ENERGY AND ITS EFFECT ON ECONOMIC GROWTH:

The Role of Coal in the Future Economic Environment of Southern Africa

[1]R Jeffrey and [2]R Falcon
[1]Econometrix
[2]University of the Witwatersrand

PCC Conference 2016

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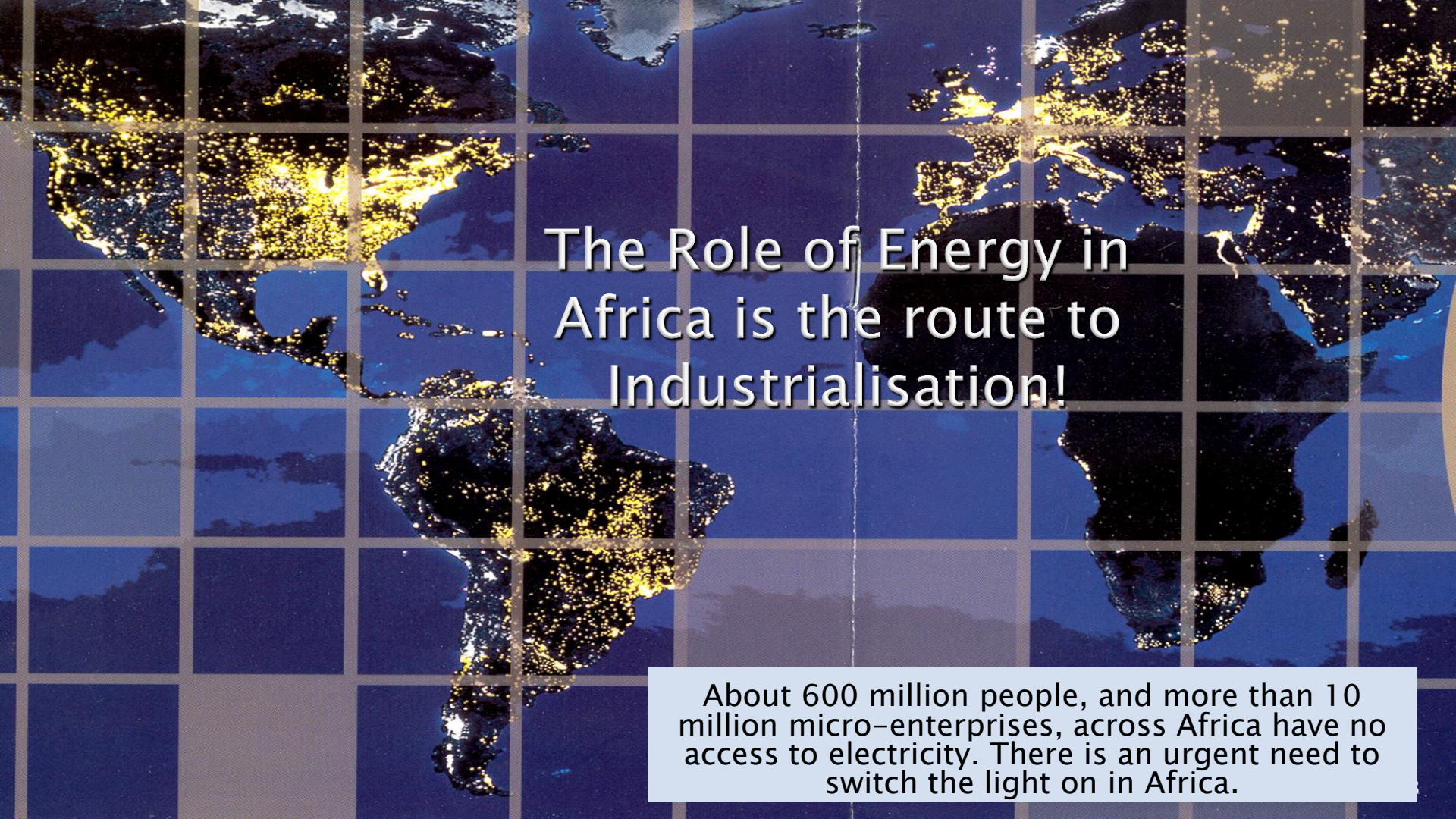
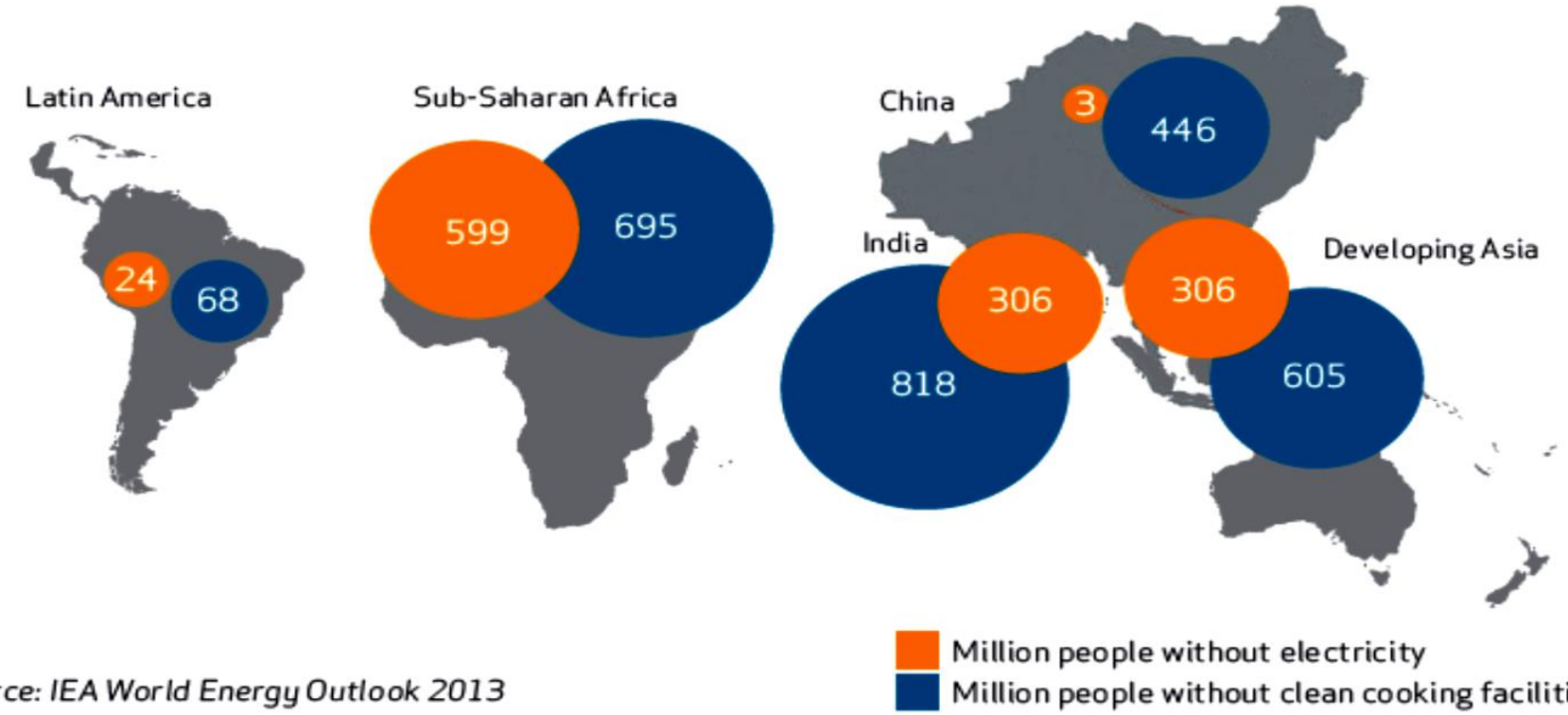
- **Introduction**
- Major Trends in Future African Economic Growth
- Electricity and Economic growth
- Comparative costs of electricity
- Challenges in Southern Africa
- Environmental issues – IPCC, COP21 and Carbon Tax
- Solutions – Clean Coal Technologies
- Conclusion



