Energy Analysis of South Africa

Presented by:

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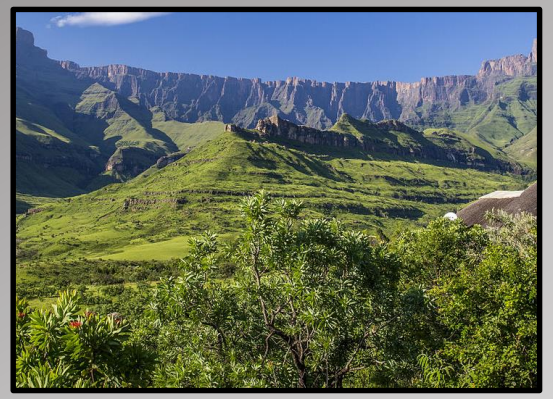
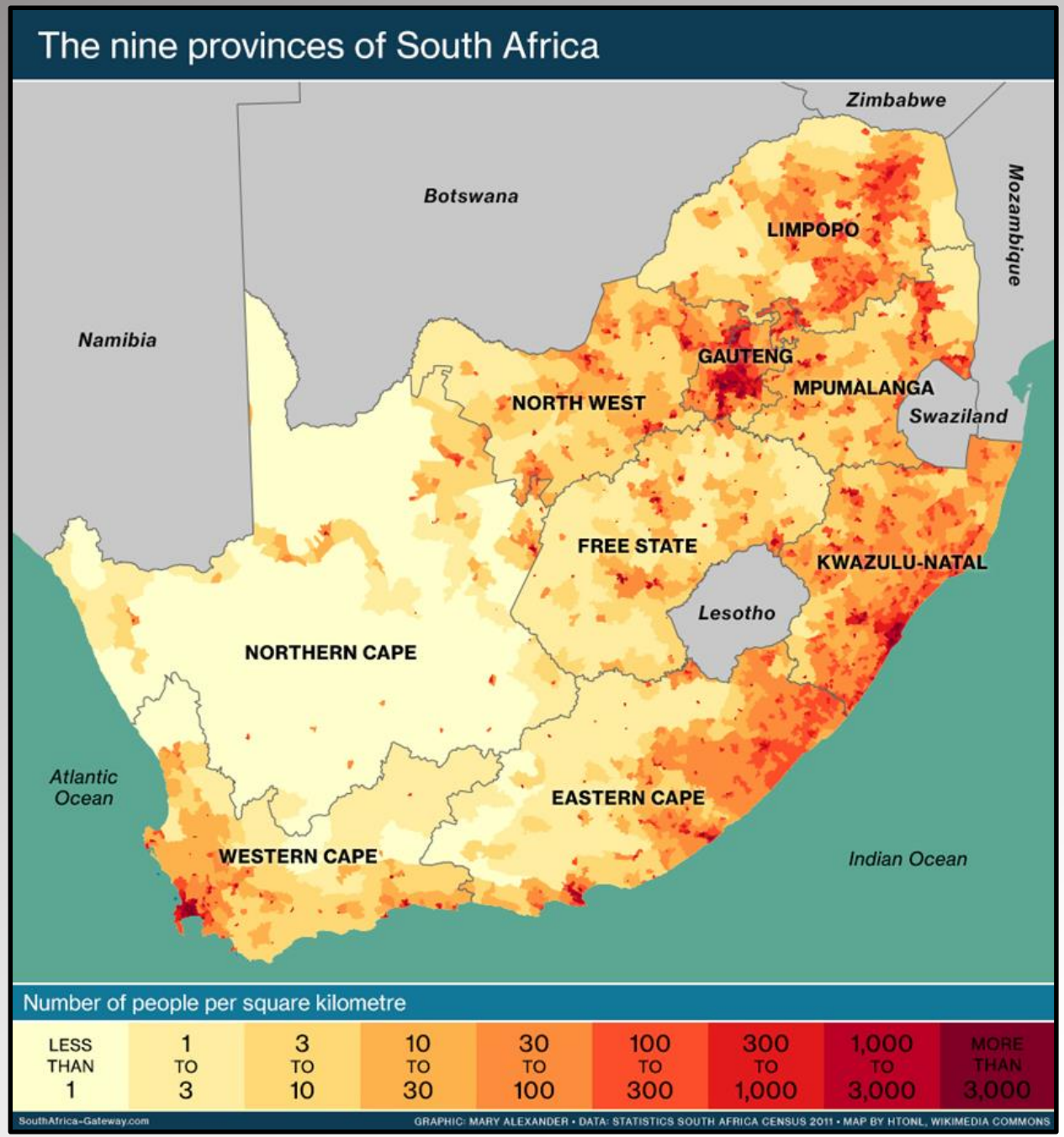
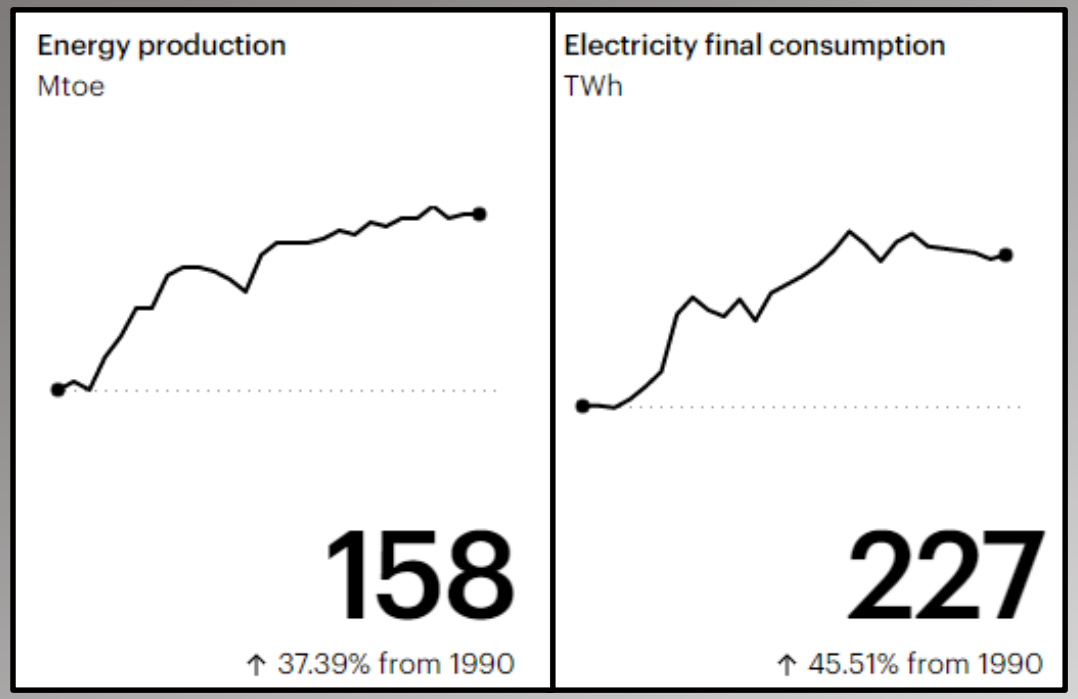
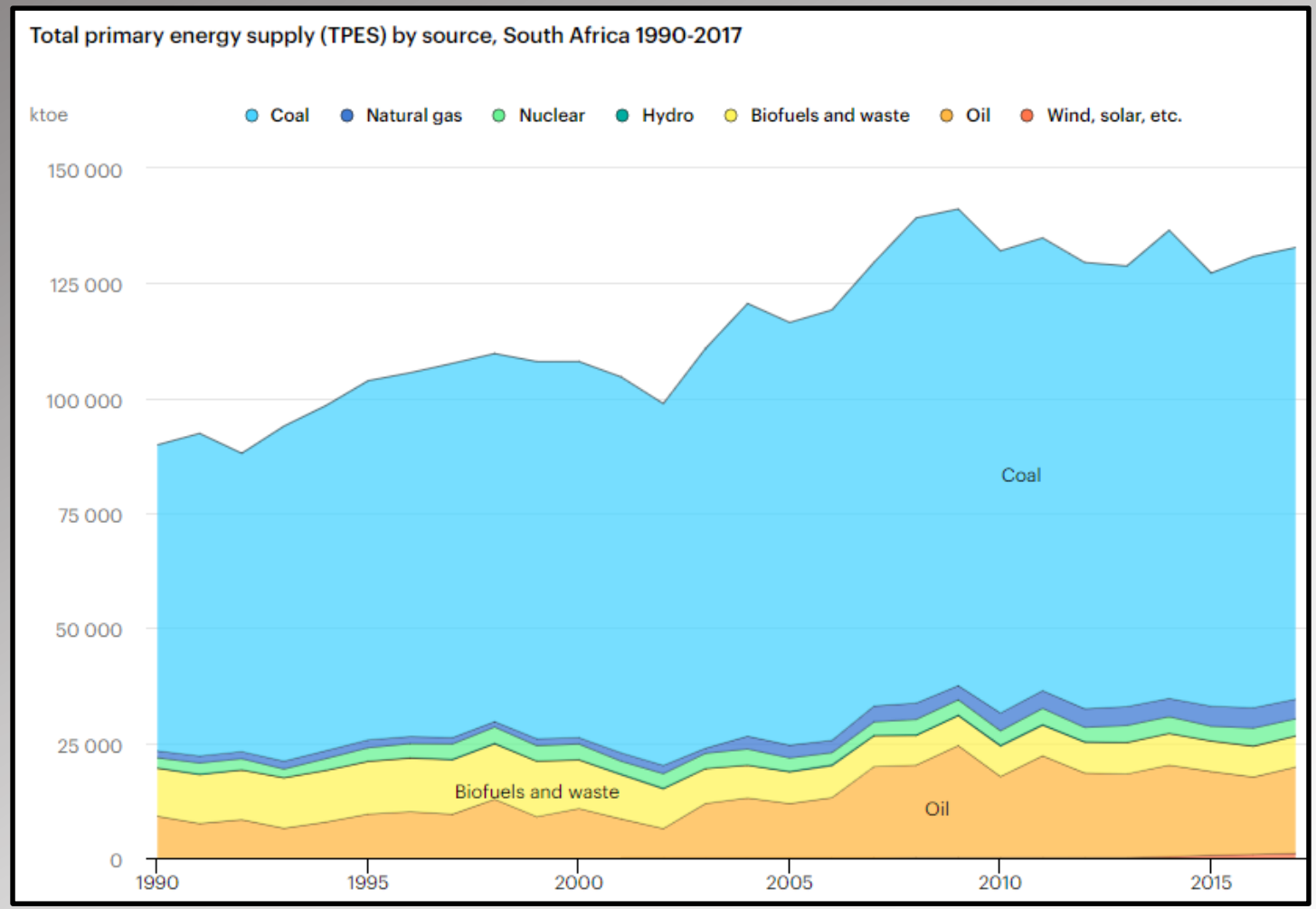
Overview of South Africa





