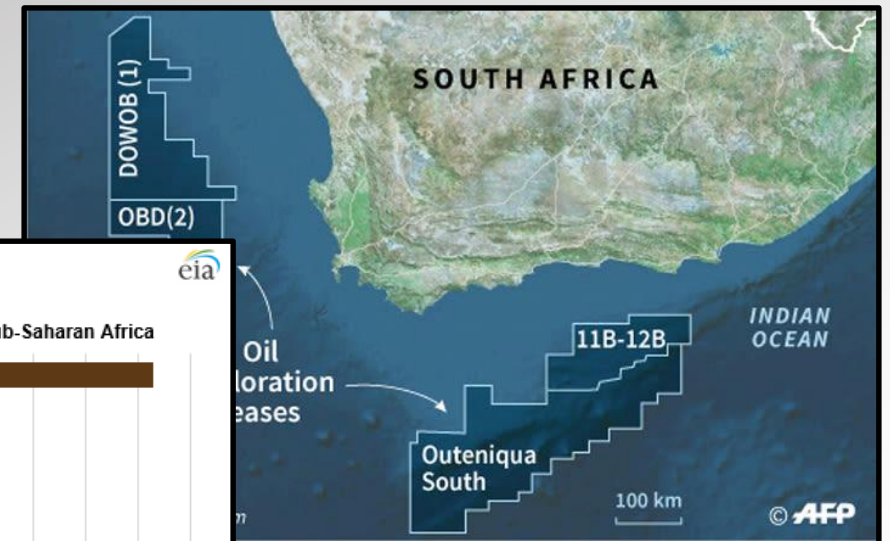
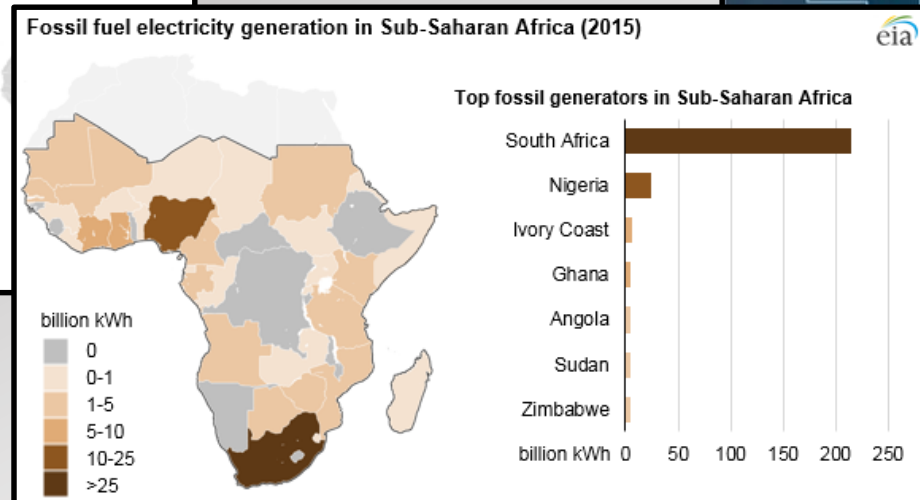
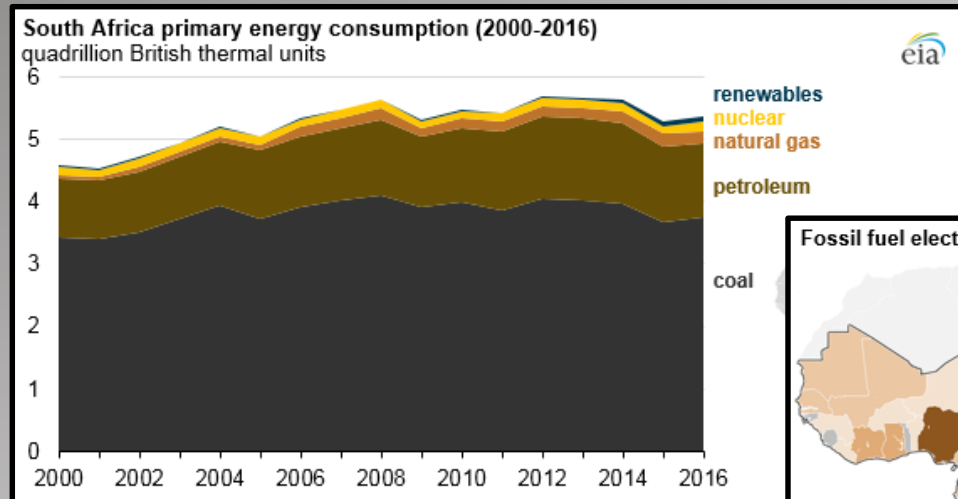
Government funding and involvement is important to ensure the project is properly implemented and economic, rather than bailing out private industry if oil wells turn up dry.

