



COAL UTILIZATION IN AN UNCERTAIN ECONOMIC WORLD (A SOUTH AFRICAN PERSPECTIVE)

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and*

All other South African coal researchers

**IPCC Oct 2015
Pittsburgh
USA**

It all starts here[®]



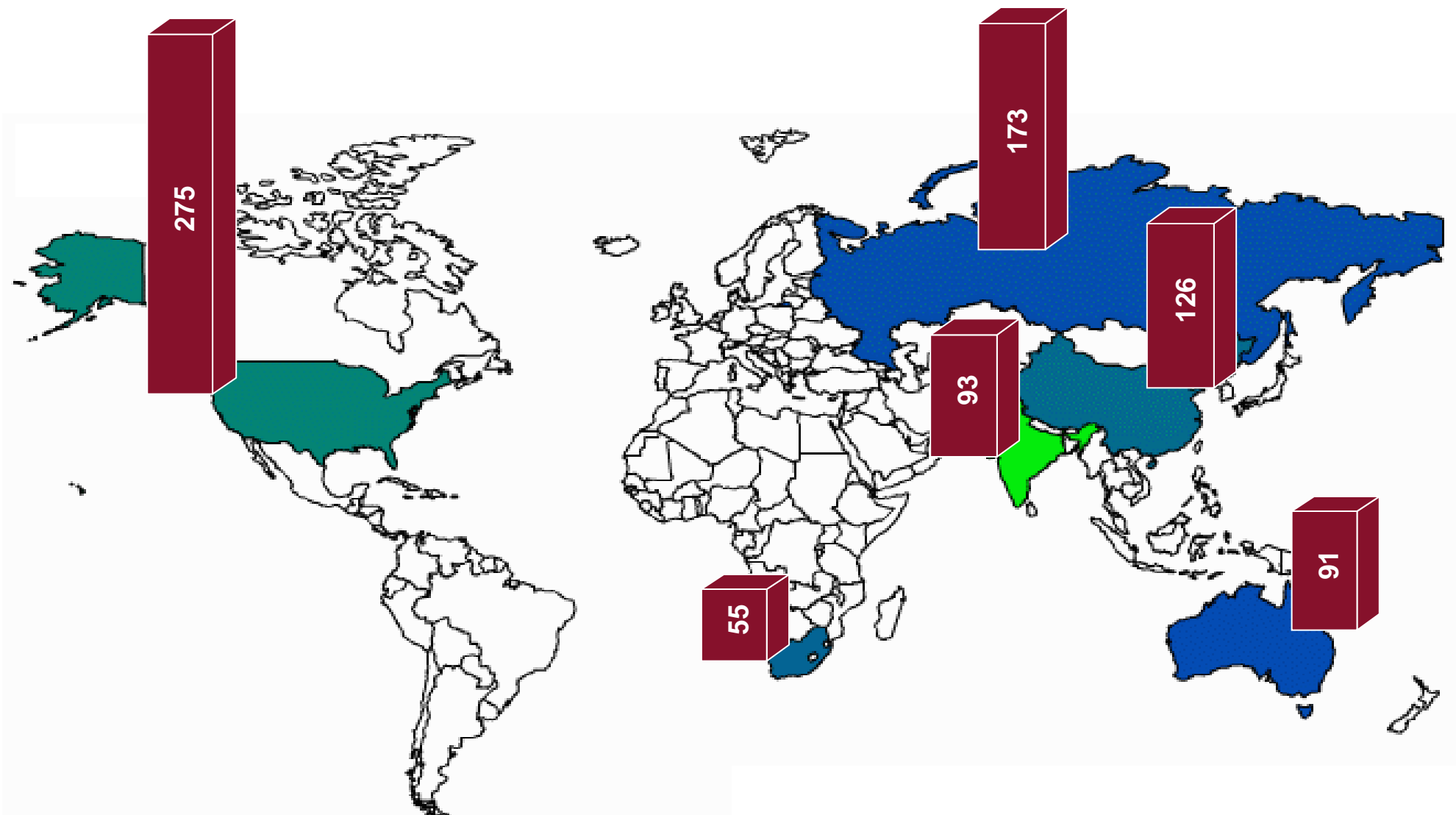
NORTH-WEST UNIVERSITY[®]
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NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Outline

- **Introduction**
 - Setting the coal scene
 - The energy needs - Africa
- **Economics**
 - Global economic information
 - South African scenario
- **Other alternatives**
 - State of Energy Research in South Africa
 - Renewable non-bio Energy (wind, solar, fracking)
 - Nuclear Energy
 - Bio-Energy
 - Fossil Fuel Energy – the one remaining source
- **Final Conclusions**
 - Research: NWU
 - IPCC 2016

Setting the coal scene

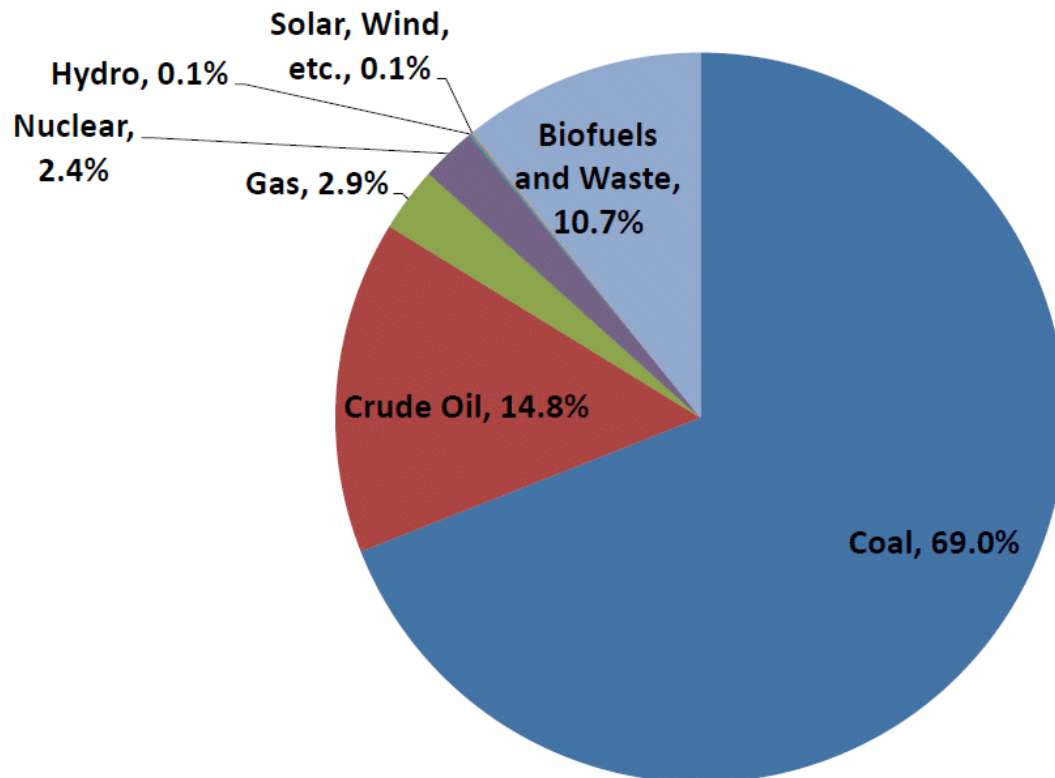
Regions with very large coal reserves (Billion Short tons)



The energy needs - Africa

- Around 77% of South Africa's energy needs are directly derived from coal
- 92% of coal consumed on the African continent is mined in South Africa.
- South Africa supplies two-thirds of Africa's electricity

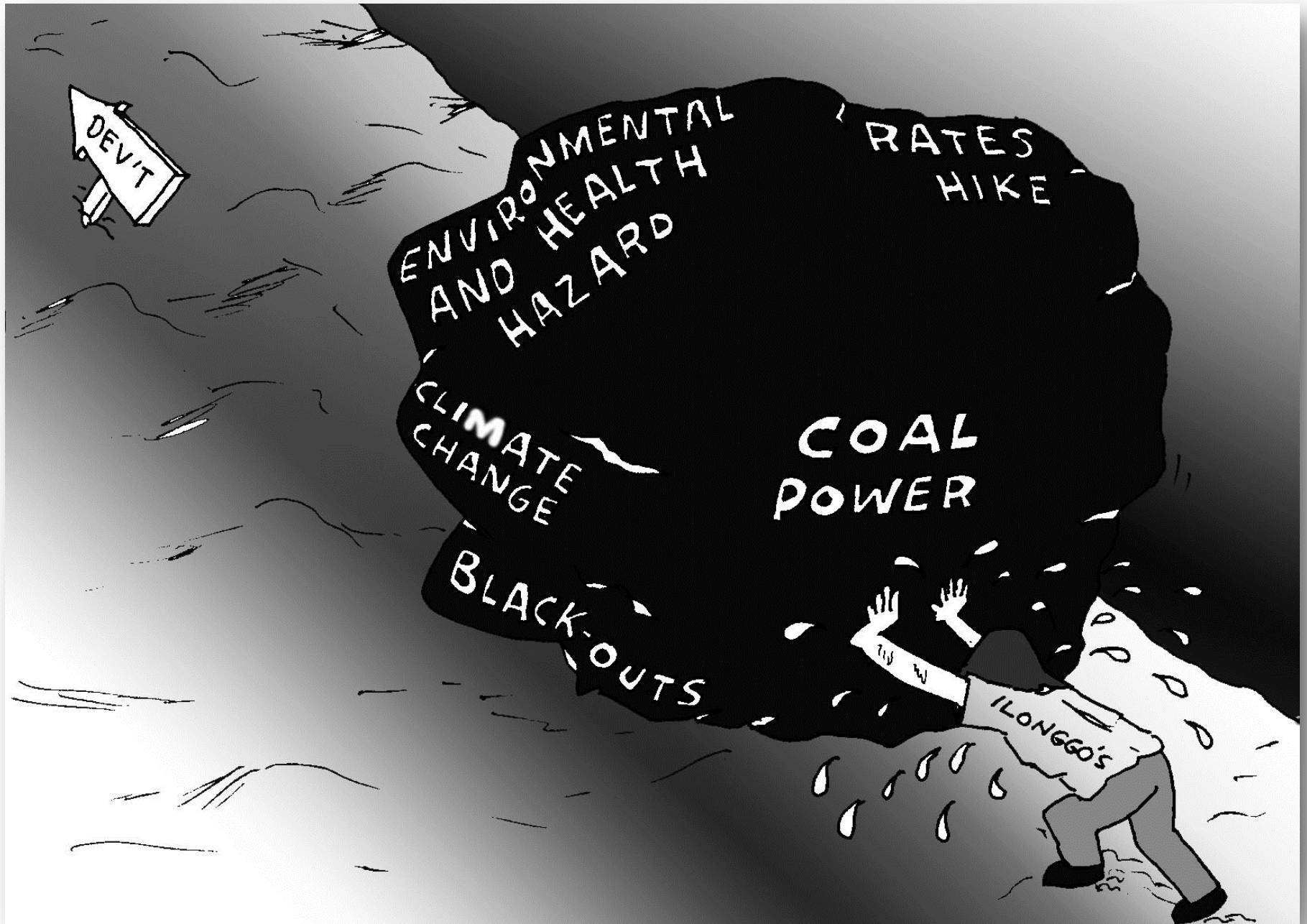
Total Primary Energy Supply in South Africa 2012 [% TPES]



- Almost 90% of South Africa's electricity is generated in coal-fired power stations.
- Koeberg, a large nuclear station near Cape Town, provides about 5% of capacity.
- A further 5% is provided by hydroelectric and pumped storage schemes.
- Renewables are starting to come online