Energy Summary



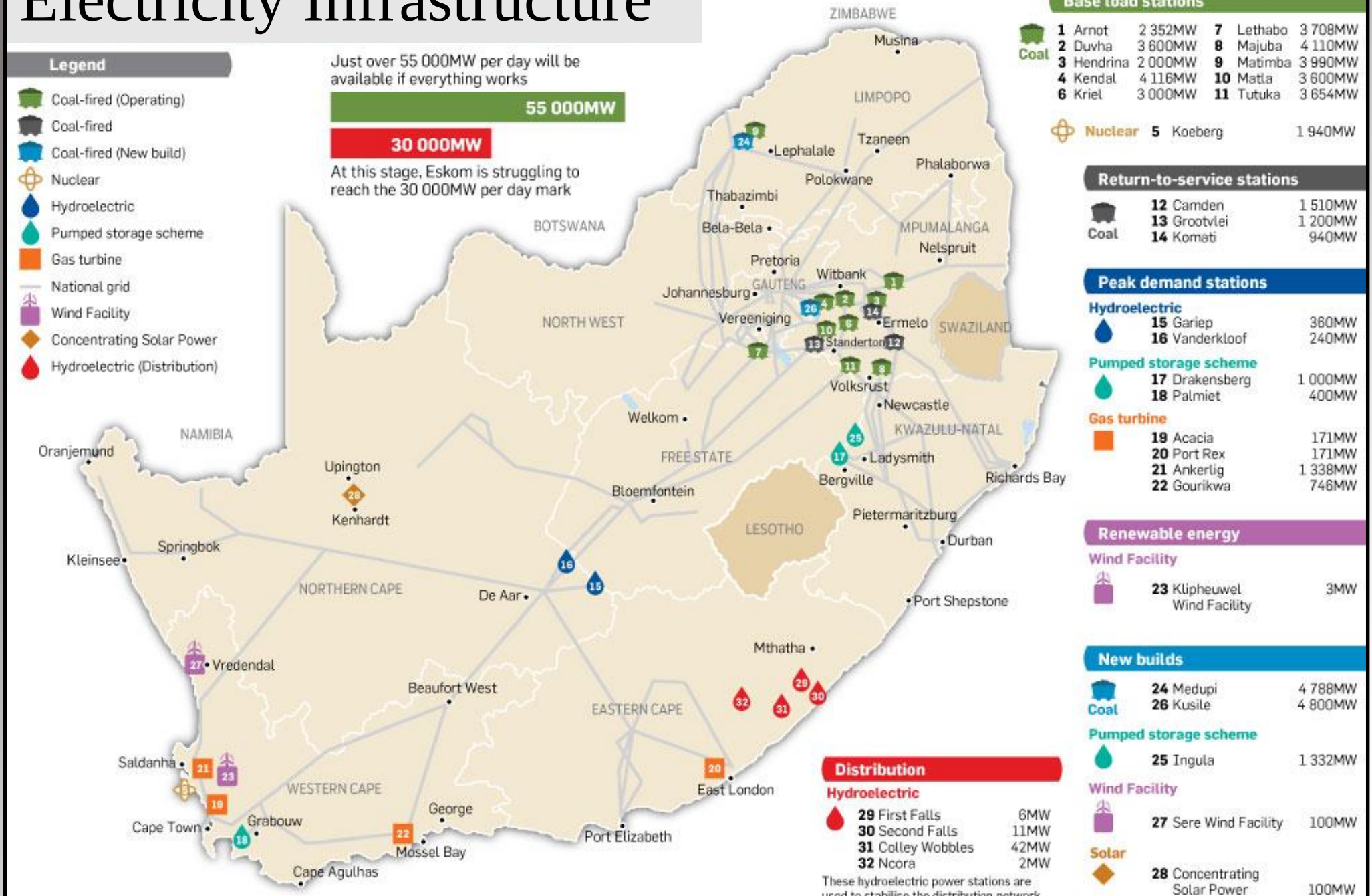


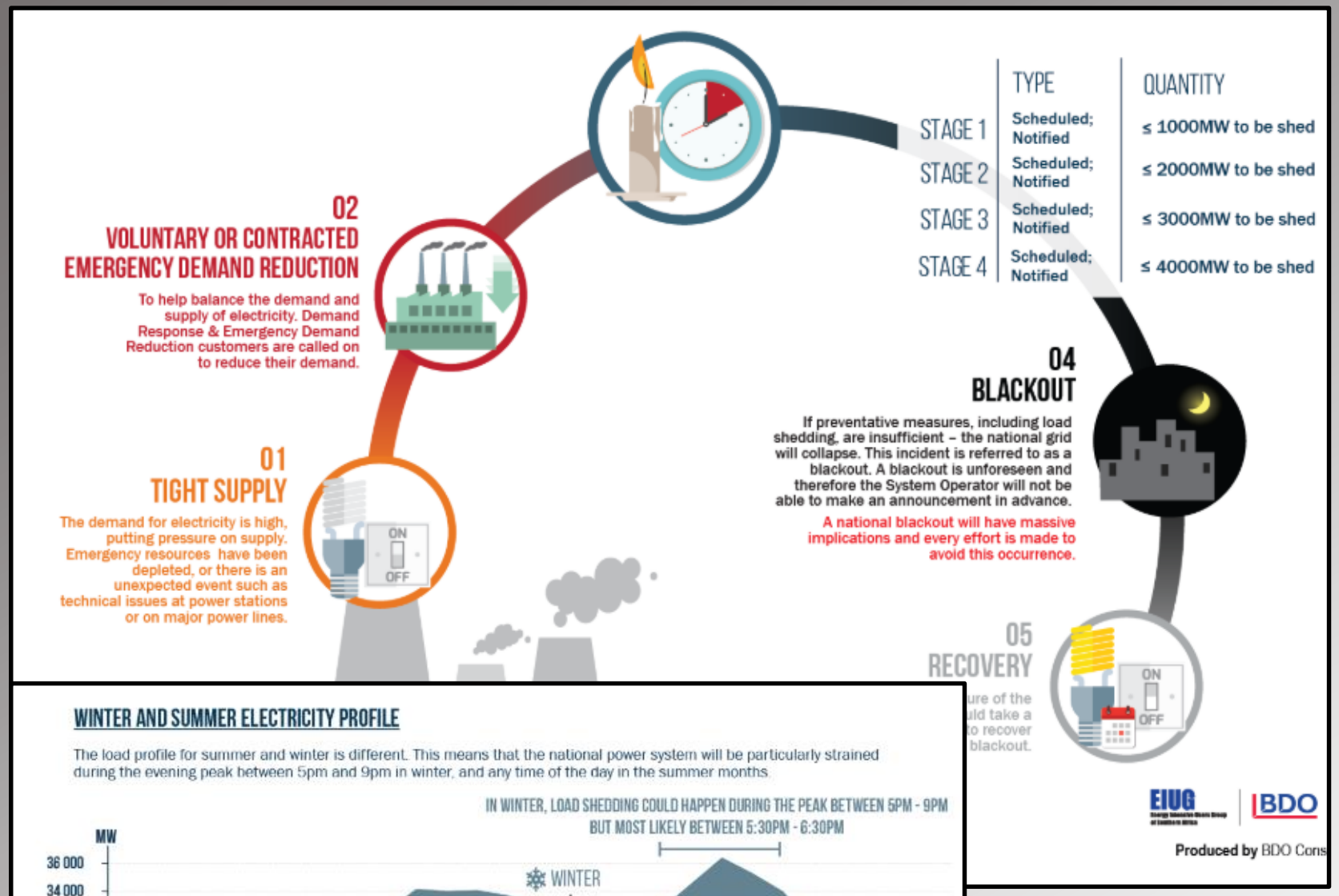
- Total domestic electricity generation capacity is 51 GW
- Eskom is the dominant energy provider in South Africa, generating 95% of the country's electricity and supplying 45% of electricity across the African continent.
- Current access to the national power grid is 86% (April 2020 estimates from USAID)
  - 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