There is concern for transportation with oil 1000km away from some localities that could benefit from this added resource.

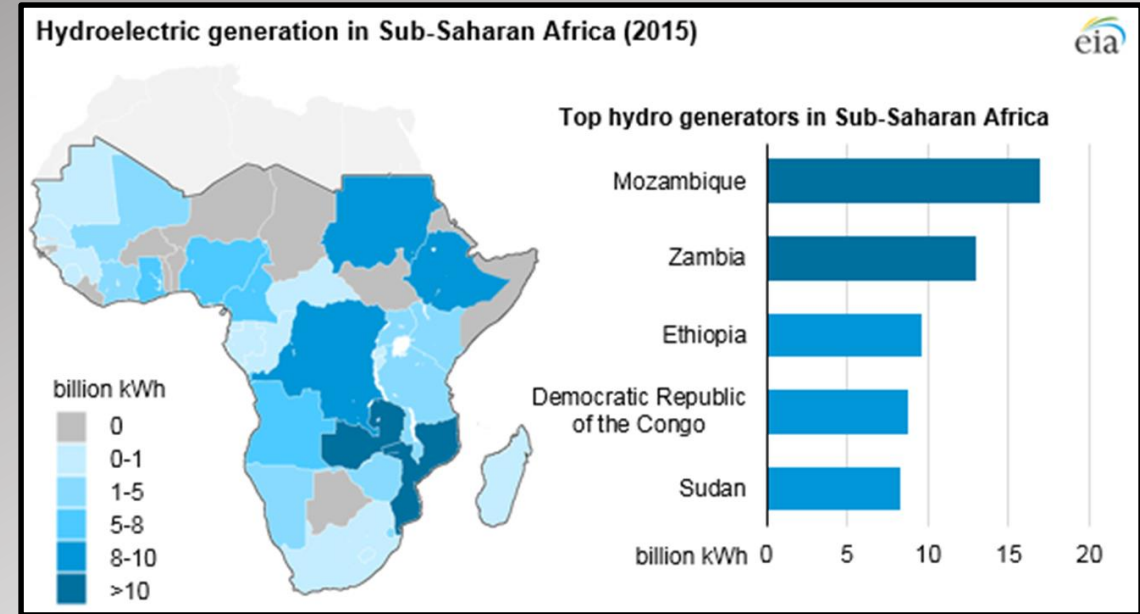
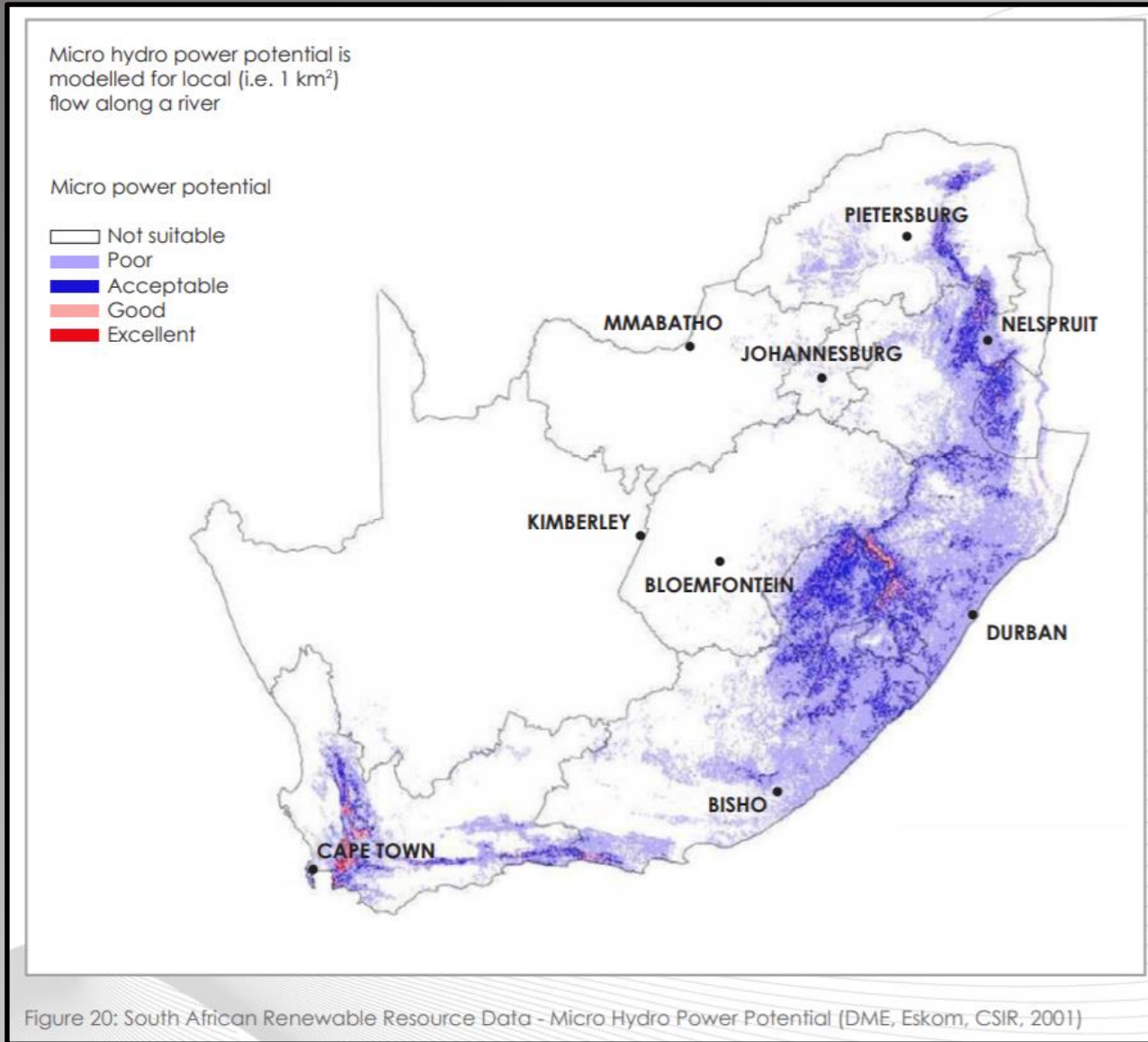
Investment in South African oil from other African countries is more likely when the market price for barrels of oil is higher.

South Africa does not produce their own oil yet. 60% of their oil is imported from other African countries and the Middle East (sapia.org).

In 2003, South Africa extracted “930 000 tonnes of natural gas and 104 000 tonnes of associated condensate” (energy.gov). Natural gas contributes 4% of total primary energy consumption in South Africa (eia.gov)



# Hydropower in South Africa



Colley Wobbles: 42MW  
 Second Falls: 11MW  
 First Falls: 6MW  
 Ncora: 2MW (eia.gov)

# Biomass

South Africa has 42 million hectares of forest, 1.35 million hectares of agriculture, and 1.2 million tons of wood  
pubs.iied.org.