The Role of Energy in Africa is the route to Industrialisation!

About 600 million people, and more than 10 million micro-enterprises, across Africa have no access to electricity. There is an urgent need to switch the light on in Africa.

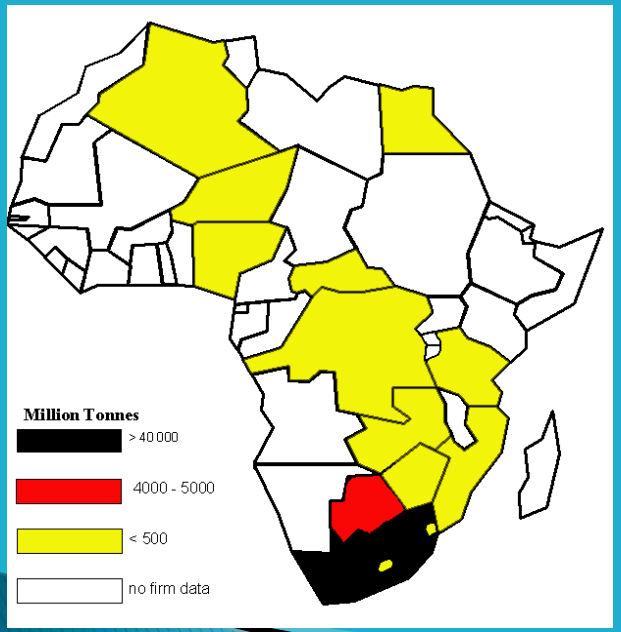
GLOBAL ENERGY POVERTY



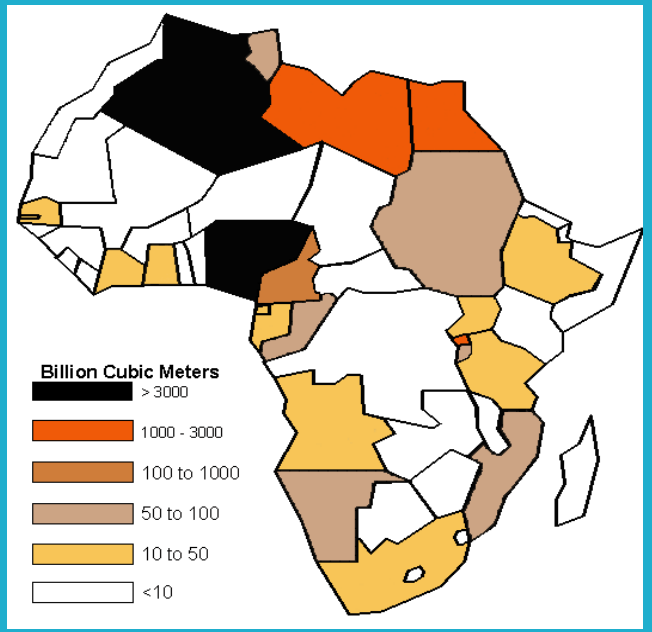
Source: IEA World Energy Outlook 2013

FOSSIL FUEL DISTRIBUTION IN AFRICA

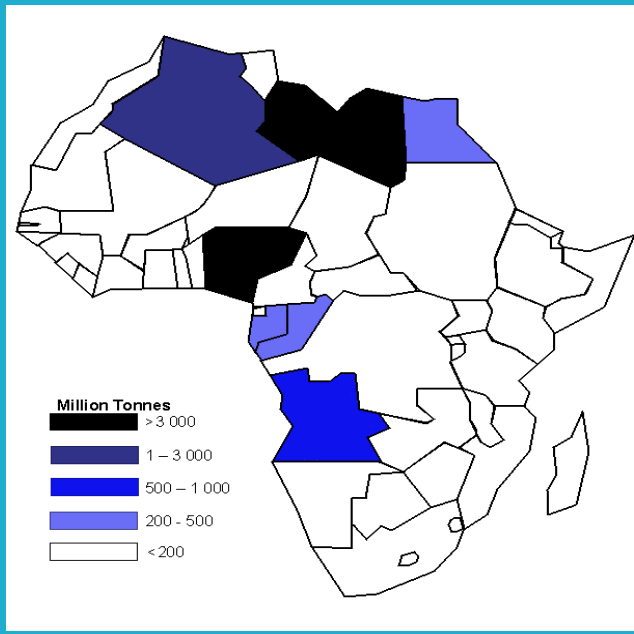
COAL



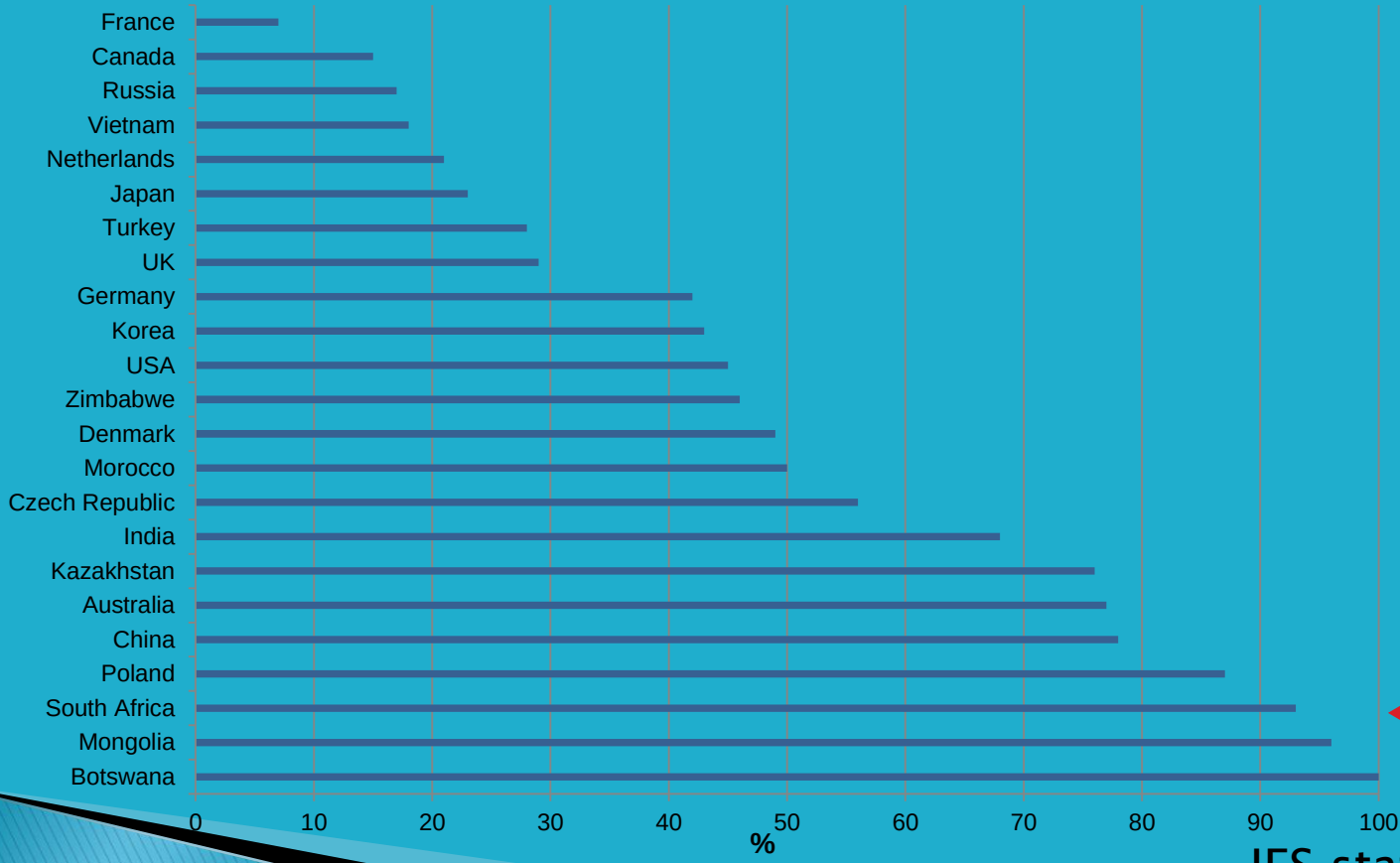
GAS



OIL



COUNTRIES HEAVILY DEPENDED ON COAL



SA

IES statistics

PREDICTED LIFE SPAN OF PROVEN COAL RESERVES

- **GLOBAL PREDICTION**: **118 years** (including hard and brown coal); [**Gas 59** years and **Oil 46** years] Source: World Coal Association/IEA 2011 report on 2010 data

- **SADC PREDICTION**: **Likely to be 200 years** under current usage, subject to exploration, market and logistics

- **SOUTH AFRICA**: **120 years** (hard coal) under current production – NB: an updated Coal Resource and Reserve Assessment us currently being undertaken.