<http://www.energy.gov.za/>

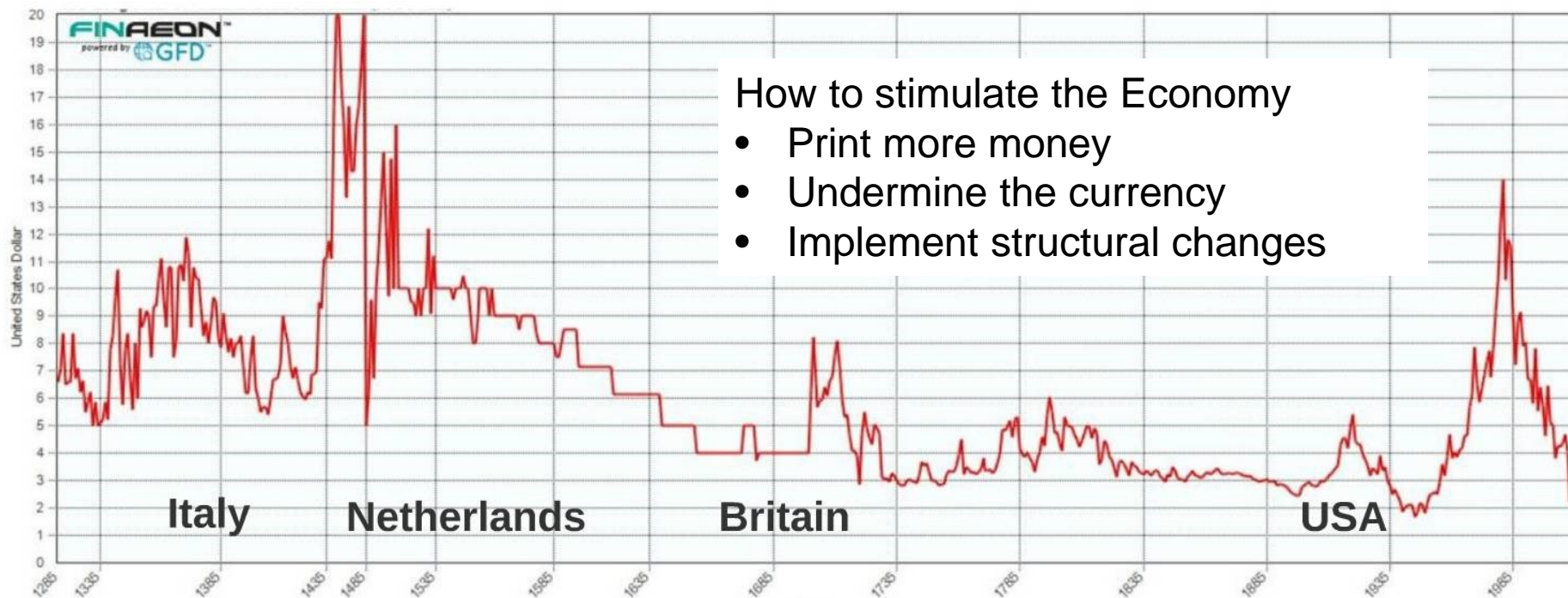
"Coal". Department of Energy (SA).



Global economic information

The Global Yield Curve

Bond rates from the country at the center of world power



Lending rates decrease as standards of living increase...

700 Year Low in 2012

Swiss 10 Year Yield



South African scenario

SA's Political Economy

The Tri-Partite Alliance

ANC

- Pre-94, Liberation Org.
- '94-'08 Turned Neo-Liberal
- Post '08 NDR vs. NDP
- 2009 "Z"-years
- Institutional destruction

Result

- Ideologically confused
- Contradictory policies
- Weak implementation

Then Cosatu Now

- | | |
|---|---|
| <ul style="list-style-type: none">• Marketing arm of ANC• Power on shop floor• Well organized• Workers first | <ul style="list-style-type: none">• Joined political elite• Vacuum on shop floor• Rivals Amcu et. al.• Self Destruct |
|---|---|

Then SACP Now

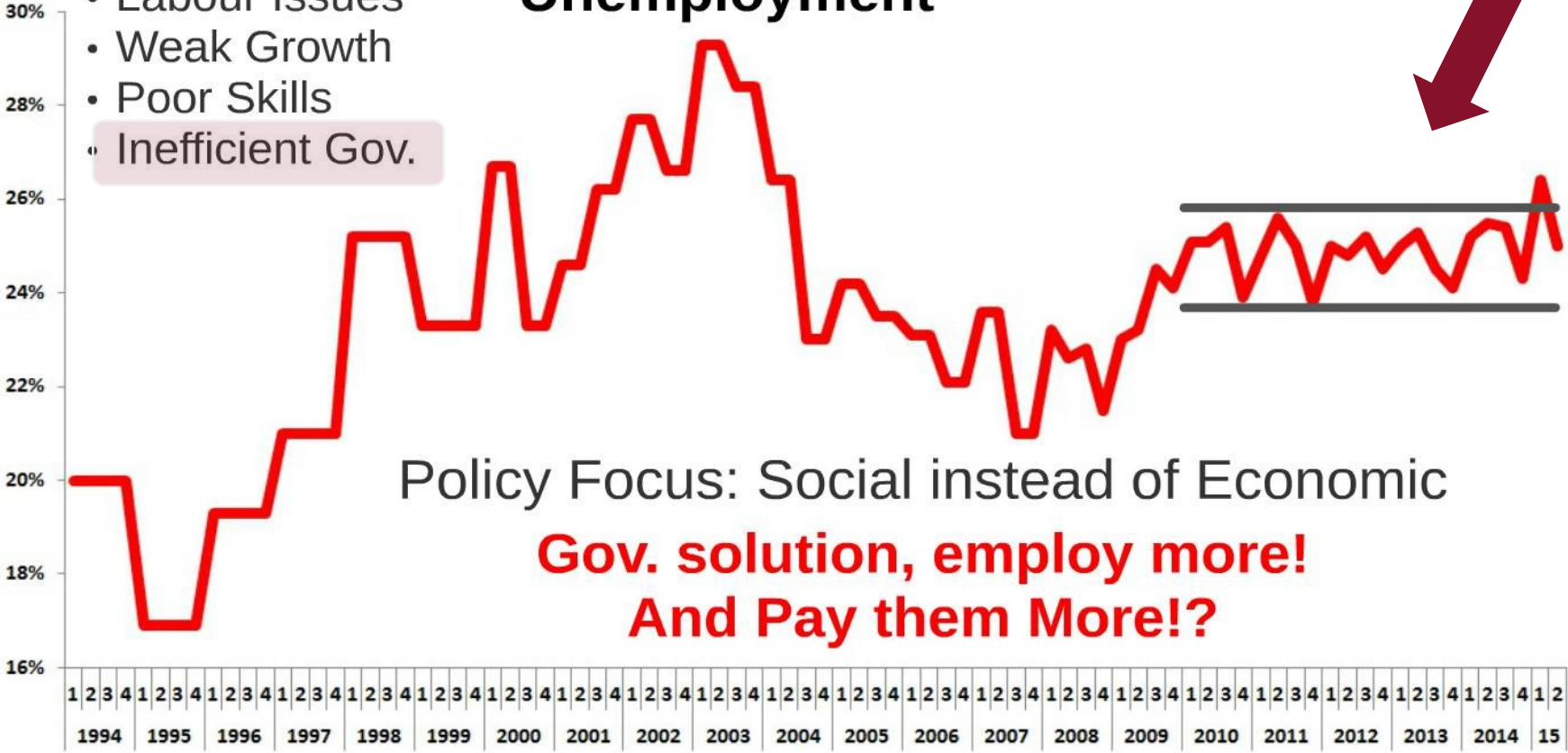
- | | |
|--|---|
| <ul style="list-style-type: none">• Ideological Base• Intellectually strong• Pro- workers/poor• Not Marxists but, Leninists | <ul style="list-style-type: none">• Bling communists• Intellectually weak• Political rent seekers• Very influential• No Support Base• Remain Leninists |
|--|---|

Additionally about 20% have stopped seeking jobs



Unemployment

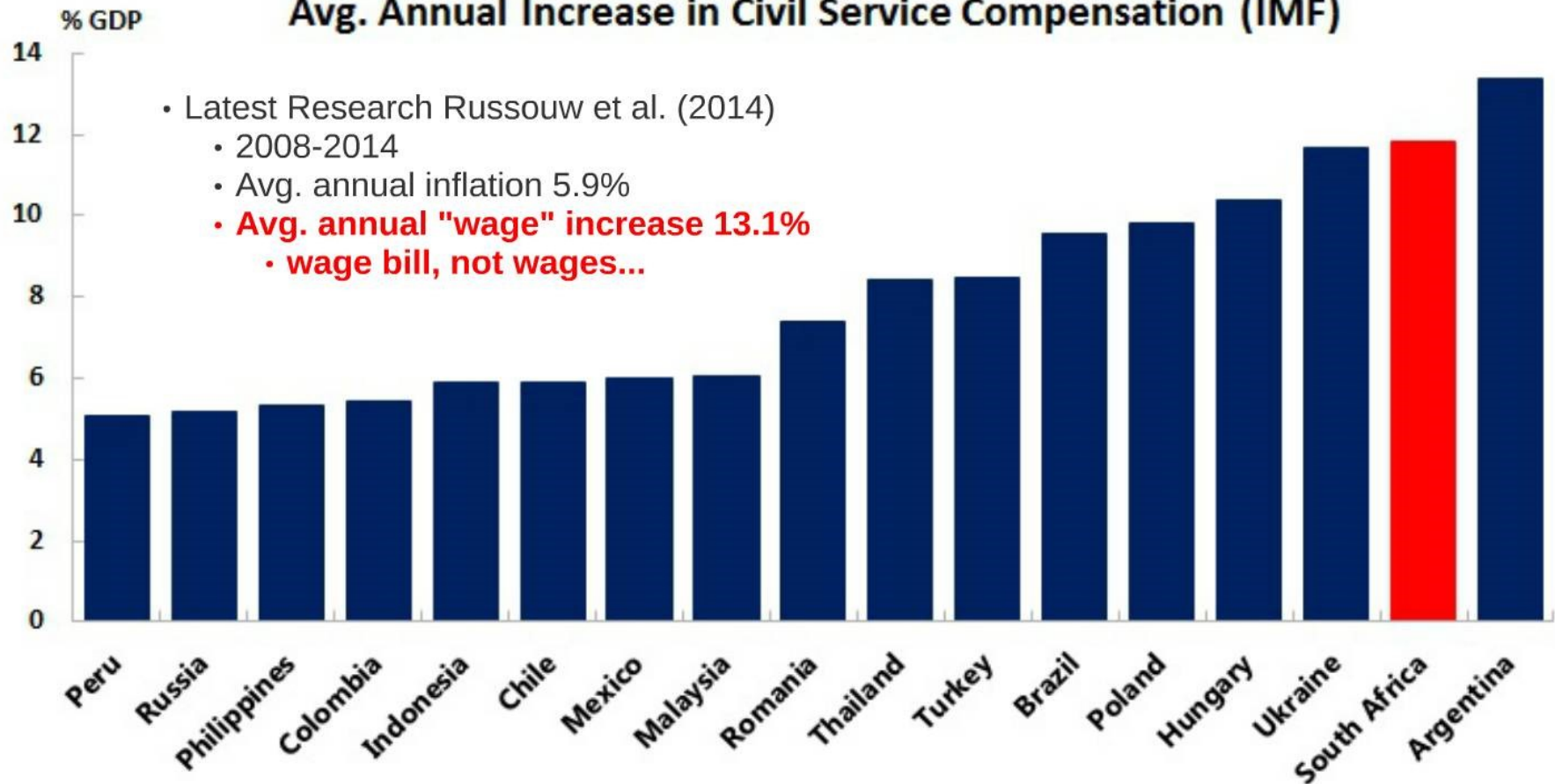
- Labour Issues
- Weak Growth
- Poor Skills
- Inefficient Gov.



Policy Focus: Social instead of Economic
Gov. solution, employ more!
And Pay them More!?