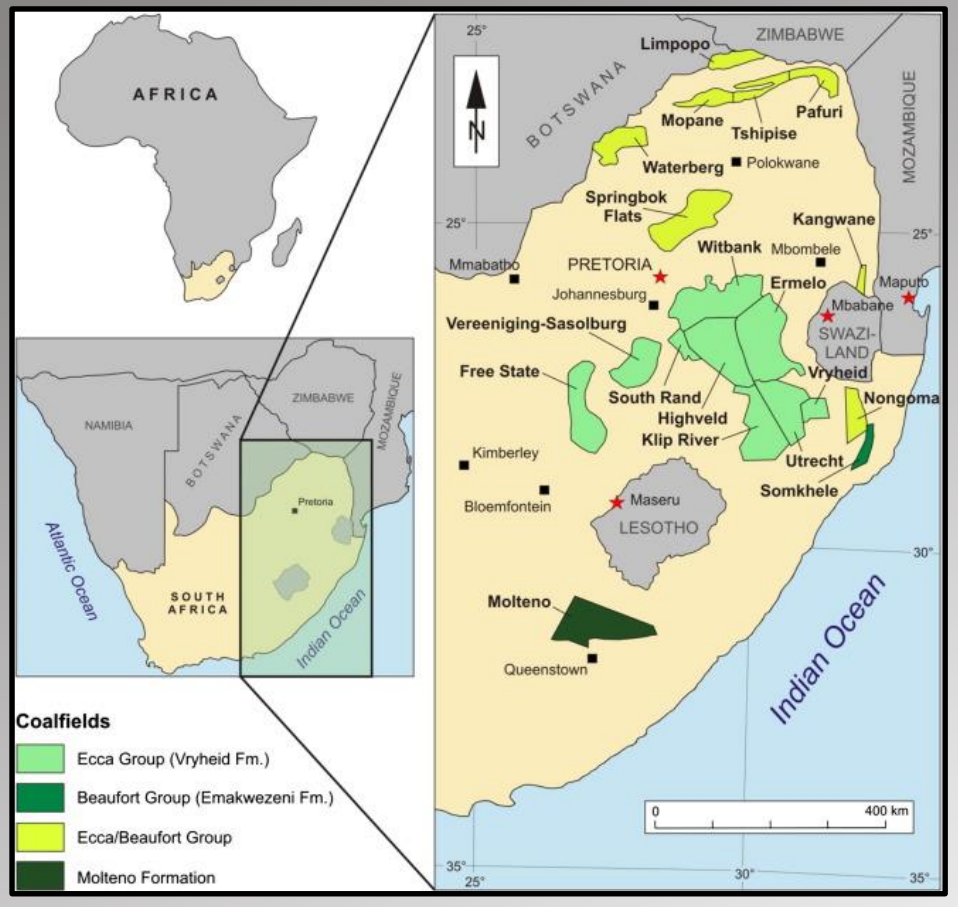


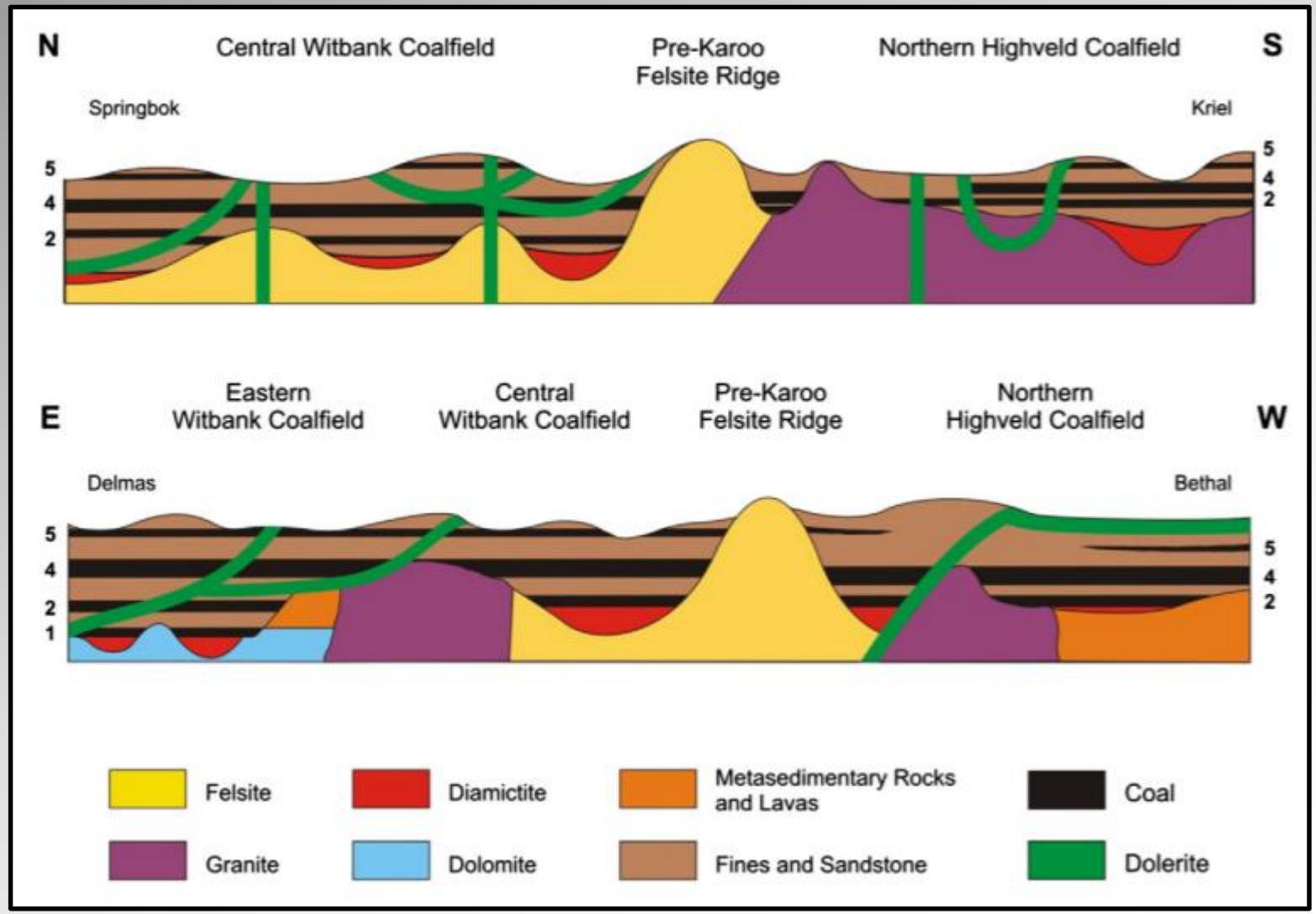
Load Shedding

- 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