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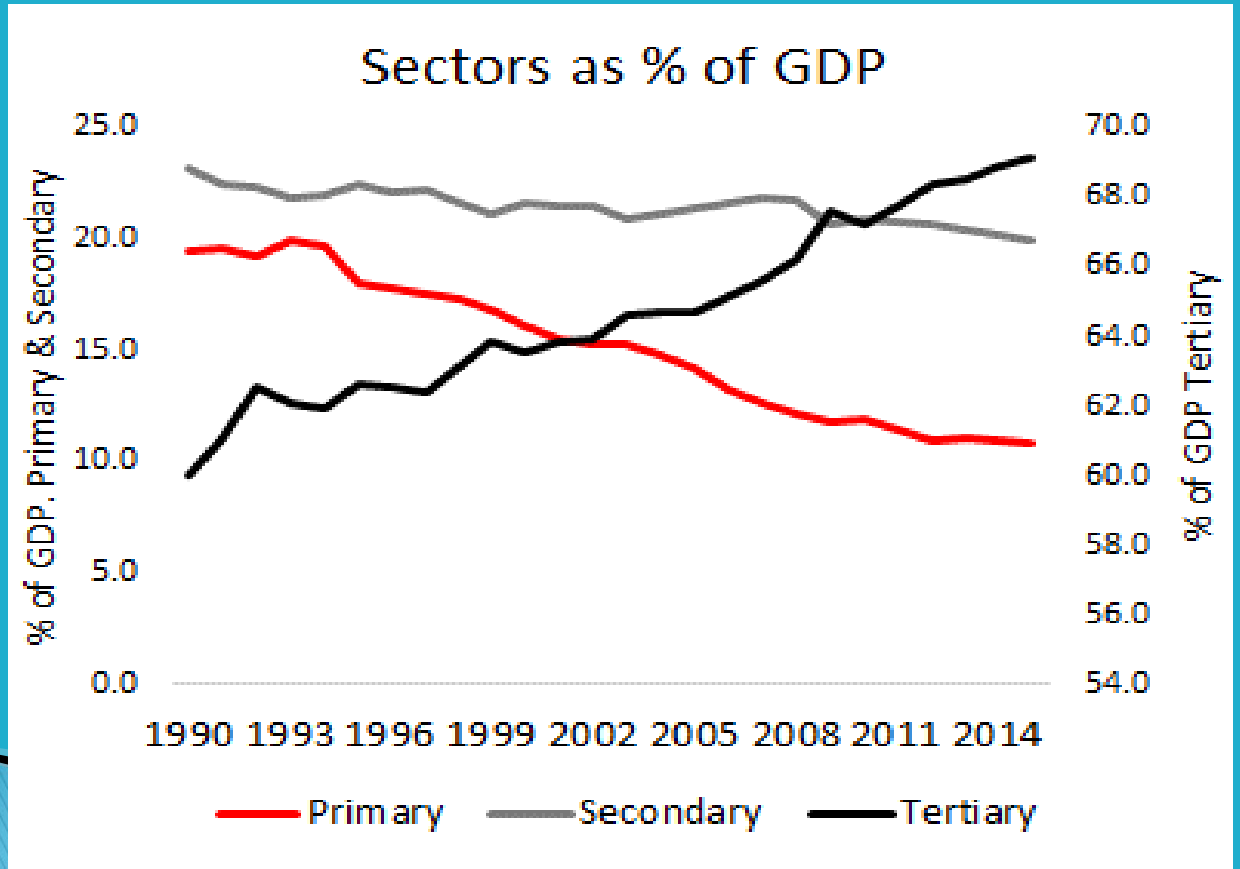
INFRASTRUCTURE IN SUB-SAHARAN AFRICA'S LESS DEVELOPED COUNTRIES

Low income countries		
	Sub-Saharan Africa	Rest of world
Total Road density *(km/km²)*	137	211
Paved road density *(km/km²)*	31	134
Power generation capacity *(mw/pop in millions)*	37	326
Electricity access *(% of population)*	16	41
Access to reliable water *(% of pop)*	60	72
Access to sanitation *(% of population)*	34	51