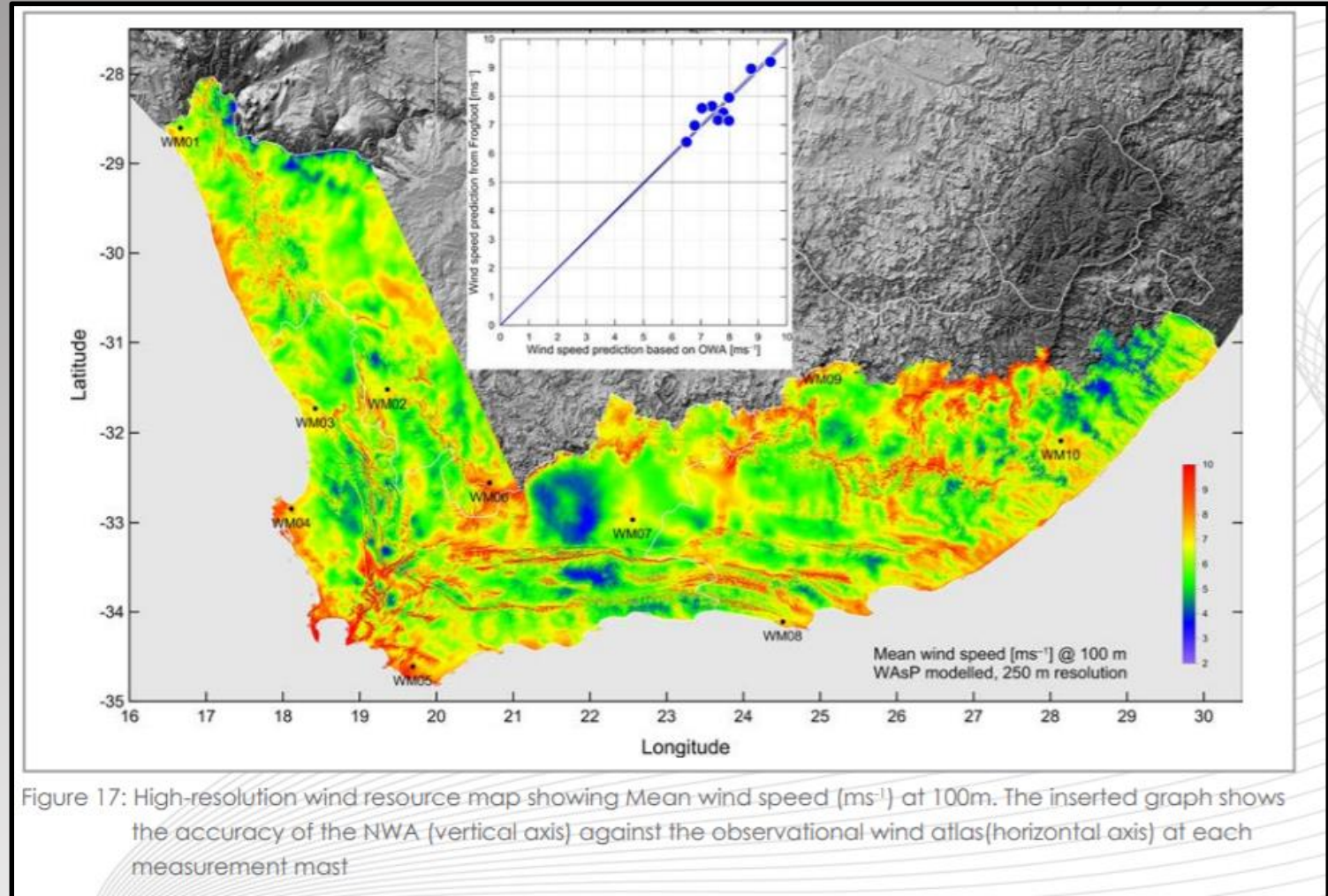
“Fast wood monocultures. These plantations are typically used to produce paper, charcoal, and wood-based panels; the most common species are eucalyptus (especially in Brazil, India, and South Africa) and acacia (mostly in south and southeast Asia). The impact of fast wood monocultures varies depending on prior uses of the land: in Brazil, for instance, fast wood plantations are most often grown on former pastures, while in Southeast Asia they often replace natural forests and have become a major driver of deforestation.” (Union of Concerned Scientists)