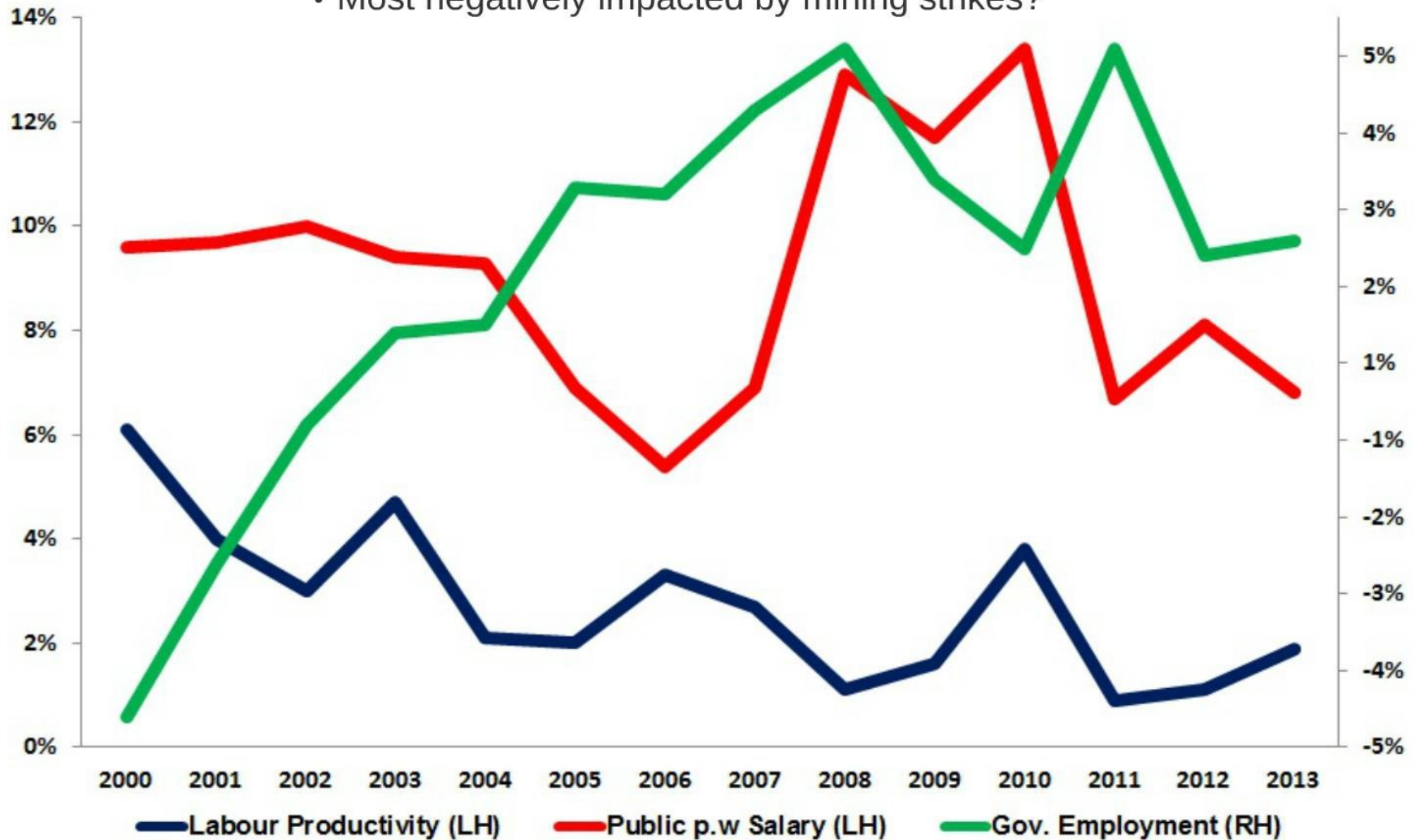
Source: STATSSA, EFG

Avg. Annual Increase in Civil Service Compensation (IMF)



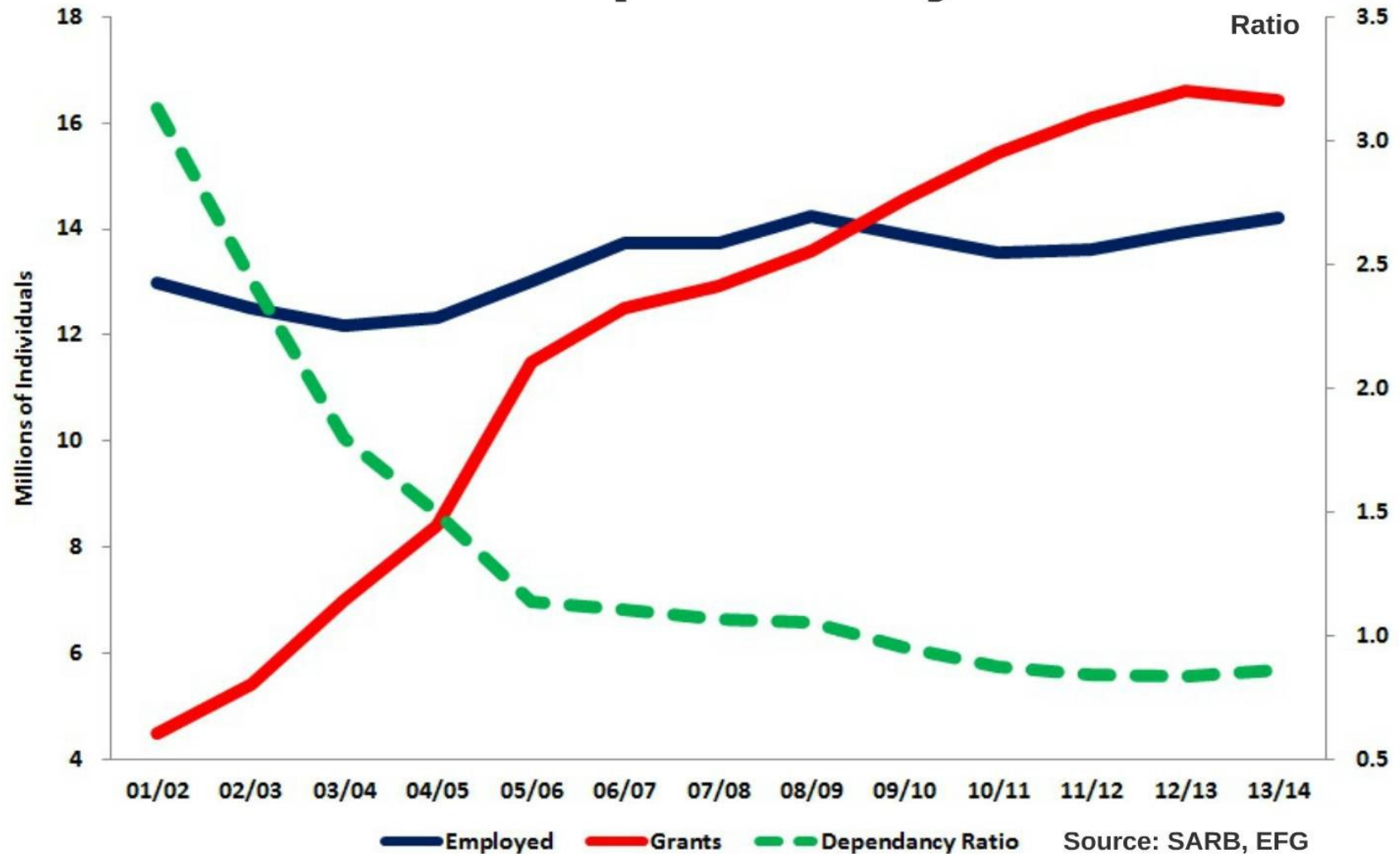
Productivity and Wages

• Most negatively impacted by mining strikes?