POOR GOODS PRODUCING SECTOR RESULTS IN INCREASING IMPORTS AND INSUFFICIENT EXPORTS - AND LOW GDP

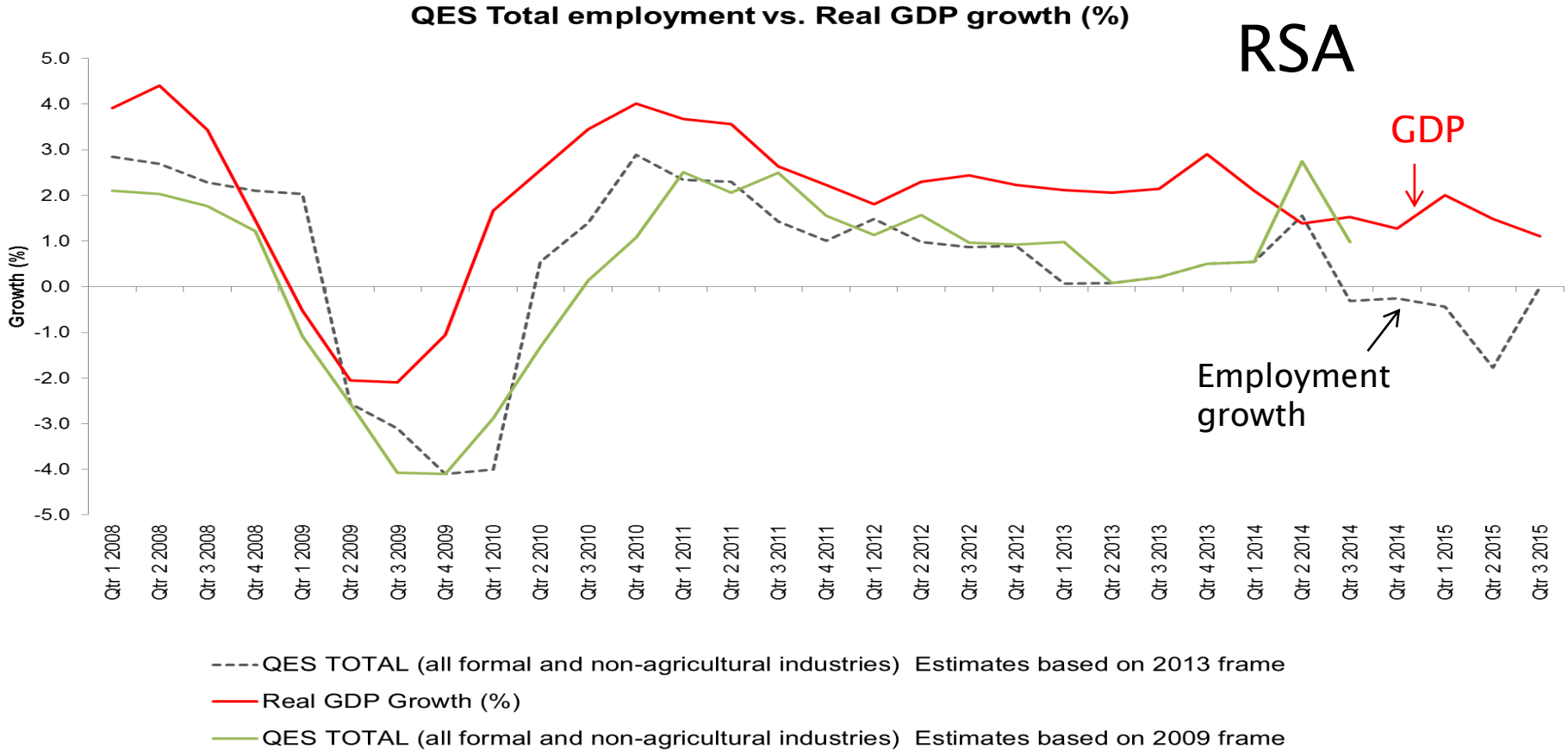


- **PRIMARY SECTOR** - goods produced
- **SECONDARY SECTOR –** goods exported
- **TERTIARY SECTOR –** goods
- imported

WORLD POPULATION (Millions)

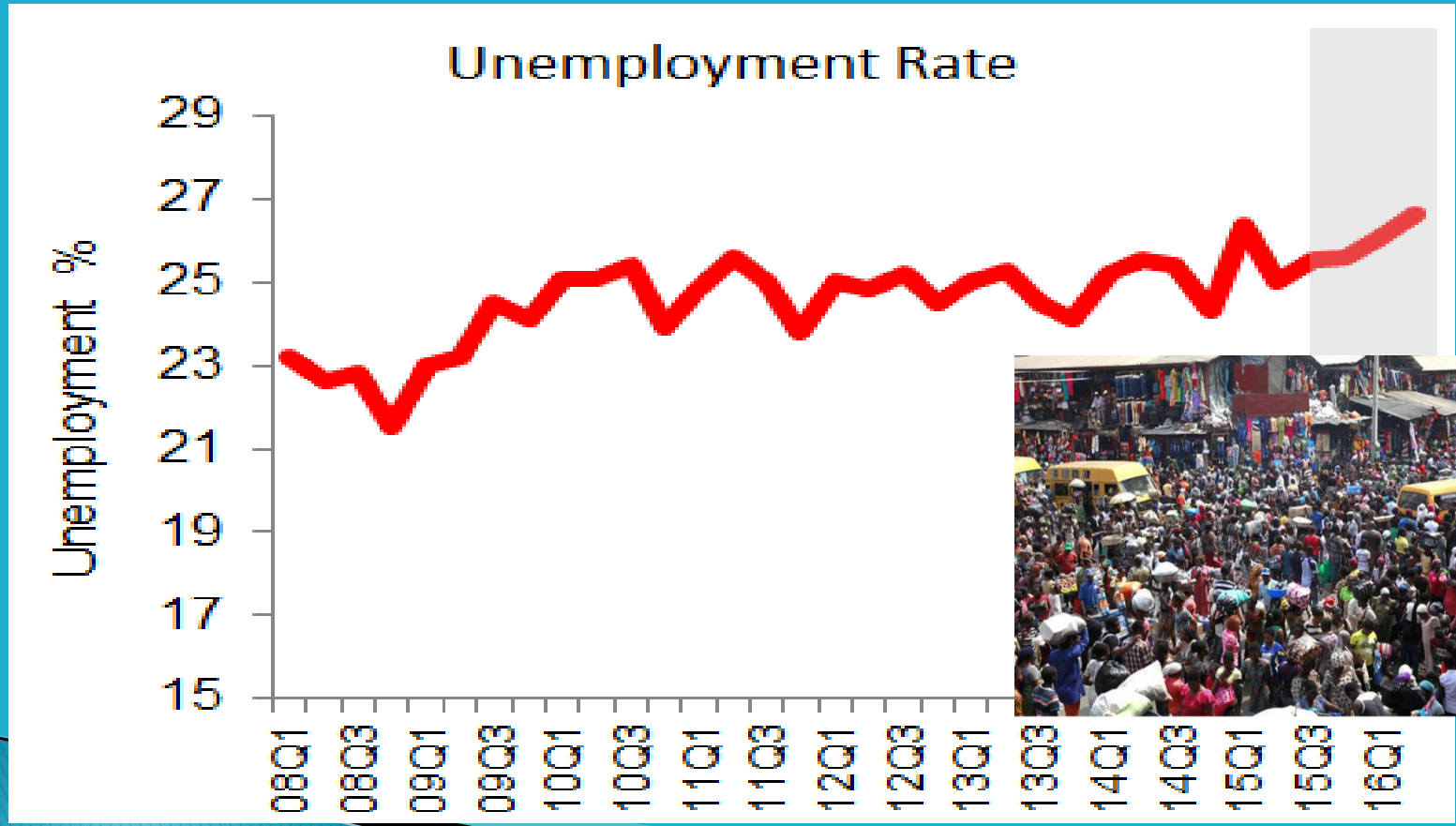
	Population		2050 Population as a Multiple of 2013
	Mid-2013	Mid-2050	
Sub-Saharan Africa	926	2185	2.4
Africa	1100	2431	2.2
Northern Africa	208	316	1.5
World	7137	9727	1.4
United States	316	400	1.3
Latin America & the Caribbean	606	780	1.3
Asia (excl. China)	2945	3970	1.3
China	1357	1314	1.0
Western Europe	190	199	1.0
Southern Europe	153	146	1.0
Eastern Europe	295	260	0.9