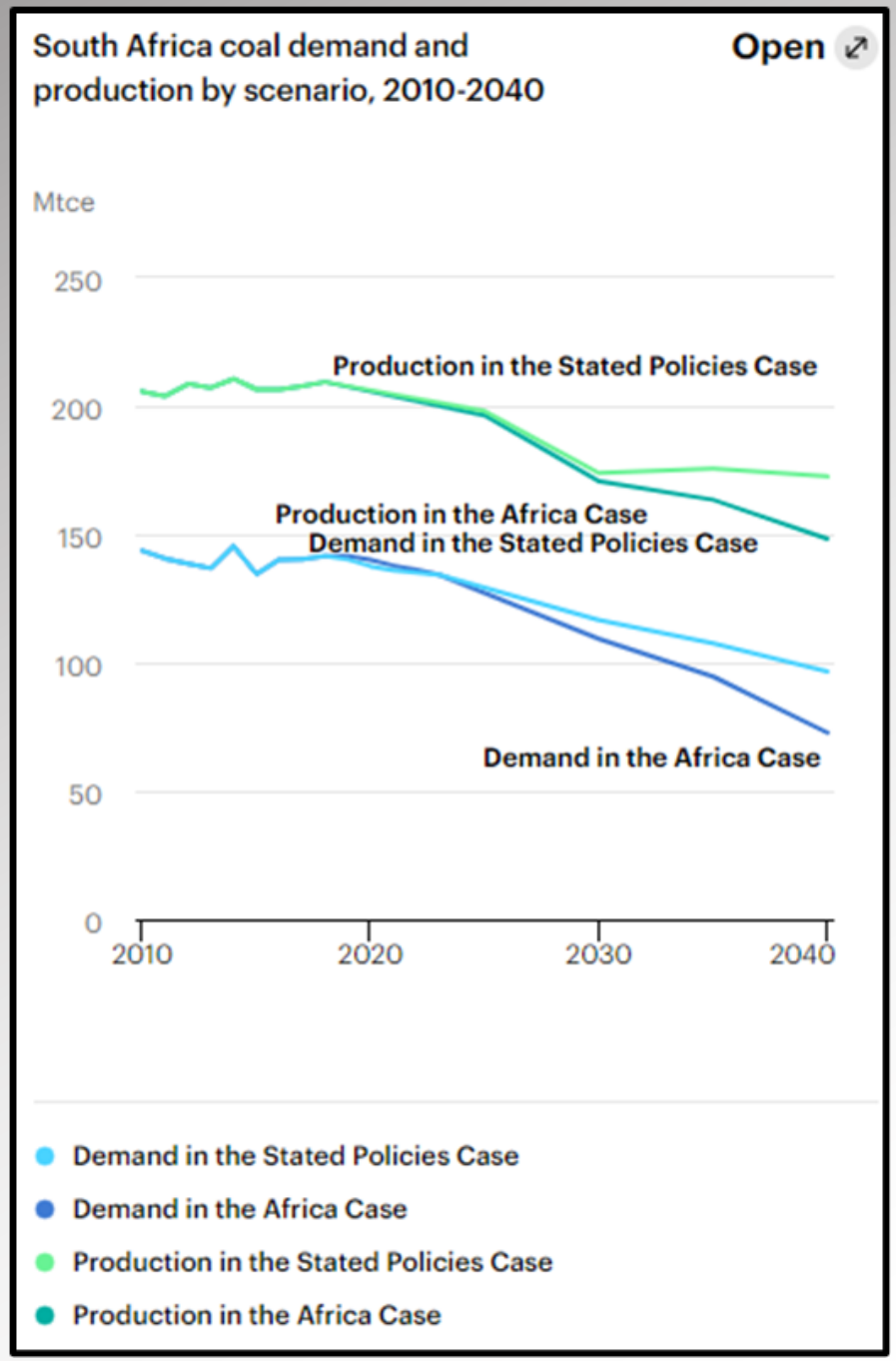
(Hancox, 2014)





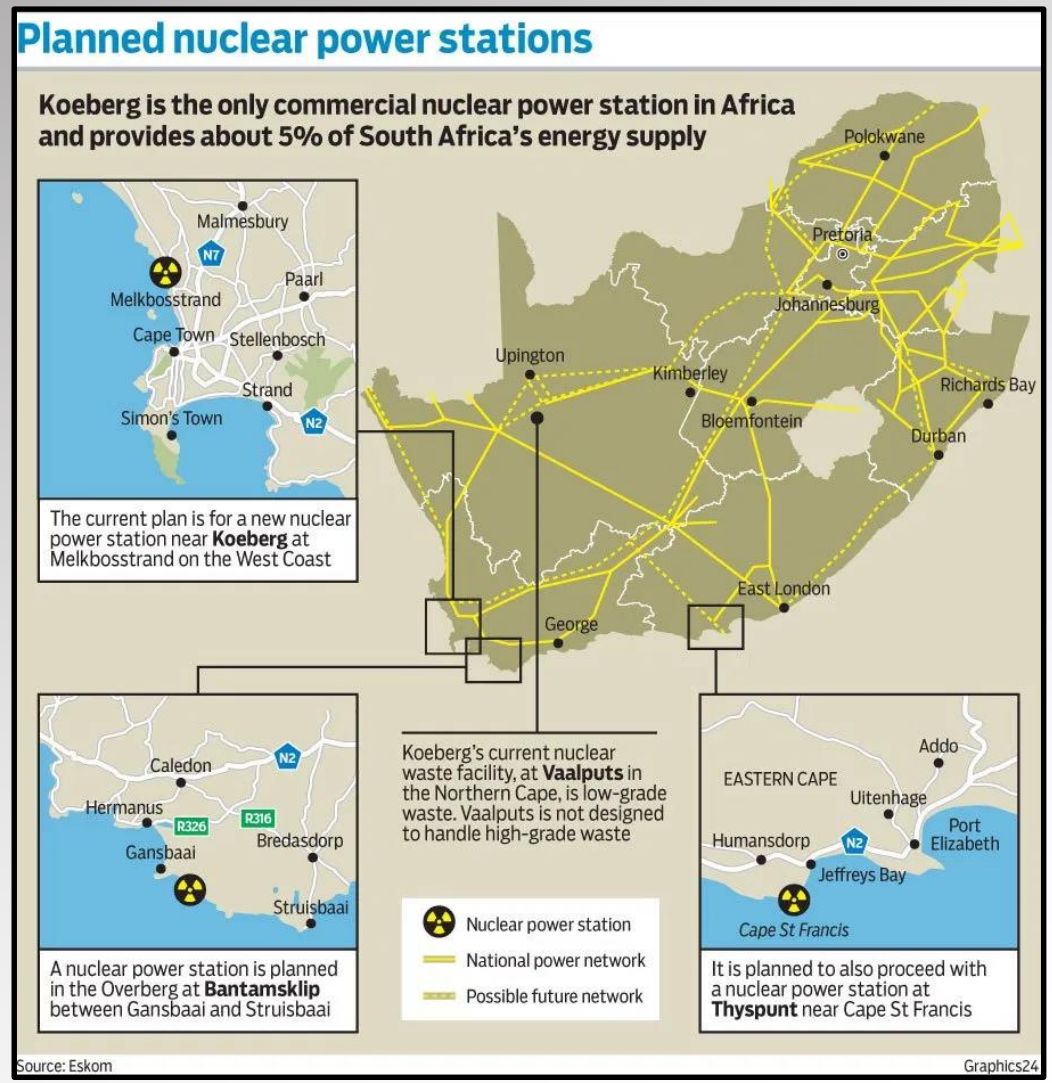
Future of Coal

- 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.