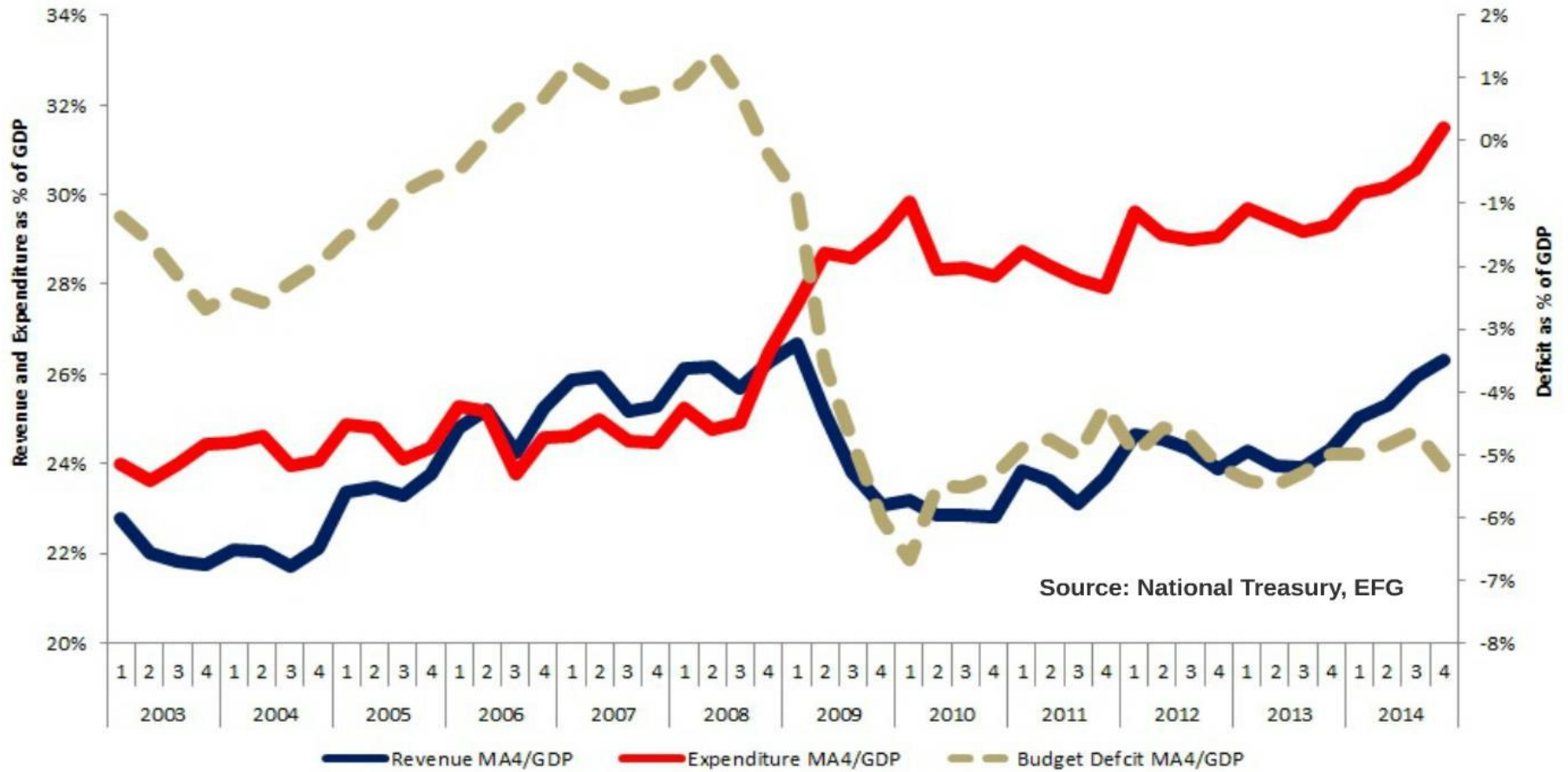


Source: SARB, EFG

Social Dependency in SA

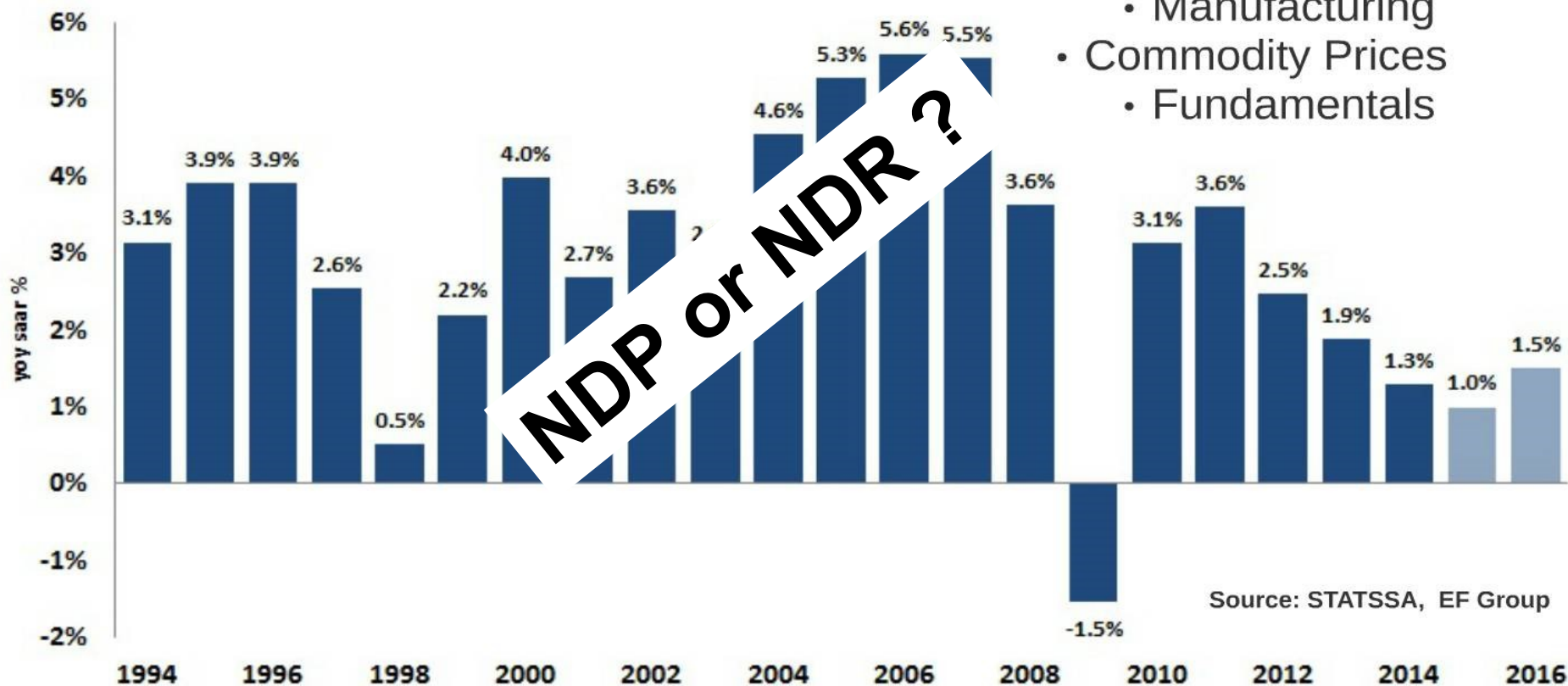


The Bigger Picture, Fiscal Finance/GDP



GDP

- Eskom
- Strikes: Gold, Coal, Gov?
- Mixed Signals
 - Manufacturing
- Commodity Prices
 - Fundamentals



How to deal with the energy crisis in South Africa and the utilization of resources when these economic matters are in play??

THAT IS THE QUESTION



**Double, double toil and trouble;
Fire burn, and cauldron bubble.
*With thanks: Shakespeare's Macbeth***

**Is it better to know or not to know
*With Thanks: Shakespeare's Hamlet***



*Applying scientific thinking
in the service of society*

State of Energy Research in South Africa

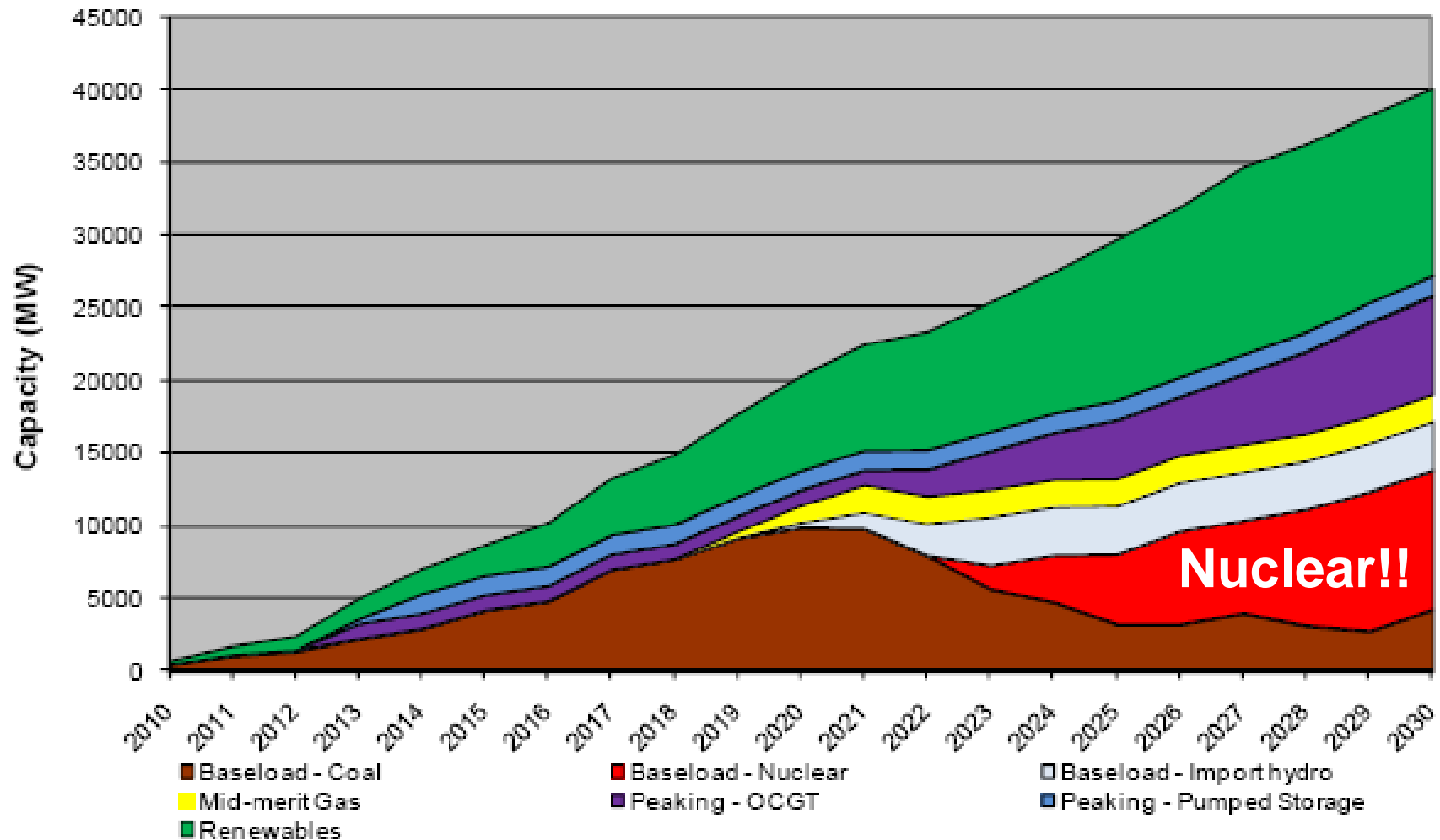
Frikkie van Niekerk (DVC NWU) May 2014

The DST 10 year Innovation Plan (2008)

Coal & gas including large hydro (50 000MW)	Nuclear equivalent to > 4 x Koeberg capacity (8 000MW)	Renewable energy sources (2 000MW)	Energy generation sources
Clean coal technologies Carbon capture and sequestration	3 rd generation nuclear reactors Pebble bed modular reactors	Solar, hydro, wind, ocean/wave, biomass and waste	Technologies for cultivating energy sources
Eskom, Sasol, PetroSA, CEF/Saneri and universities	Eskom, Necsa, PBMR, IST Nuclear and universities	Eskom, CEF, Sasol, independent producers, Saneri and universities	Research organs in the NSI
Electricity Liquid fuels Cooking & heating	Electricity Process heat Hydrogen	Electricity Biofuels Hydrogen	End uses

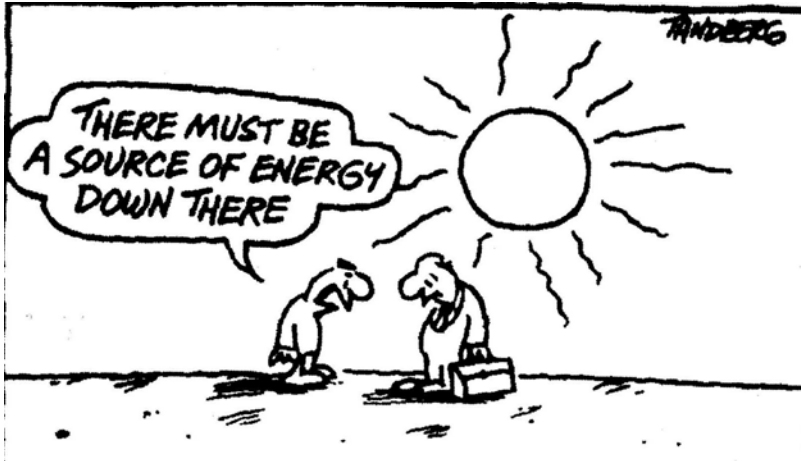
- Embracing Renewable Energy Technologies (Non-Bio and Bio)
- Nuclear Energy Revisited
- Clean Coal Technologies

The Integrated Resource Plan or IRP 2010



- More than 20 000 MW of renewable energy will be contracted – bio, wind, solar.
- Nuclear??
- Older coal-fired power stations will be decommissioned (about 11 000MW) and new coal-fired power stations (about 6 000 MW) commissioned

Wind and solar ??



Only operational solar plant 100MW 2015
With some 400 MW planned before 2020



The first large scale wind farm in South Africa became operational in 2014, and others are in planning and construction stages

6 farms with total energy < 330MW
6 planned with total energy 430 MW
2 farms with total 800 MW possible

THUS before 2020 <1 GW

Fracking ??

Shale gas in the Karoo will prove "a game-changer" for the South African economy, President Jacob Zuma said on Thursday.

In his state-of-the-nation address, delivered at Parliament, he told MPs government had evaluated the risks and opportunities involved in extracting shale gas, a process known as fracking.

"Having evaluated the risks and opportunities, the final regulations will be released soon and will be followed by the processing and granting of licenses.

"The development of petroleum, especially shale gas, will be a game-changer for the Karoo region and the South African economy."

But what is the current situation ??

Although the moratorium on exploration for shale gas in the Karoo was lifted 10 months ago, no drilling has taken place yet, and is unlikely to do so for 6 to 18 months.

WHAT THE FRACK

1 Well: 20 Million litres of water.

2500 trucks.

32 wells on a pad.

10 pads in a development.

Many developments in SA.

52% of the Karoo.