LOW GDP GROWTH MEANS LOW EMPLOYMENT GROWTH



Source: Statistics South Africa

RSA - RISING UNEMPLOYMENT RATE



KEY ISSUES FACING EMERGING ECONOMIES

- Rising unemployment, increasing social issues, and slow growth,
- There are three major policy objectives.
  - POVERTY ALLEVIATION,
  - REDUCING INEQUALITY AND
  - RAISING STANDARDS OF LIVING
- **Economic growth** is of paramount importance in the goods-producing sectors.
- **Electricity growth** is essential to support economic growth
- Emerging economies require **security of supply of electricity at the lowest possible cost**.

FUTURE LOW GROWTH MEANS RISING UNEMPLOYMENT

Population GDP growth and unemployment			
Current Statistics	**1995**	**2015**	**2030**
Population	45m	54m	**69m**
Unemployment	3.7m	8.4m	**?**
GDP Growth 2008-2015		1.9% pa	**?**
Current growth rate less than		2% pa	**2.5% pa ?**
Jobs created 2008- 2015 QLF		1.2million	**2.5 million**
Jobs required by 2030			**16 million**

R Jeffrey 2016

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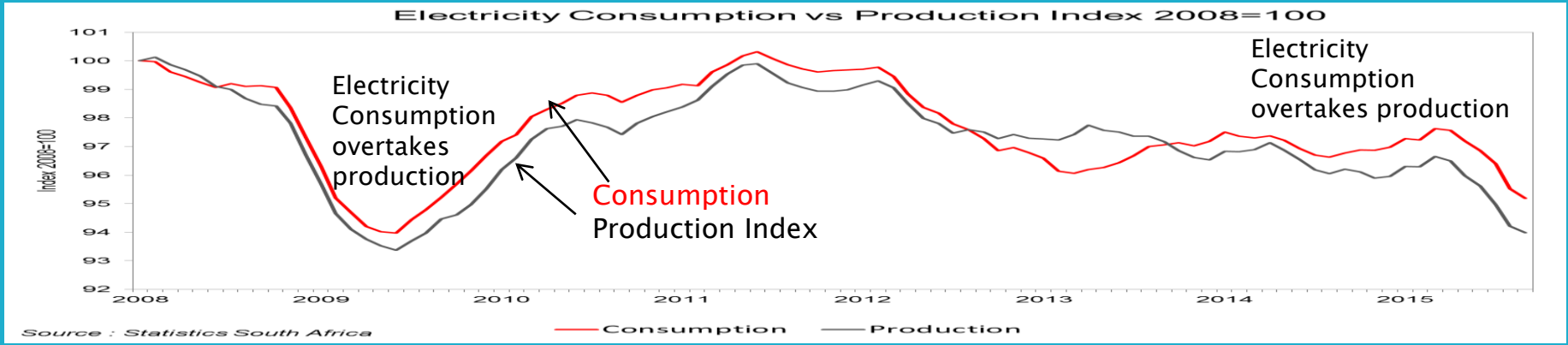
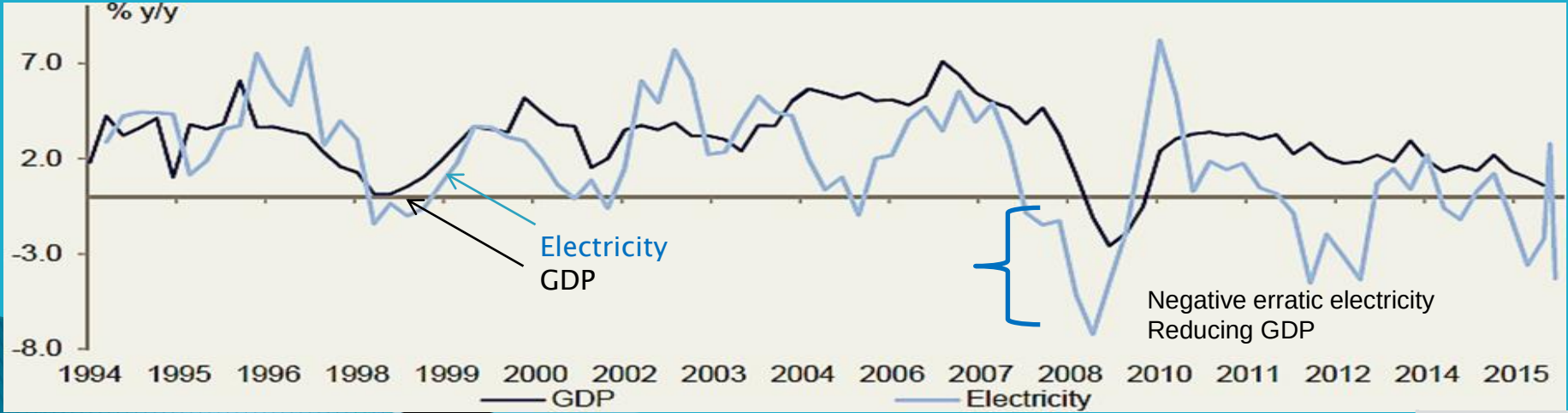
ELECTRICITY AND ECONOMIC DEVELOPMENT