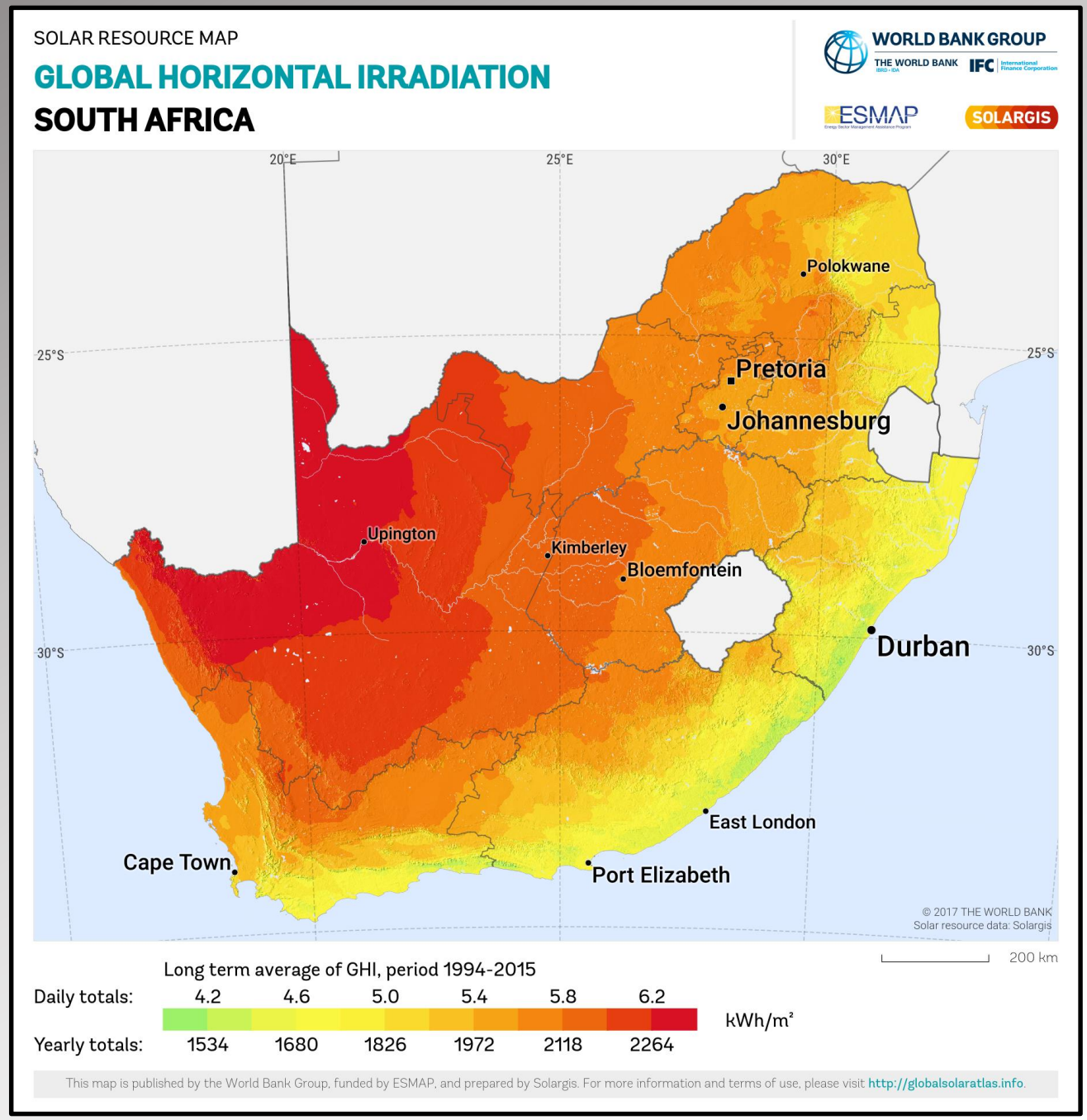
Nuclear Power

- 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 Koeburg'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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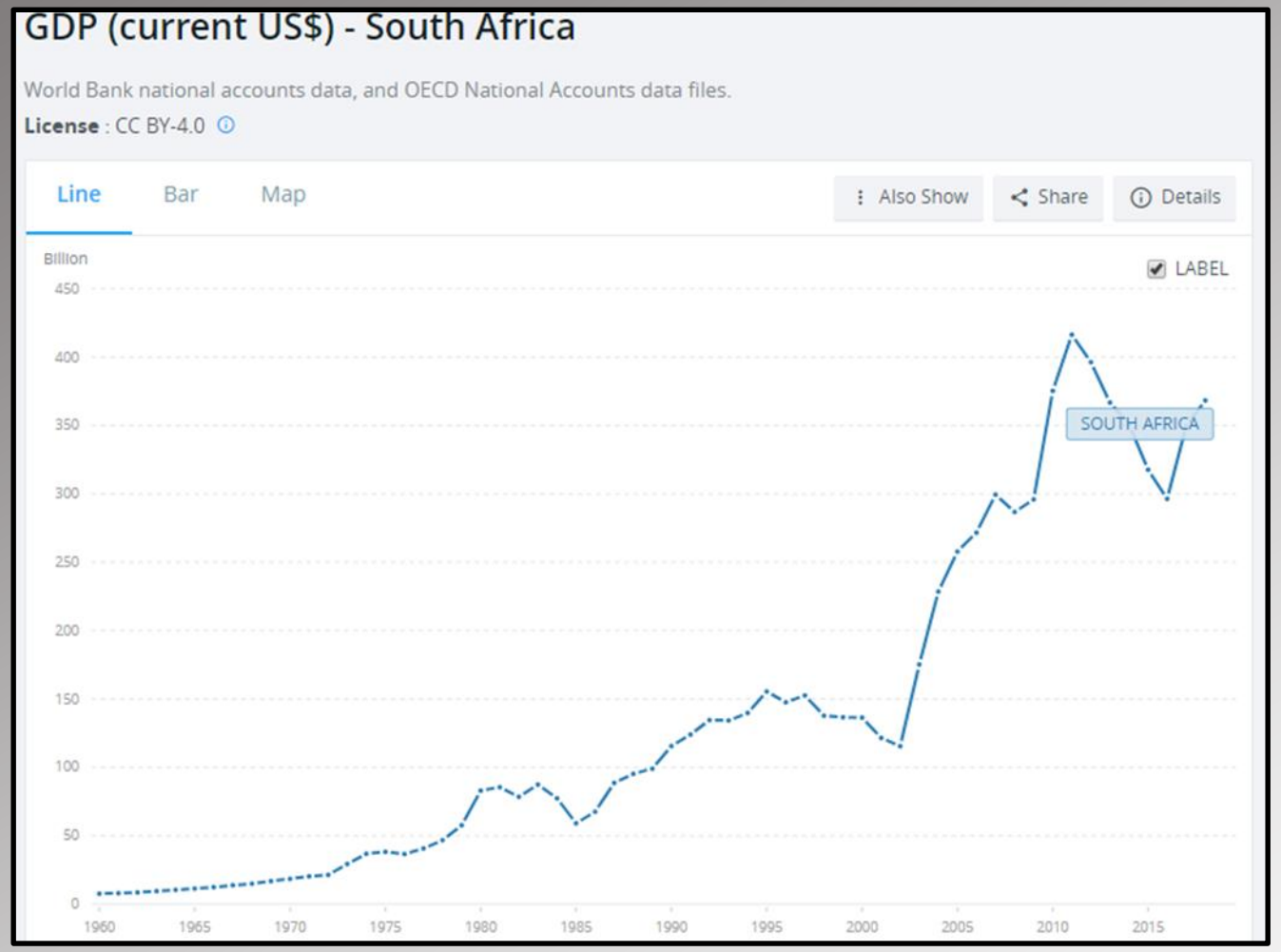
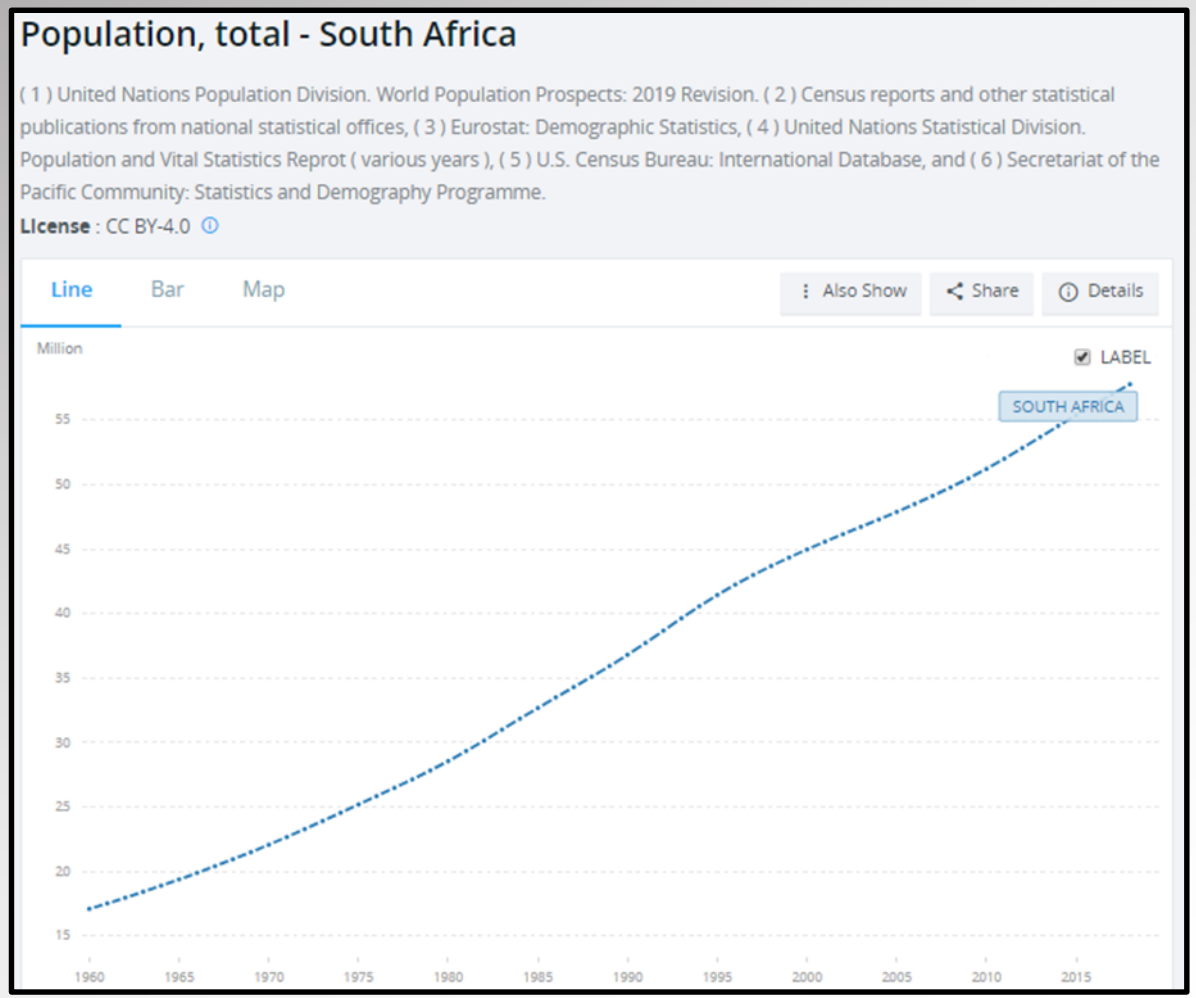
Break Slide