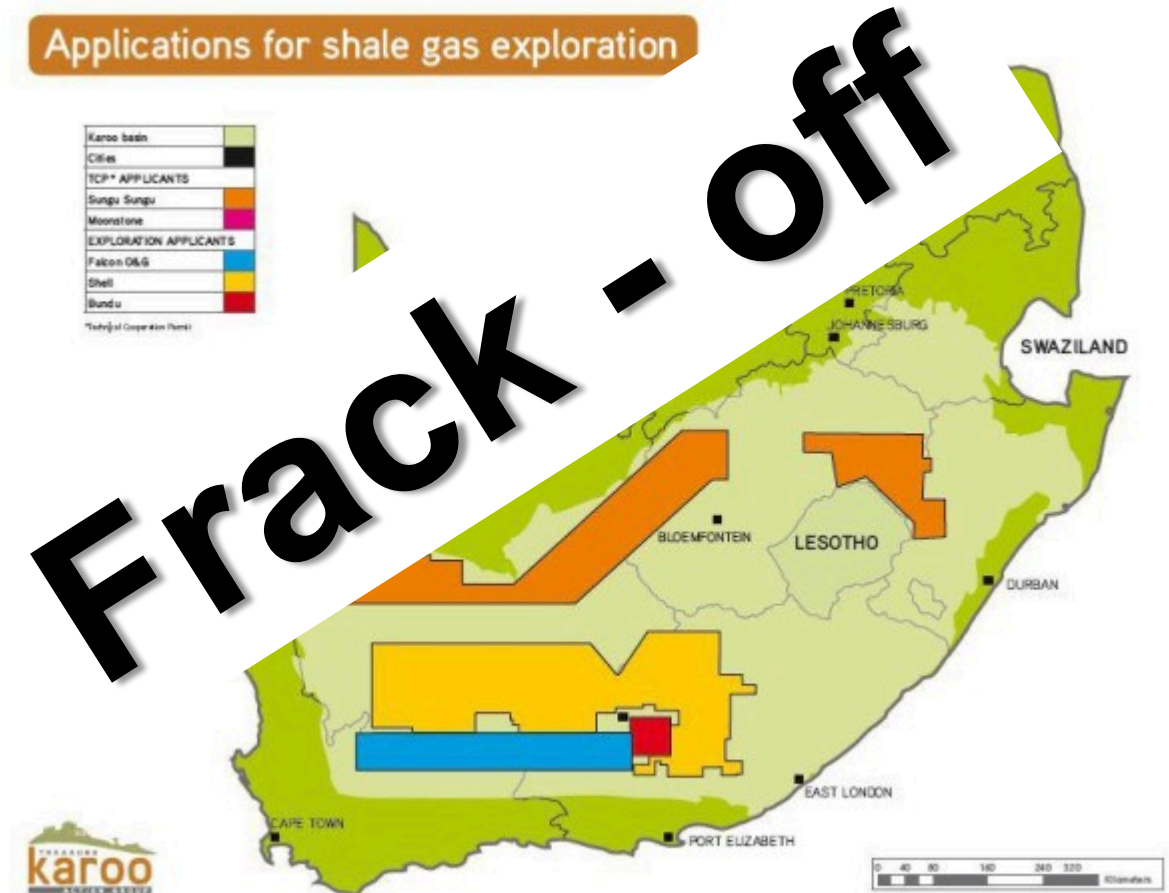
More than 20% of SA.

France has banned it.

Many US cities don't want it.

IS Fracking the answer for

SA?



Nuclear??



Nuclear energy

- 1 Experimental site – Safari 1
- 1 Operational site: Koeberg 1.8 GW

Possible deal for \$100bn to build 8 nuclear power plants in South Africa by Russia

Currently a hotly debated topic



Renewable Energy Technologies (Bio)

What is the Ecological Footprint? What is it composed of?

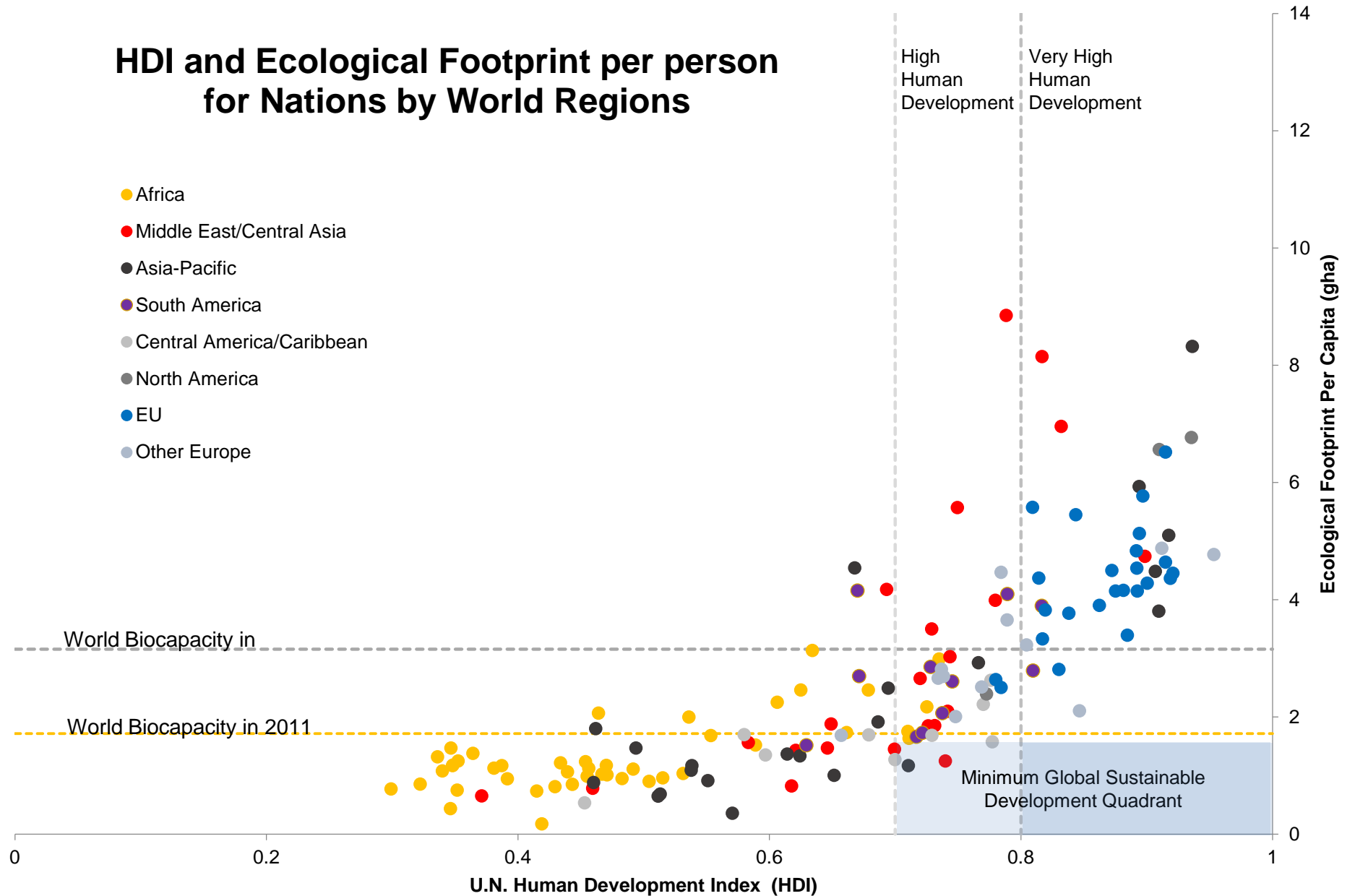
The Ecological Footprint is the area of land and water it takes for a human population to generate the renewable resources it consumes and to absorb the corresponding waste it generates, using prevailing technology.

In other words, *it measures the "quantity of nature" that we use and compares it with how much "nature" we have.*

What is Biocapacity?

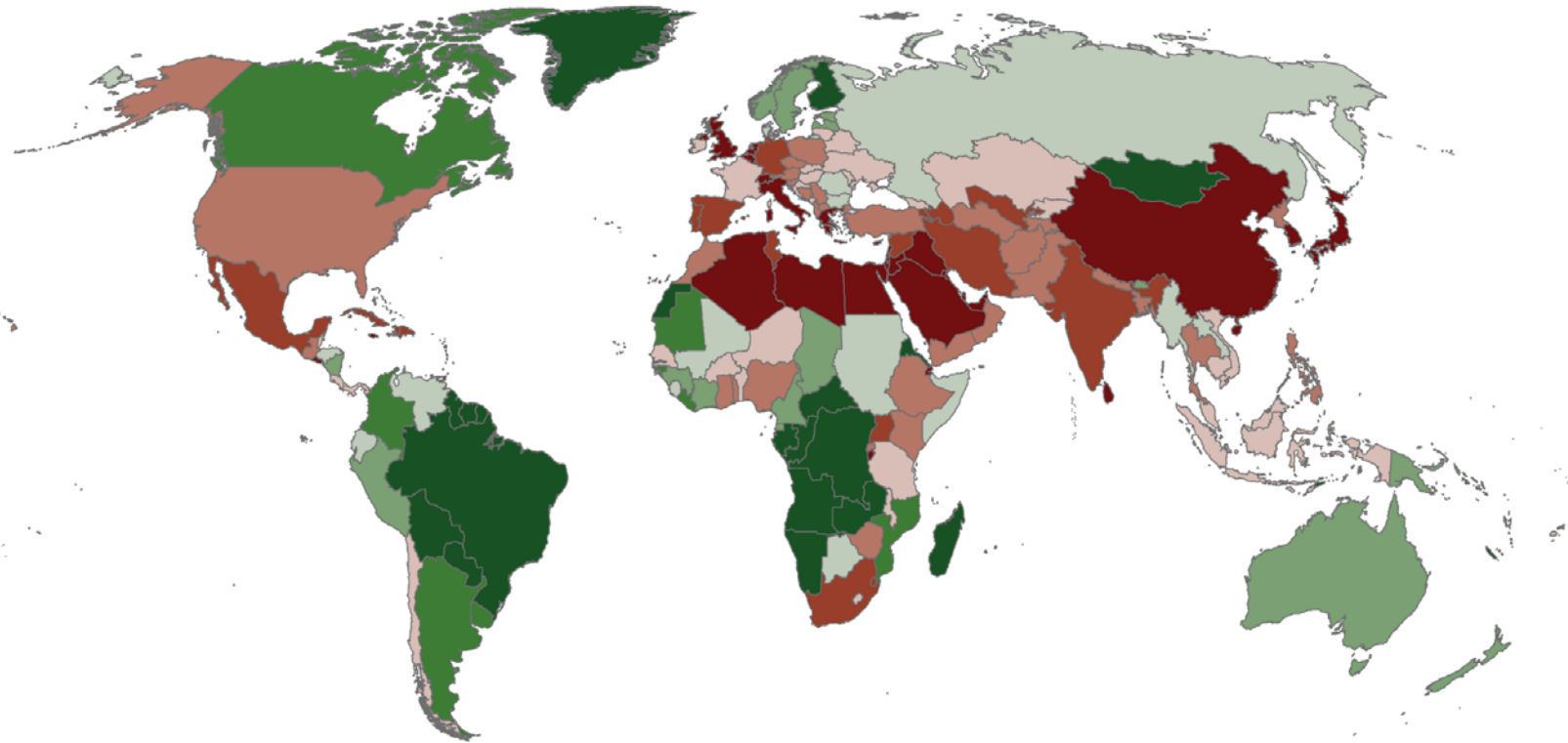
Biocapacity serves as a lens, showing the capacity of biosphere to regenerate and provide for life. It allows researchers to add up the competing human demands, which include natural resources, waste absorption, water renewal, and productive areas dedicated to urban uses. As an aggregate, *biocapacity allows us to determine how large the material metabolism of human economies is compared to what nature can renew.*

HDI and Ecological Footprint per person for Nations by World Regions

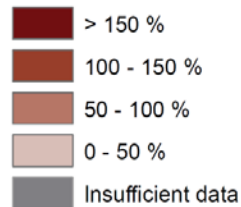


Ecological Footprint values are 2011 values from the 2015 National Footprint Accounts, Global Footprint Network
 HDI 2011 values are from the 2014 Human Development Report, UNDP