ELECTRICITY AND PRODUCTION





THE ESSENTIAL ECONOMIC TRUTHS

- Economic growth is essential for raising standards of living, reducing unemployment and reducing inequality
- But economic growth can only take place with secure and increasing electricity production
- Low electricity growth leads to low economic growth

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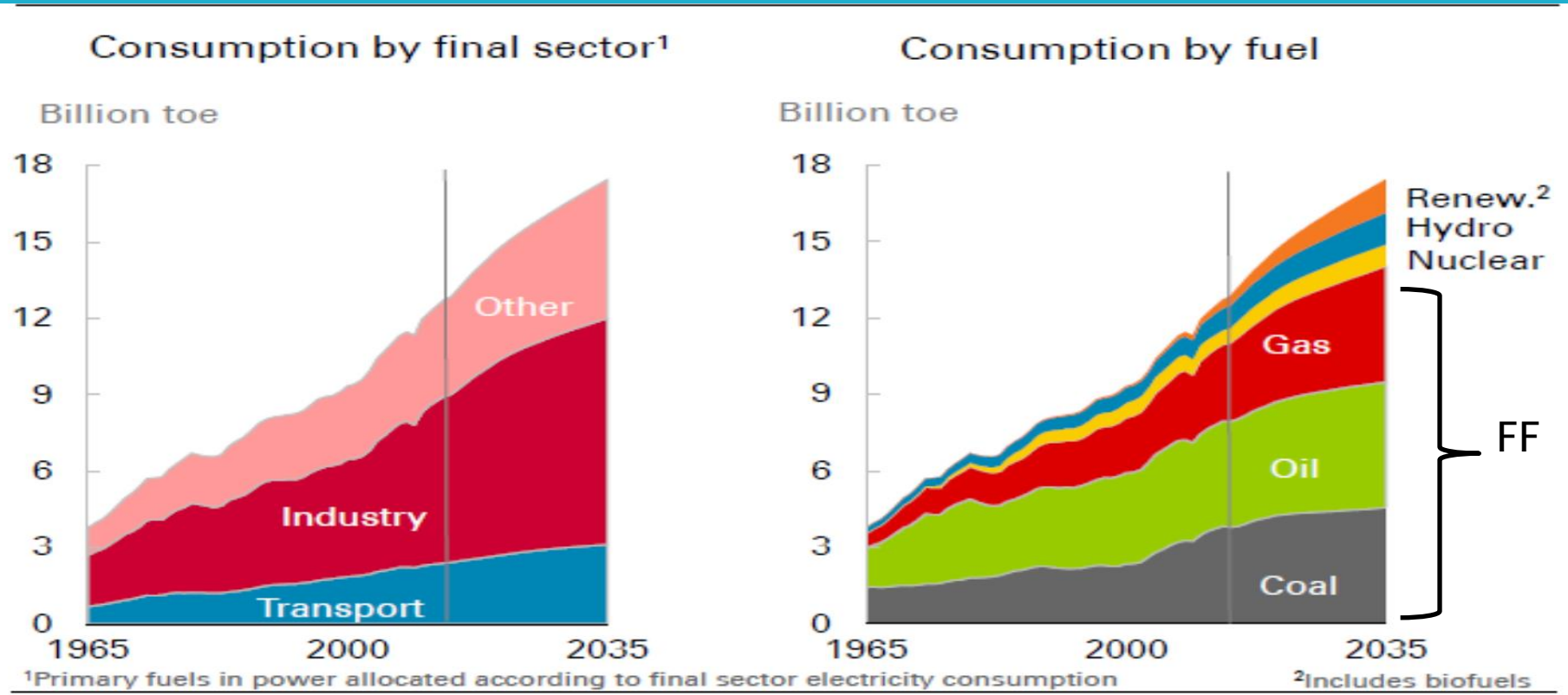
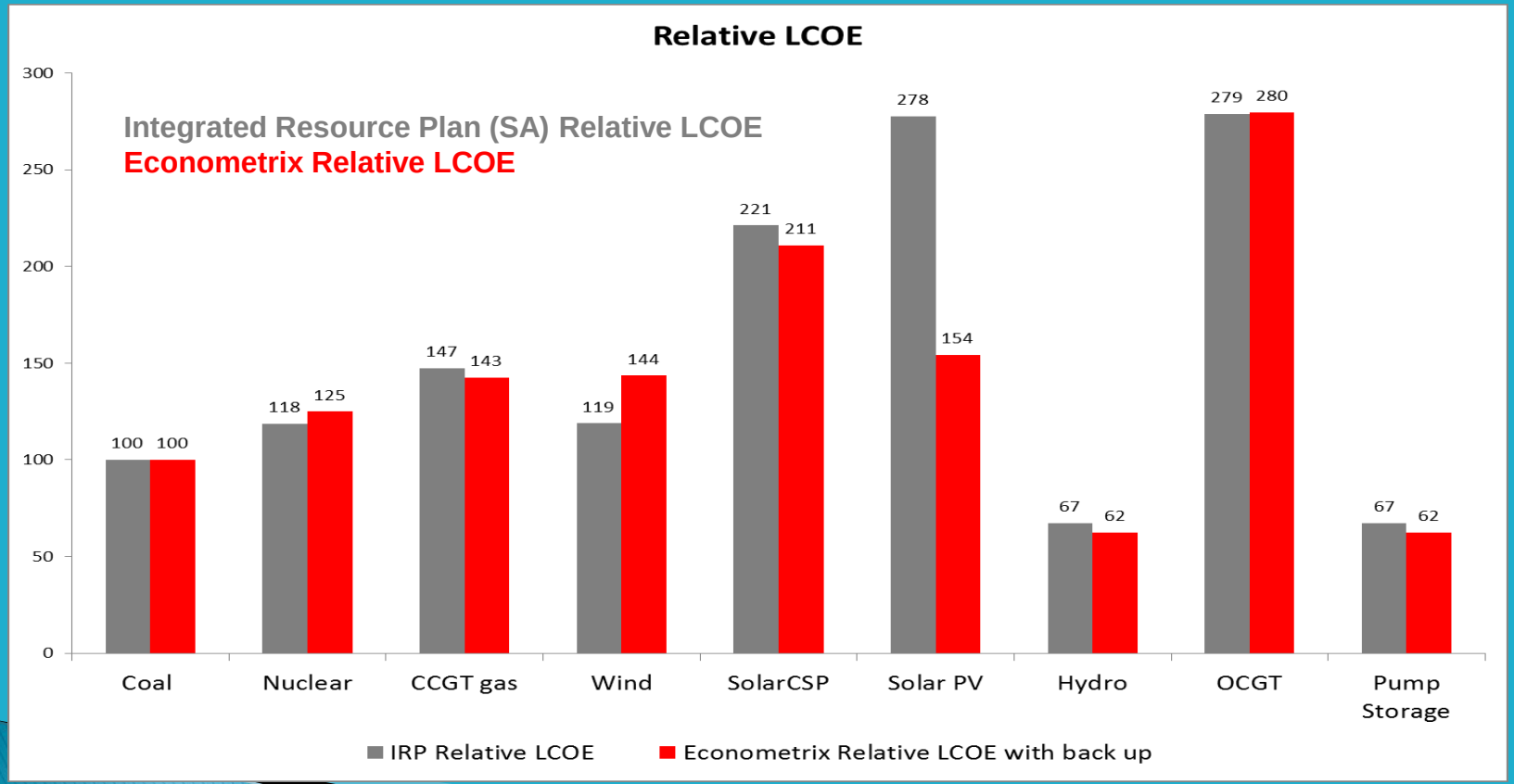
ALL POWER SOURCES HAVE COSTS AND BENEFITS