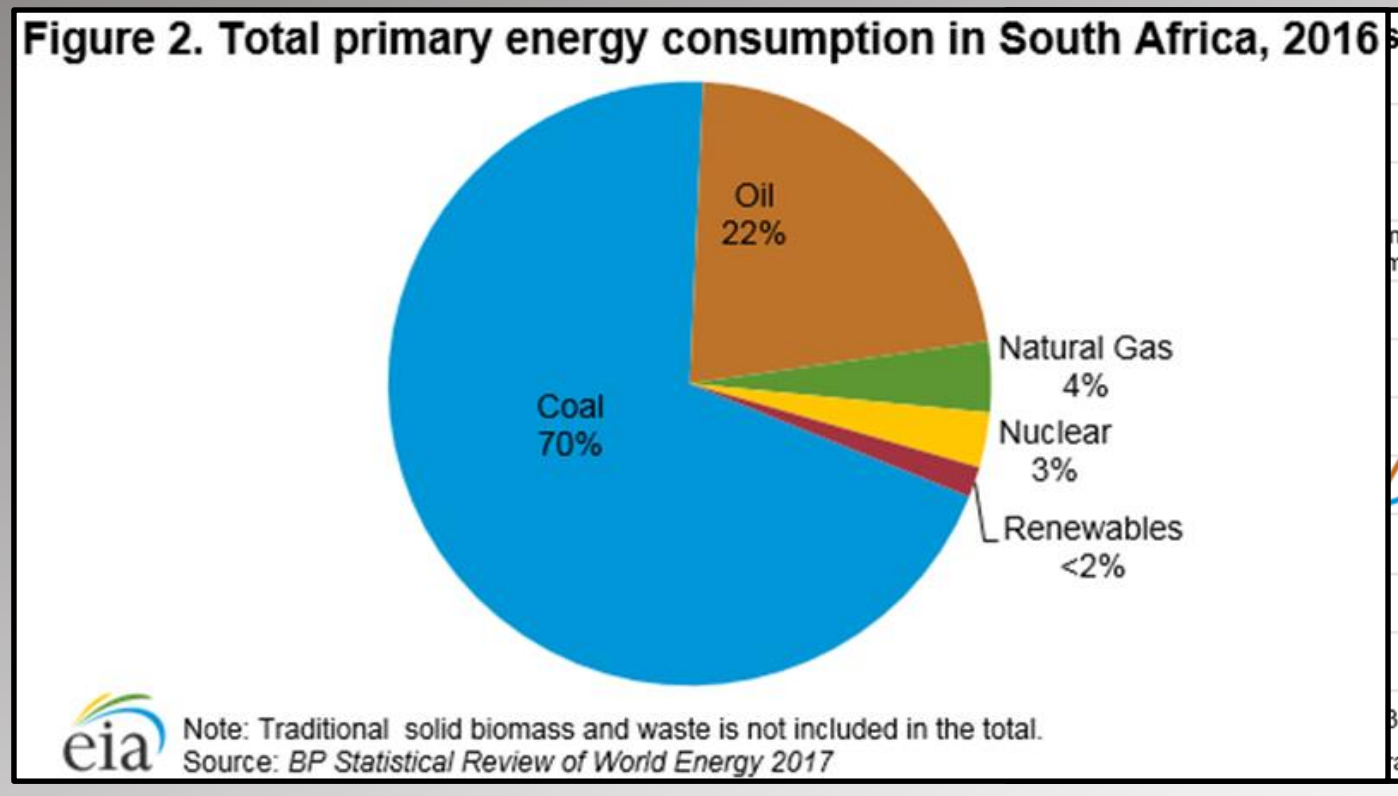
World Bank Statistics about South Africa

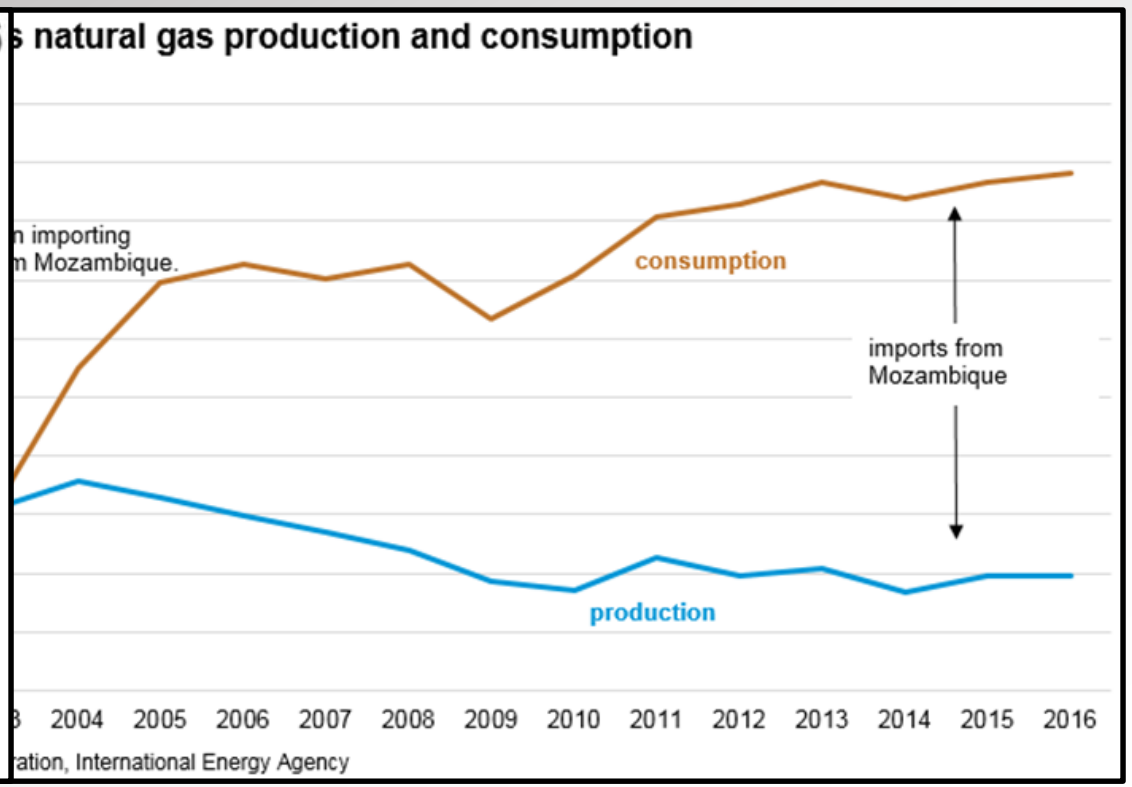




EIA general information on South Africa's energy use through time

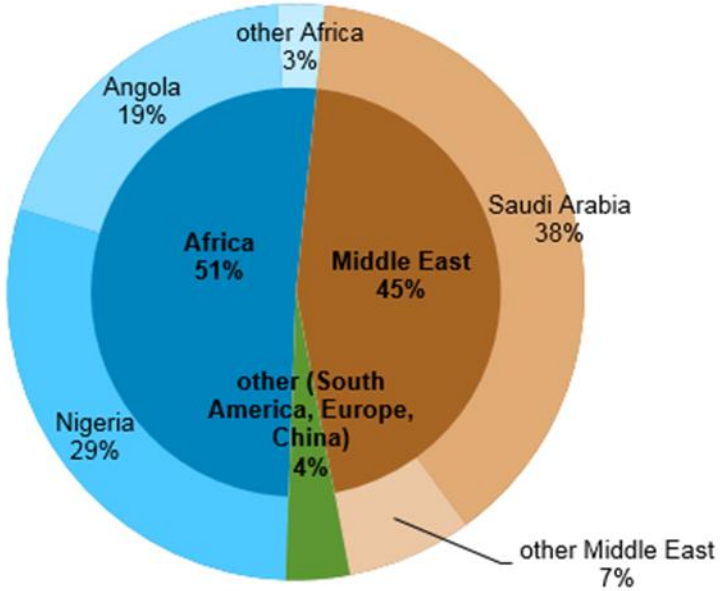
- South Africa plans on using more natural gas and renewable energy