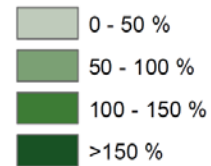
Biocapacity Deficit and Reserve



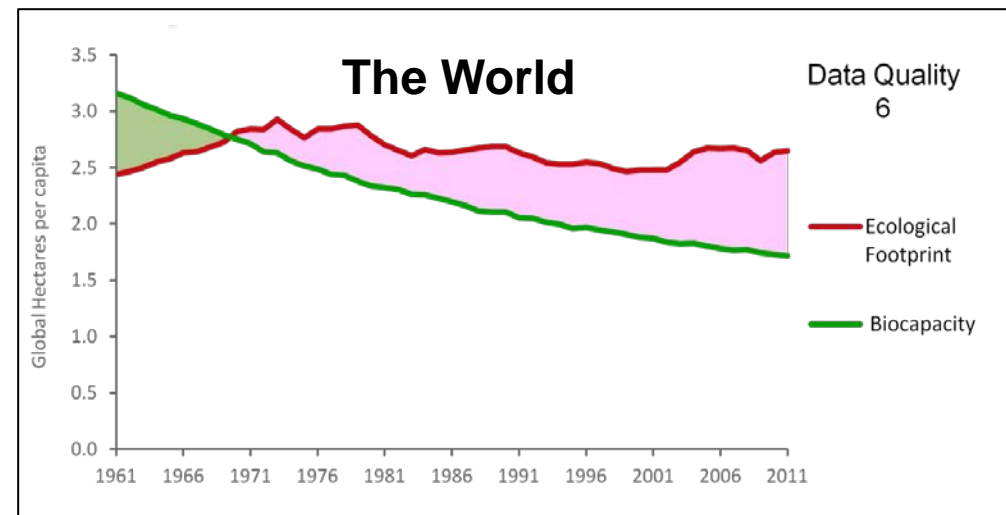
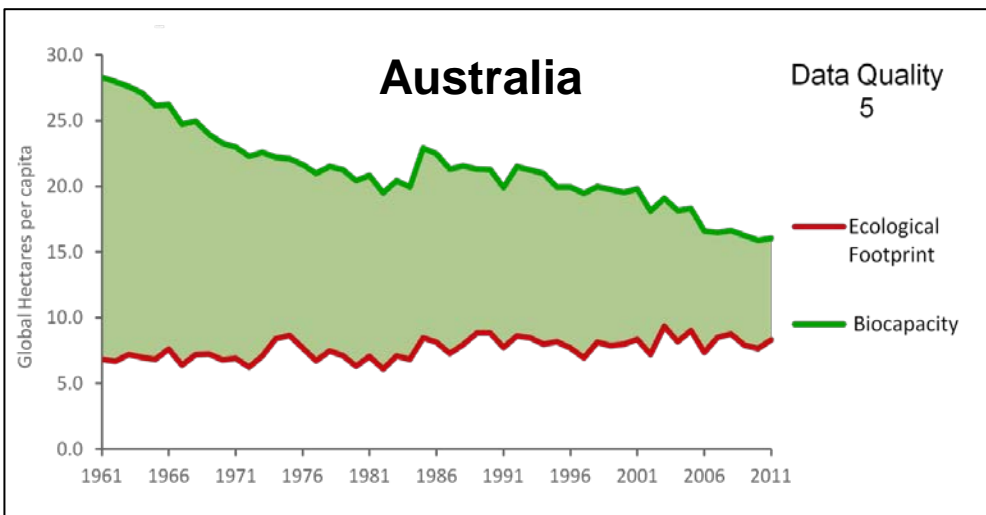
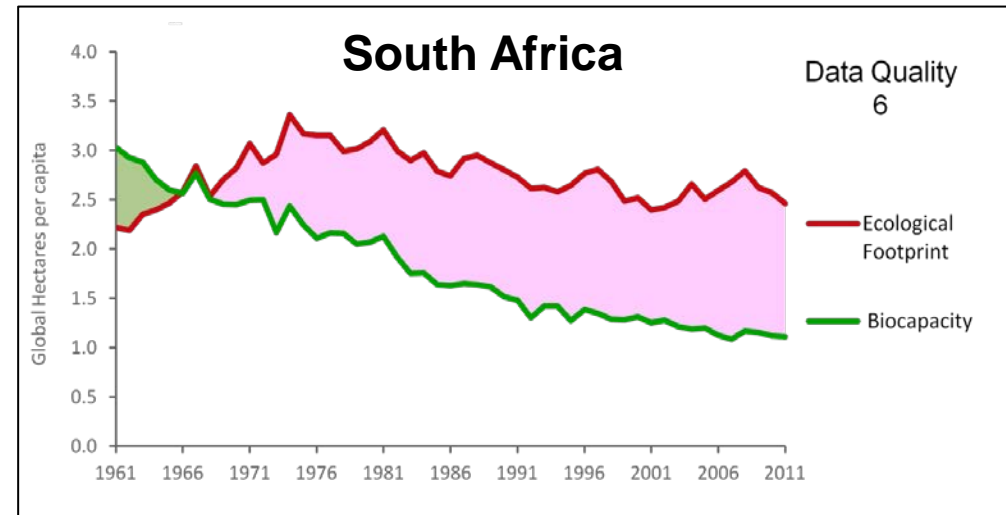
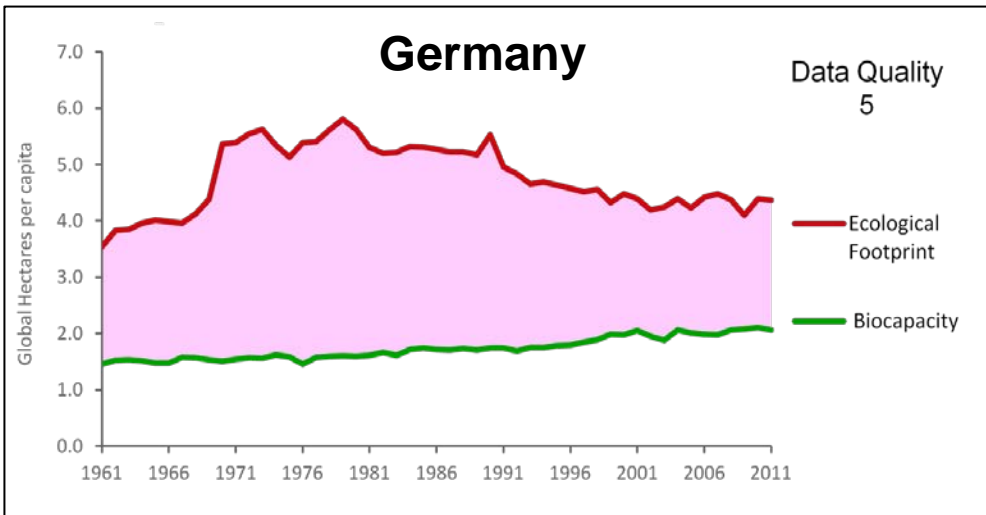
Ecological Footprint of consumption exceeds domestic biocapacity



Domestic biocapacity exceeds Ecological Footprint of consumption



2011 data from the National Footprint Accounts 2015 Edition. www.footprintnetwork.org



THE ONE REMAINING SOURCE

World
inter
highlig
continu



coal in South Africa
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a lack of a clear
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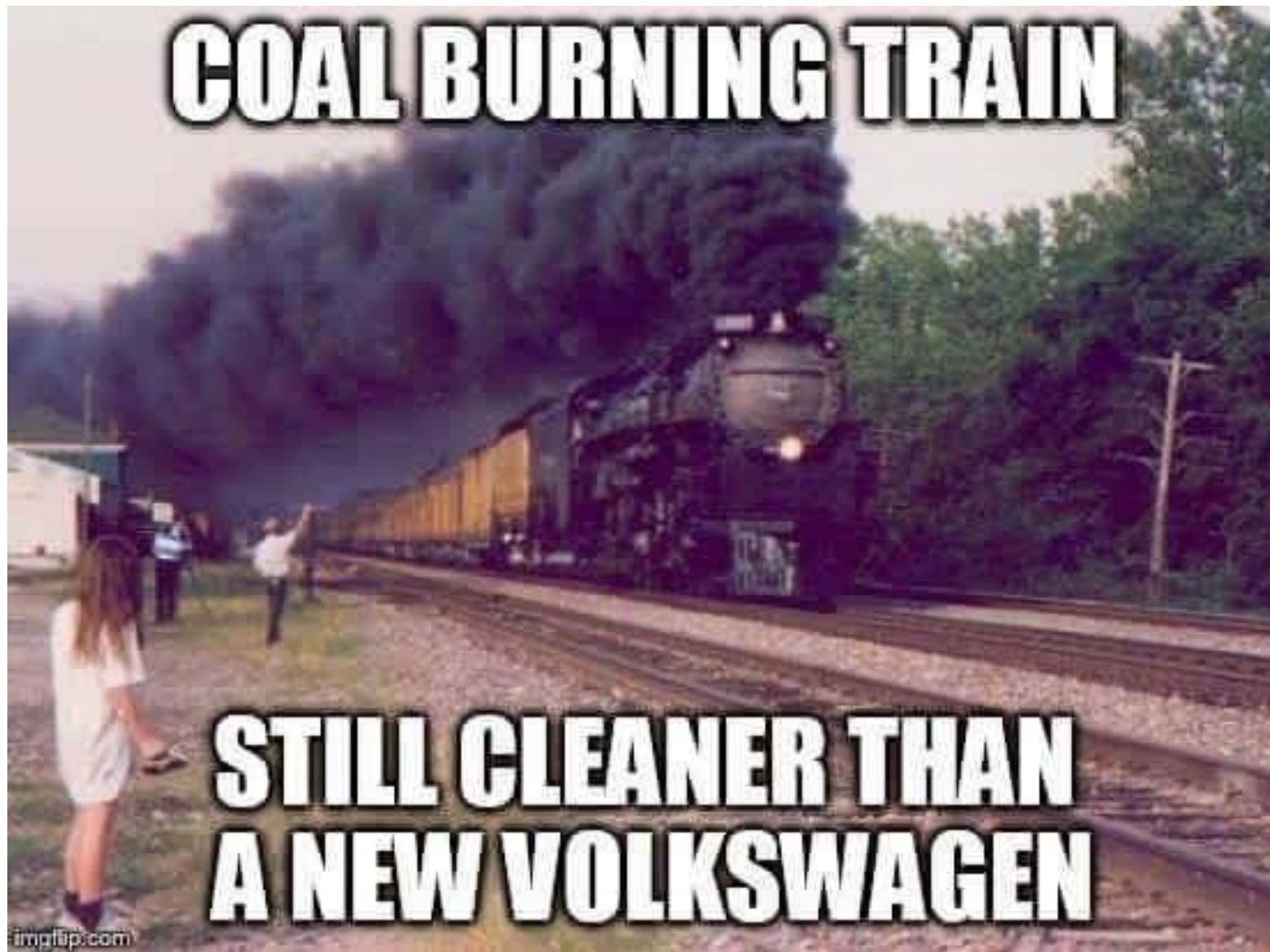
“Coal has beco
what oil is to
the Middle East
economy...”