# Wave and Wind Energy

- esi-Africa.com states that in 2015 an ocean wave power plant project began.
- South Africa has almost 3,000km of coastline.
- The project projected revenue of \$140 million.
- South Africa has a potential of 35-50MW/Km, 56800MW along the entire coast, and 8-10GW for South African electricity (Fourie and Johnson 2017)



# Fun Facts

- Some houses in South Africa are designed to have large thermal masses to store heat energy.
- The Sun shines in windows during the day for solar gain. The houses cool at night.
- Coastal South Africa is a good location for wind energy.
- Mississippi Valley type ore deposits with lead and zinc can be found in South Africa.
- The Bushveld Complex in South Africa is a large igneous province with Pt, V, and Pd ore.
- Diamonds are found in kimberlite pipes at the Kaapvaal Craton in South Africa, uniformly distributed over basement rock formed in high pressure temperature conditions.
- South African gold mine goes a mile below the surface with fans to cool it off.

Source: Lecture for Energy and Environment course by Dr. Eby, Professor at UMASS Lowell, Personal Communication

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<https://www.eia.gov/todayinenergy/detail.php?id=34752>

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Fossil Fuel and Hydroelectric: <https://www.eia.gov/todayinenergy/detail.php?id=37153>

<https://www.eia.gov/international/analysis/country/ZAF>

Biomass: <https://pubs.iied.org/pdfs/17165IIED.pdf>

Wave and Wind: <https://www.esi-africa.com/top-stories/south-africa-wave-energy-power-plant-development/>

[https://www.esrl.noaa.gov/gmd/grad/meetings/BSRN2018\\_documents/Solar%20Radiometric%20Activities%20at%20De%20Aar,%20South%20Africa%20\(Brighton%20Mabasa\)%20.pdf](https://www.esrl.noaa.gov/gmd/grad/meetings/BSRN2018_documents/Solar%20Radiometric%20Activities%20at%20De%20Aar,%20South%20Africa%20(Brighton%20Mabasa)%20.pdf)

Fourie, Stoffel & Johnson, David. (2017). The Wave Power Potential of South Africa.

[https://www.researchgate.net/publication/318599488\\_The\\_Wave\\_Power\\_Potential\\_of\\_South\\_Africa](https://www.researchgate.net/publication/318599488_The_Wave_Power_Potential_of_South_Africa)

<https://archive.is/20140202144236/https://www.sait.org.za/indy/ener/wind/af/sa/index.htm>

Lecture notes

Google images Biomass: [https://www.energydigital.com/sites/default/files/styles/slider\\_detail/public/bizklik-drupal-prod/topic/image/article\\_im3334\\_Biomassplant.jpg?itok=3rqsDx](https://www.energydigital.com/sites/default/files/styles/slider_detail/public/bizklik-drupal-prod/topic/image/article_im3334_Biomassplant.jpg?itok=3rqsDx)

Nuclear: <https://businesstech.co.za/news/wp-content/uploads/2014/09/Nuclear.png>

Coal: [https://steelguru.com/uploads/news/richards-bay-coal-terminal-rbct-transnet-freight-rail-tfr-thermal-coking-coal-coal-news-south-africa-coal-sector-south-africa\\_65396.jpg](https://steelguru.com/uploads/news/richards-bay-coal-terminal-rbct-transnet-freight-rail-tfr-thermal-coking-coal-coal-news-south-africa-coal-sector-south-africa_65396.jpg)

Oil and Gas: [https://cdn.primedia.co.za/primedia-broadcasting/image/upload/c\\_limit,fl\\_progressive,q\\_80,w\\_700/u2ptkcoww7iovujoirdw.jpg](https://cdn.primedia.co.za/primedia-broadcasting/image/upload/c_limit,fl_progressive,q_80,w_700/u2ptkcoww7iovujoirdw.jpg)

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Charl du Toit, personal communication

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