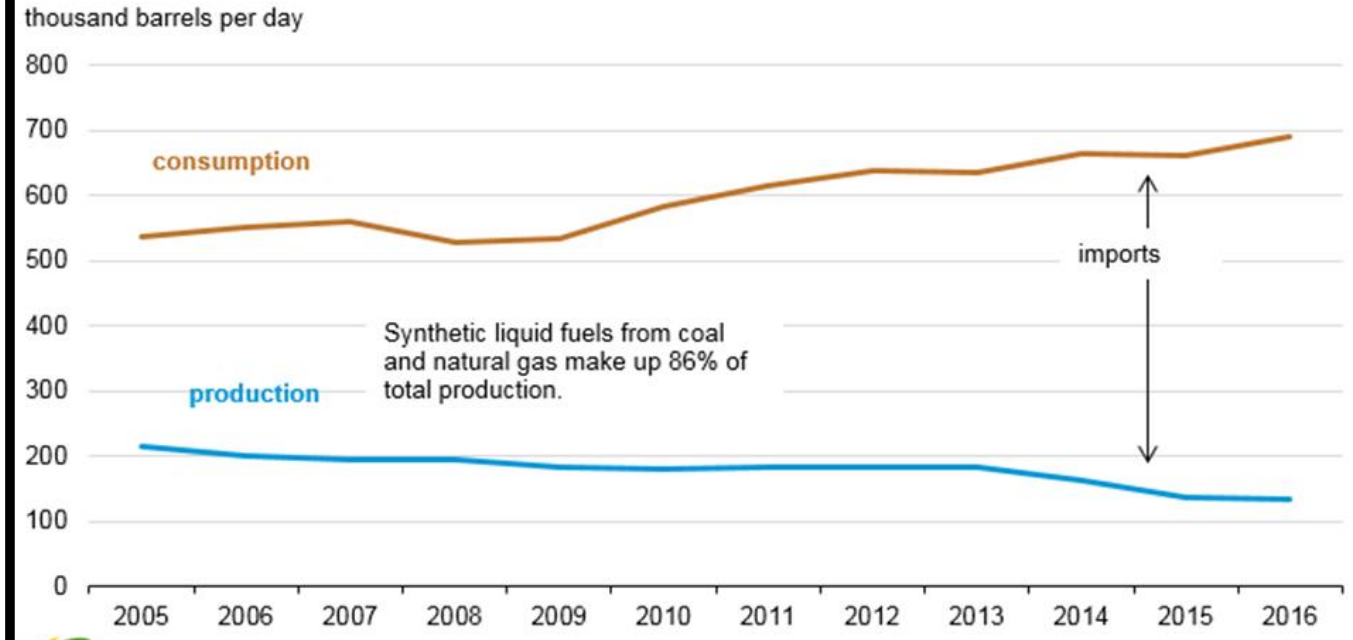
EIA South African energy projections continued

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

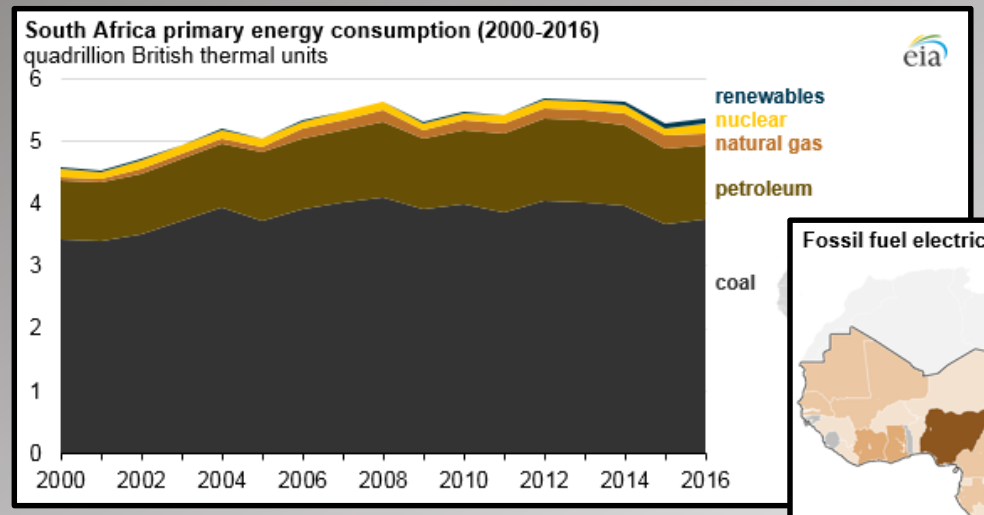
Gregg Marland
Research Institute for Environment, Energy and Economics
Appalachian State University

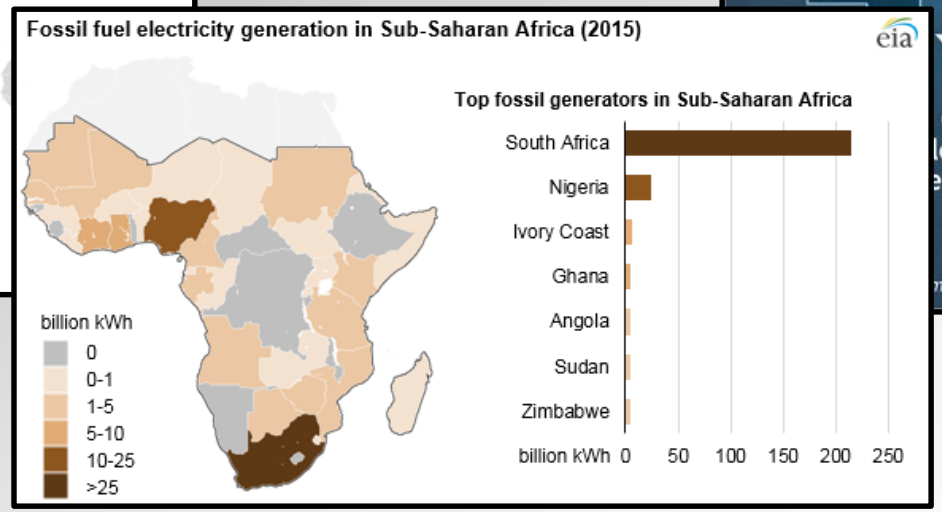
doi 10.3334/CDIAC/00001_V2017

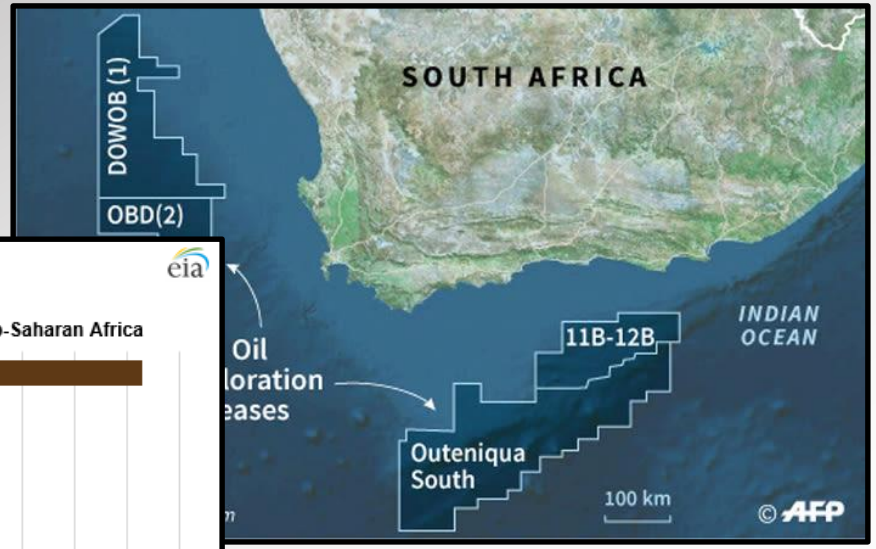
RANK	NATION	CO2_CAP
1	QATAR	13.54
2	CURACAO	10.30
3	TRINIDAD AND TOBAGO	9.32
4	KUWAIT	6.93
5	UNITED ARAB EMIRATES	6.34
6	BAHRAIN	6.28
7	BRUNEI (DARUSSALAM)	5.95
8	SAINT MARTIN (DUTCH PORTION)	5.31
9	SAUDI ARABIA	5.31
10	FALKLAND ISLANDS (MALVINAS)	5.16
11	LUXEMBOURG	4.73
12	NEW CALEDONIA	4.50
13	GIBRALTAR	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