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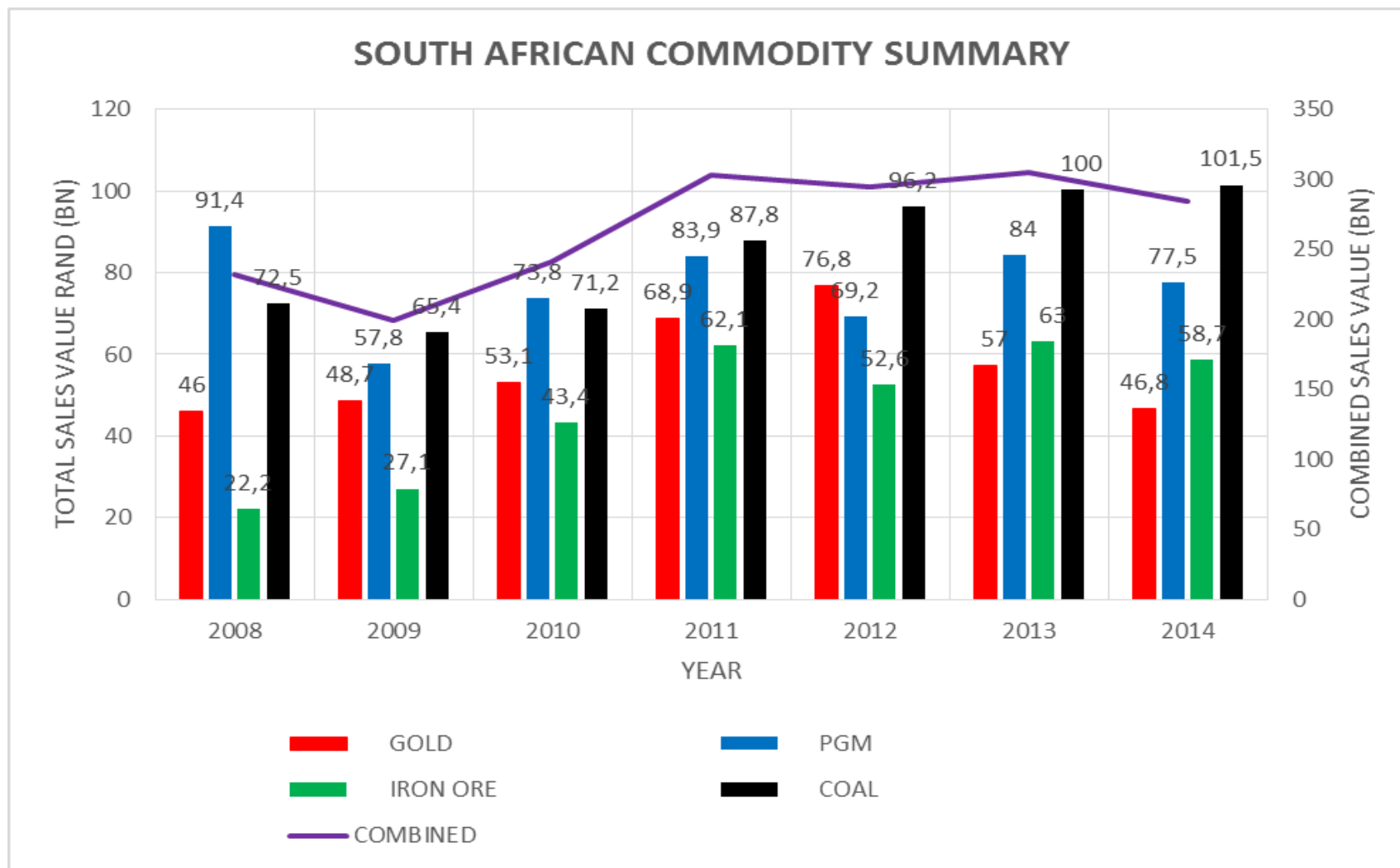
“How ‘CLEAN COAL’ will create new jobs.”

COAL BURNING TRAIN

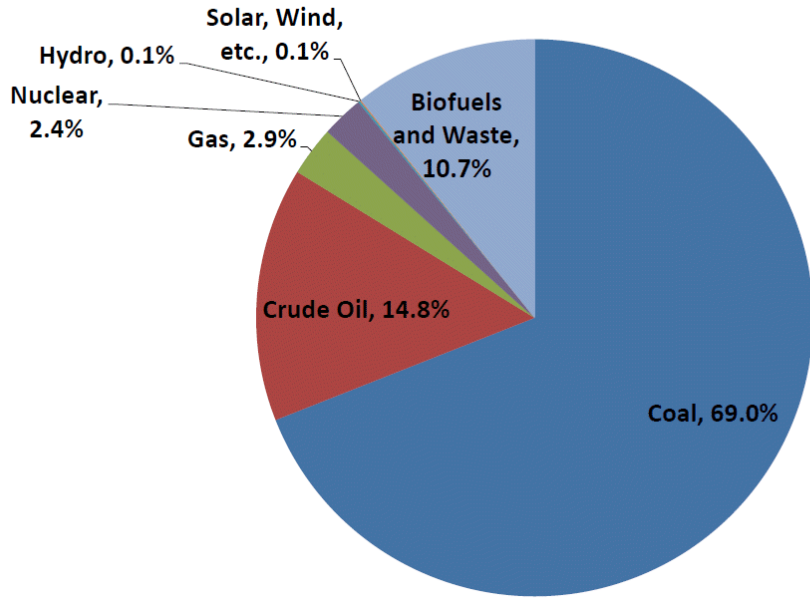


**STILL CLEANER THAN
A NEW VOLKSWAGEN**

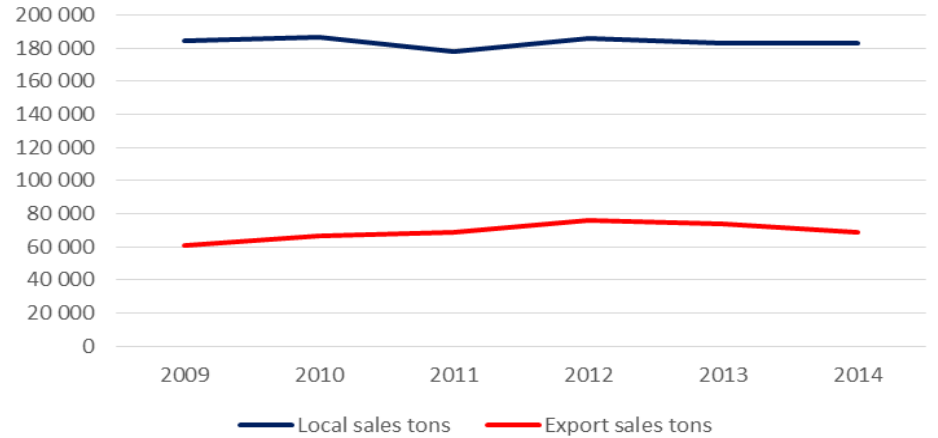
South Africa: Coal statistics



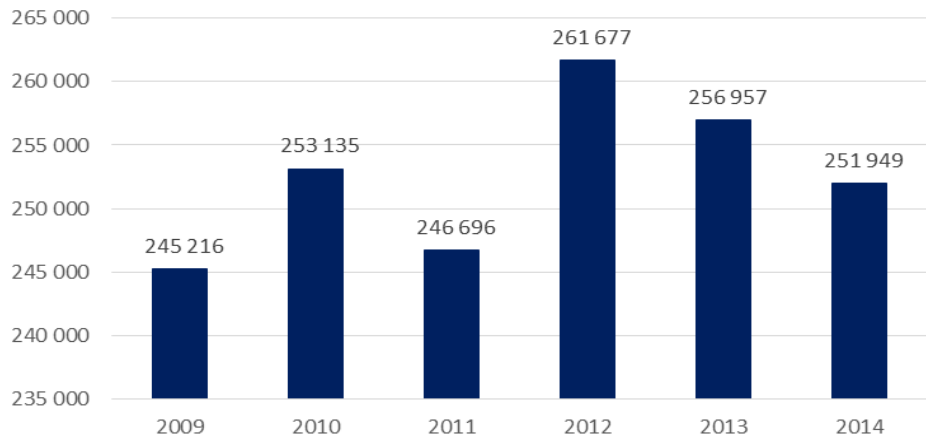
Total Primary Energy Supply in South Africa 2012 [% TPES]



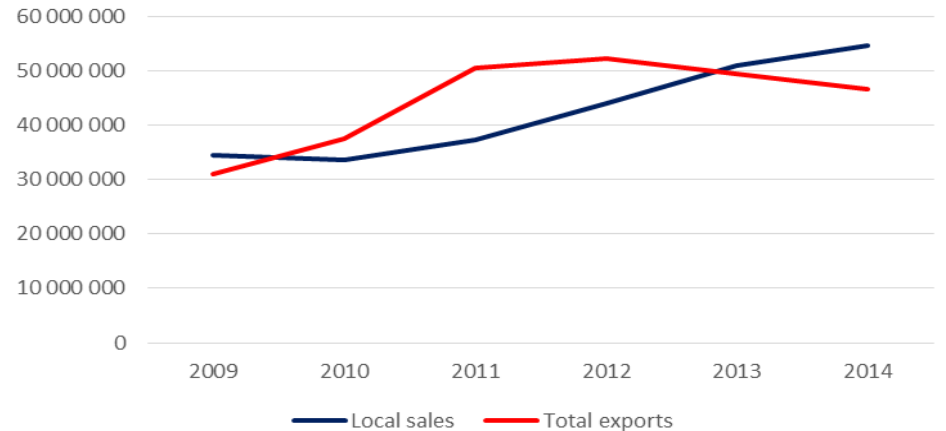
SA Coal Local and Export Sales Tonnes ('000)



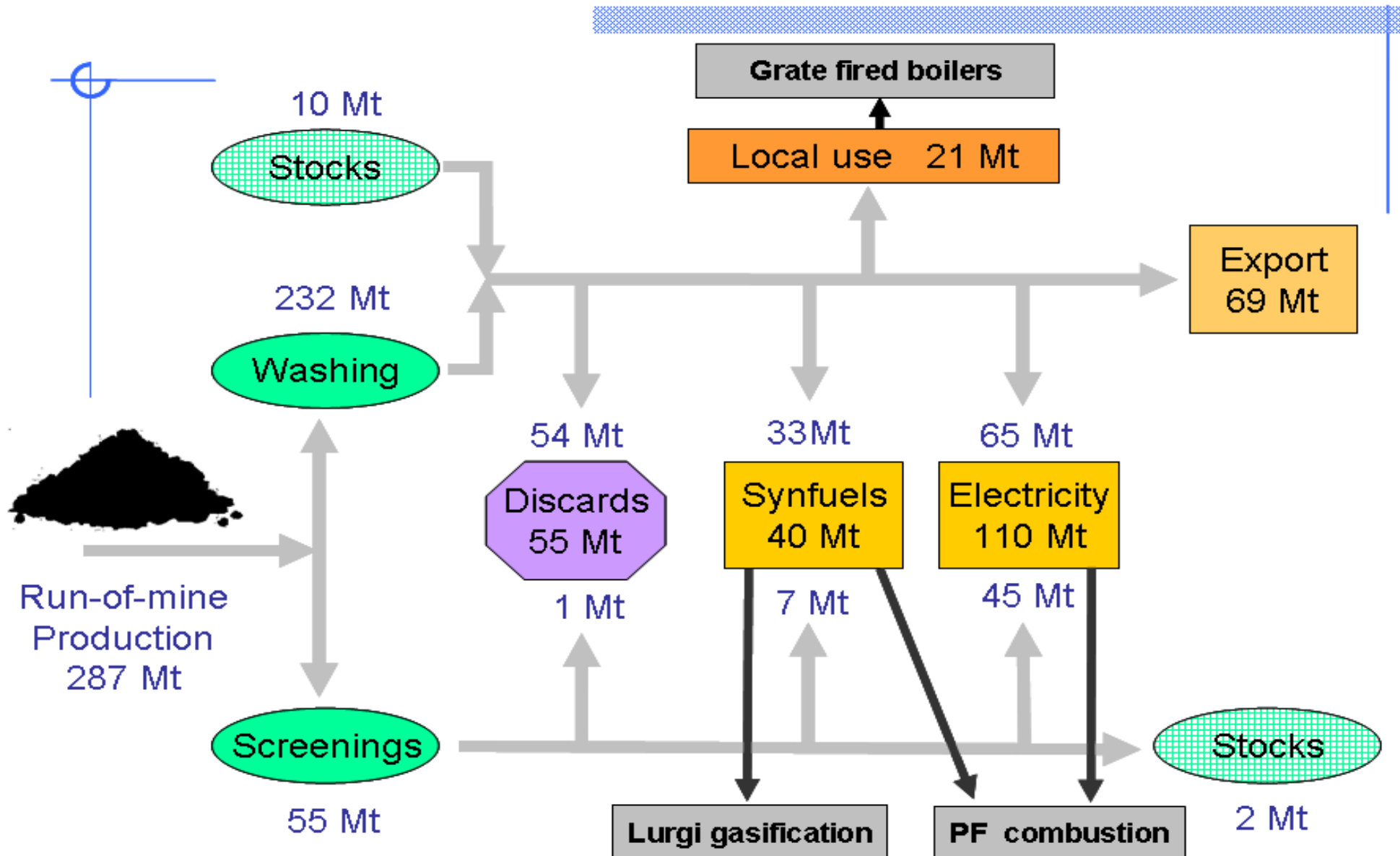
SA Coal Sales Tonnes ('000)



Coal Revenue ('000)



South African coal chain 2010



The most important coal users

in

South Africa

Sasol – the South African leg

- 1950 S.A. Coal, Oil & Gas Corporation founded
- 1954 Sigma Colliery starts production in April
Gasification testing starts in November
- 1955 First production at Sasol One - 8 drums of creosote
- 1964 Sigma Colliery produces 20 millionth ton (10 years after commissioning)
- 1969 Natref oil refinery in Sasolburg commissioned
- 1974 Sasol Two announced
- 1976 Construction of Sasol Two starts
First functional Secunda colliery, Bosjesspruit
- 1979 Sasol Limited listed on the Johannesburg Stock Exchange.
Sasol announced plans to construct Sasol Three next to Sasol Tw0
- 1992 Wonderwater open cast strip mine commences near Sasol One
- 2003 Sasol listed on New York Stock Exchange
- 2004 Mozambique Natural Gas project completed – supplying Sasol, Sasolburg
- 2010 New ethylene purification unit in Sasolburg
- 2012 Sasol New Energy constructs a 140 MW electricity generation plant, Sasolburg



**ADVANCING
SUSTAINABLE
DEVELOPMENT**

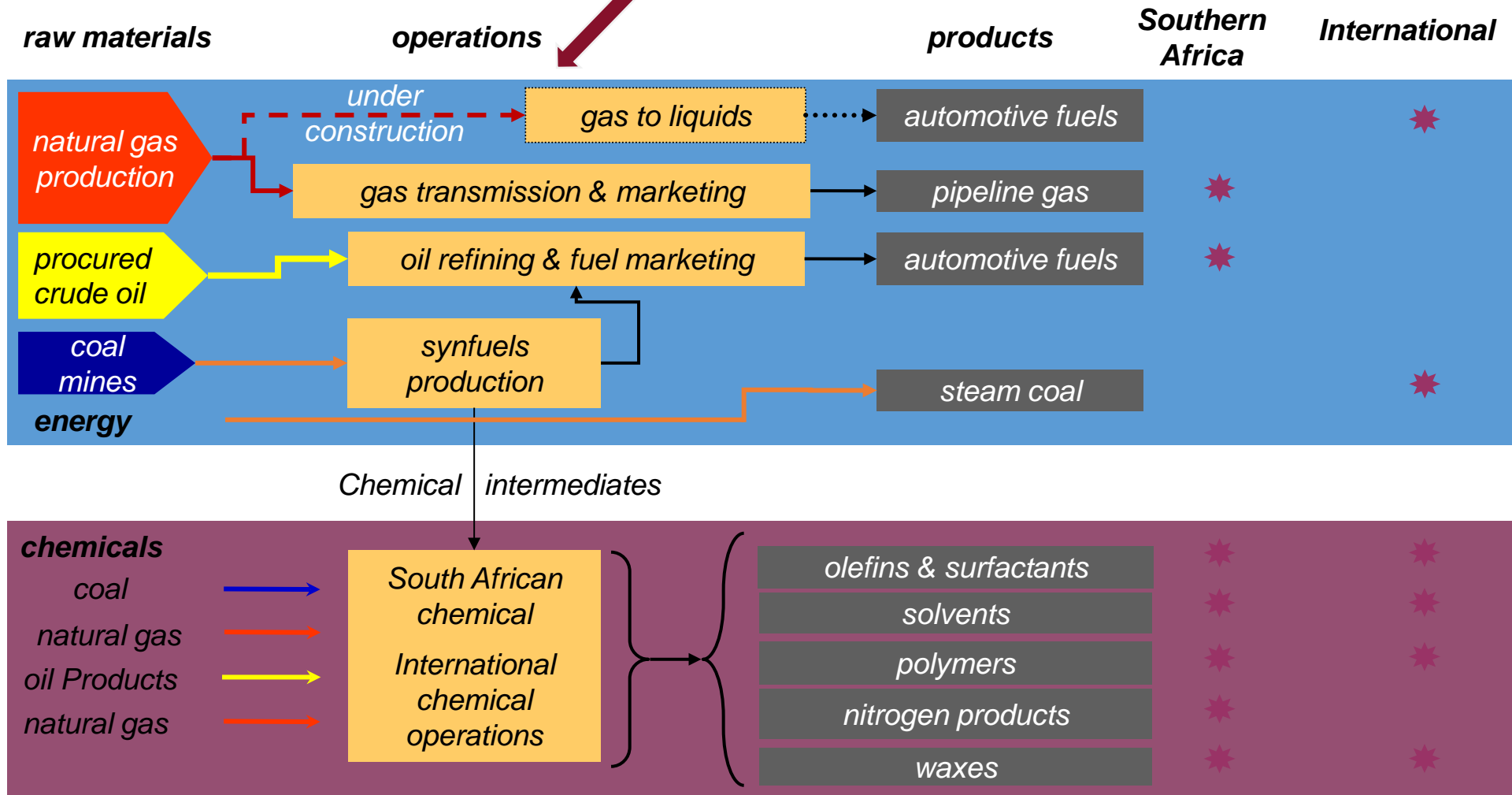
At Sasol we believe
sustainability practices
make good business sense

www.sasol.com



The Sasol process

In production
140 MW Power plant



The influence of the oil price

Crude Oil Price
48.54 USD/bbl
7 Sep '15



ESKOM: Coal fired power plants

20 power plants generate some 40GW of electricity
5 gas turbines supply 2.5GW of electricity



President Zuma officially opened the Medupi Power Station Unit 6, Liphlalale, Limpopo on 30 August 2015.

Medupi: The power station will be the fourth largest coal plant in the southern hemisphere, and will be the biggest dry-cooled power station in the world
While Unit 6 has just started up, it is the first of the six units and the total output will be 4 764MW

.... unfortunately 6 years behind schedule!

South Africa: UCG

Short History

Sasol 2009

Eskom Majuba 2007

June 2012 Africary

Sasol and Eskom sign research agreement for UCG collaboration in South Africa, June 10, 2013

Sasol New Energy and Eskom have signed a research agreement to jointly explore the full value chain of underground coal gasification (UCG) technology development in South Africa.

BUT



First venture in South Africa to produce 50 MW electricity to the grid

Theunnissen UCG site South Africa



Most notable historical developments



Household use of coal



SATURDAYStar

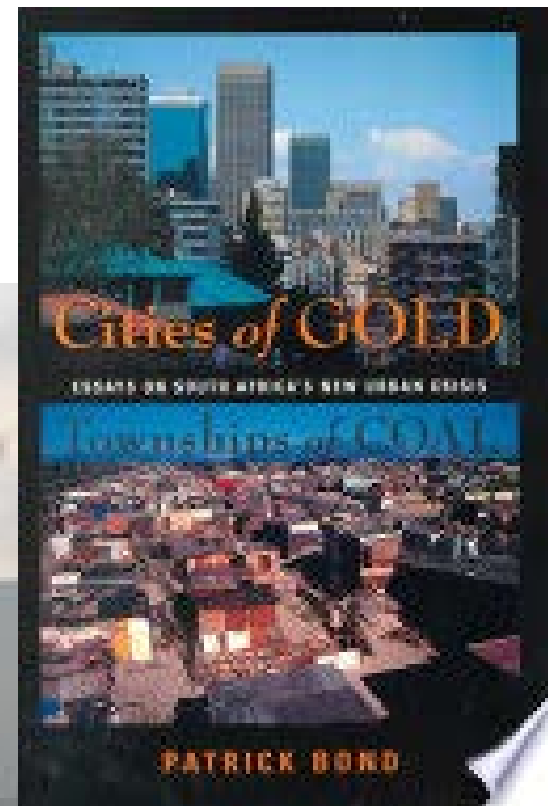
Poor 'choking to death' on pollution

February 17 2013 at 11:38am

By Sheree Bega

"We've been measuring in many of these places for almost 10 years now, and we're still measuring. We need to move towards a strategy to resolve how we're going to reduce emissions".

Picture: Johannesburg World Summit on Sustainable Development



Household coal use is estimated at 3% of total coal consumption, and an estimated 1 million households use coal as a household energy source, especially in winter

NWU Trans-disciplinary between natural sciences and engineering

Coal Chemistry

Coal Engineering

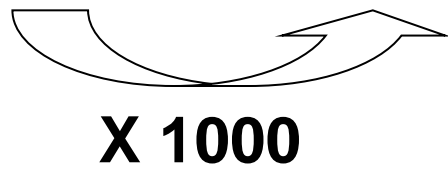
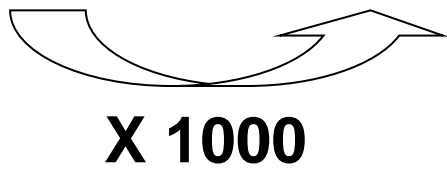
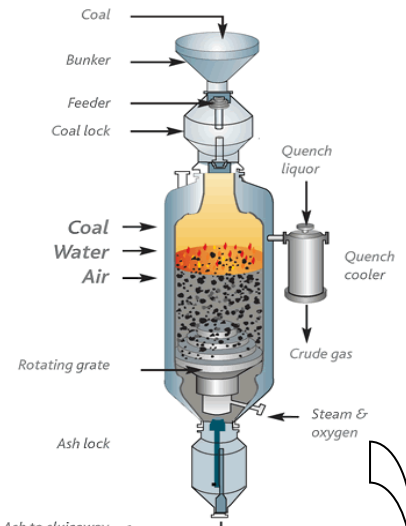
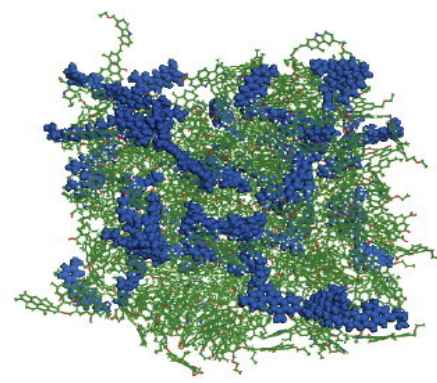


Molecular structure of coal
(nm scale)

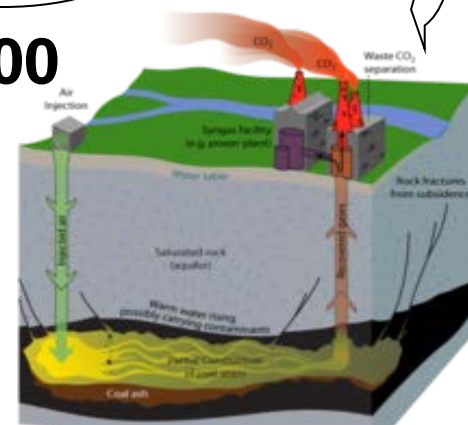
Intrinsic properties of coal
(μm scale)

Particle modelling of coal
(mm scale)

Reactor modelling of coal processes
(m scale)



**FROM MICRO SCALE TO COAL FACE
(UCG) POSSIBILITIES**



The problem with coal science.....



Not Shiny !



NO Bells and Whistles !

BUT....We have Glamorous students at NWU



FIELD WORK AT DGC: and even Professors can get their hands dirty !!!

Not Glamorous enough (Academic Snobbism) !!!!!



Courtesy of QP Campbell NWU

(1) Who publishes on coal processing?

Web of Science, filtered journal papers



(1) Authors publishing on coal processing?

Web of Science, filtered journal papers



(2) Who publishes on coal ash mineralogy?

Web of Science, filtered journal papers



(2) Authors publishing on coal ash mineralogy

Web of Science, filtered journal papers



(3) Who publishes on fixed-bed coal gasification?

Web of Science, filtered journal papers





33rd

**INTERNATIONAL PITTSBURGH
COAL CONFERENCE**

08 – 12 August 2016

SOUTH AFRICA





Thirty Third Annual International PITTSBURGH COAL CONFERENCE

Conference Announcement and Call for Papers

Abstracts Due 1 March 2016



www.Kapstadt.de

dus24.me

8 – 12 August 2016
Cape Town, South Africa
International Convention Centre

Coal - Energy, Environment and Sustainable Development



Hosted By:

- * African Carbon Energy
- * North-West University
- * University of Pittsburgh
Swanson School of Engineering



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Mr. Dawie Roodt Efficient Group

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All of the hard working citizens in South Africa involved with "COAL"

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Thank you