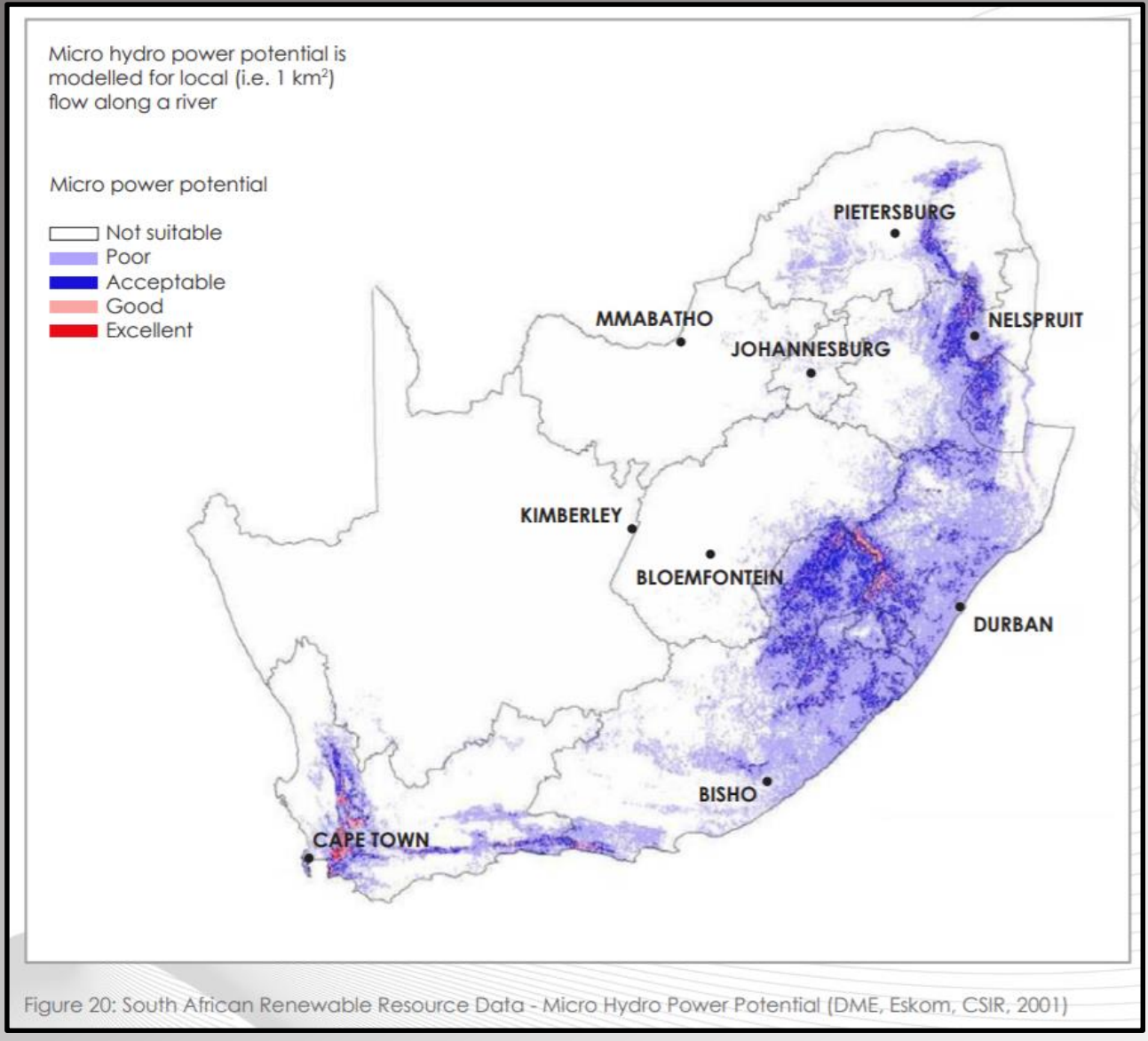
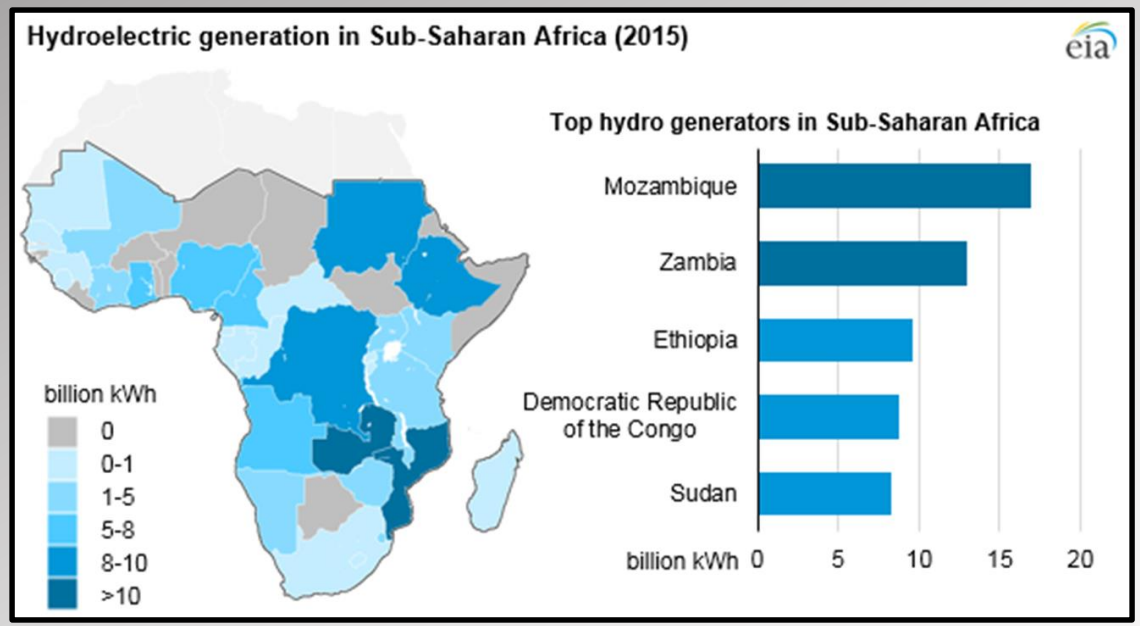


Figure 20: South African Renewable Resource Data - Micro Hydro Power Potential (DME, Eskom, CSIR, 2001)



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 od 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)

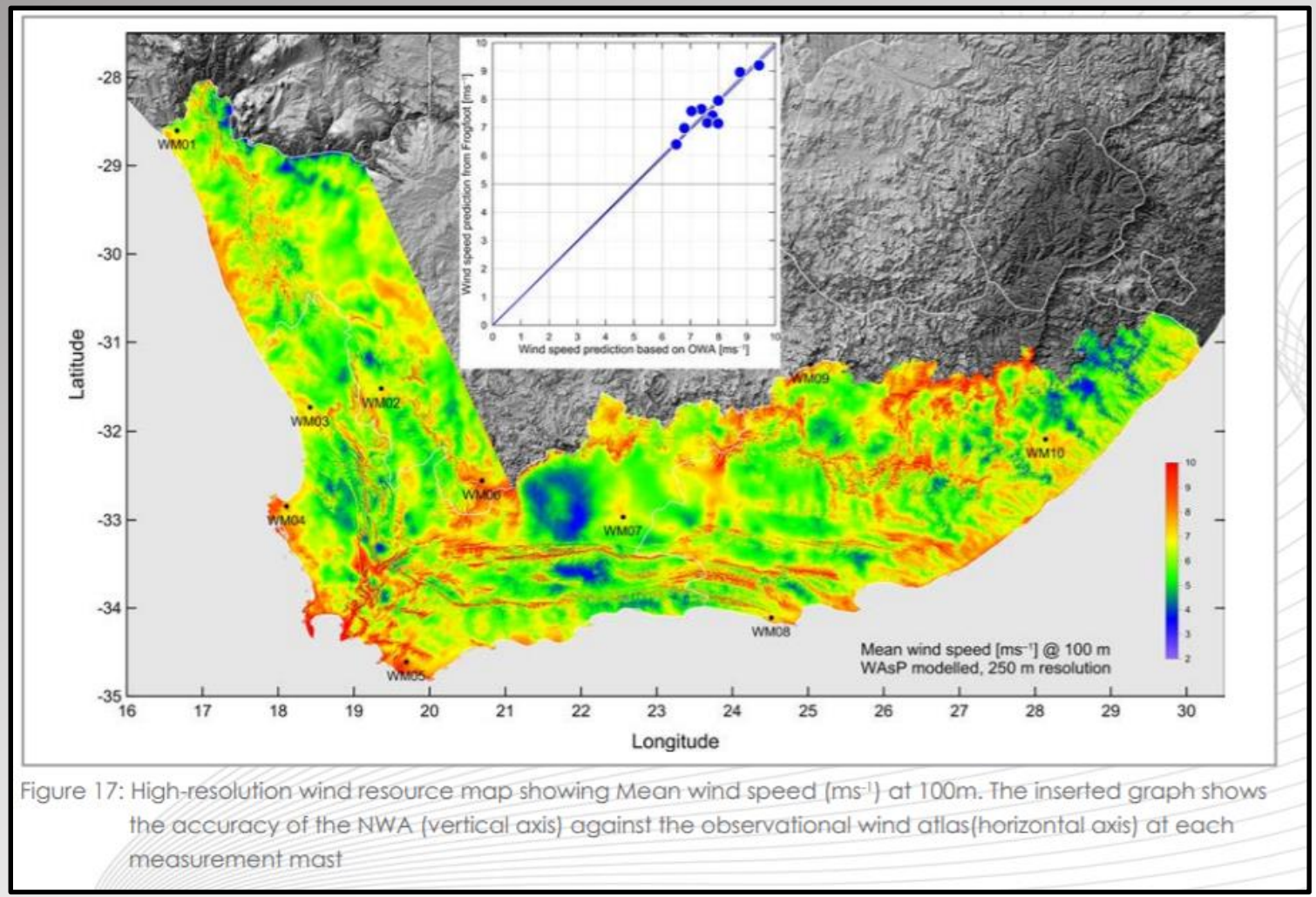


Figure 17: High-resolution wind resource map showing Mean wind speed (ms^{-1}) at 100m. The inserted graph shows the accuracy of the NWA (vertical axis) against the observational wind atlas(horizontal axis) at each measurement mast

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
https://www.eia.gov/international/analysis/country/ZAF
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
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Lecture notes
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Wind: https://i.ytimg.com/vi/G2wnoMwgYp8/maxresdefault.jpg
Dr. Eby, Lecture, Personal Communication
Charl du Toit, personal communication

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