WORLD ENERGY CONSUMPTION AND SUPPLY



Energy Outlook 2035

RELATIVE LEVELISED COST OF ELECTRICITY (LCOE)



RENEWABLES

- Renewables are **intermittent and variable** increase these costs
  - They only supply power approximately **31% of the time**.
  - Require **100% back up**

- Until **storage costs** come down, these are unlikely to change significantly in the near future.

- Wind and solar CSP are not suitable for **base load power.** **They are too variable and expensive**

REAL COSTS OF RENEWABLES

- Renewables being **intermittent and variable** increase these costs and ONLY supply power 31% of the time

- Relative Real overnight capital costs (R in millions) are therefore
  - Wind at 31%: 200
  - Solar at 31%: 712
  - Nuclear at 92%: 244
  - Coal at 80%: **125**
- Wind and solar are significantly more expensive than coal and nuclear particularly when back up power costs are added

- **Latest data from overseas estimate that the LCOE of wind is 48% higher than for coal**

R Jeffrey, Econometrix '16

RENEWABLES SECURITY OF SUPPLY AND COST

- There is increasing evidence **that renewables (wind and Solar CSP) are not suitable for mass power in industrialised or industrialising countries**
- ENERGIEWENDE IN GERMANY have **driven up electricity prices** to unacceptable and uneconomic levels
- THE GERMAN GOVERNMENT have **capped wind and are in the process of withdrawing subsidies.**
- SOUTH AUSTRALIA'S Lessons for the World:- **Wind Power The Fastest Route to Social & Economic Disaster**
- SOUTH AUSTRALIA'S Intermittent & unreliable renewable energy is leading to the **deindustrialisation and reduction in its citizens' living standards.**

ENERGY POVERTY - NEW TO INDUSTRIALISED COUNTRIES

- **54 million** people in Europe are affected by **rising energy poverty, around 1.5 million** people could be dying prematurely
- Average real electricity prices for households and industries have increased **by 29%** between 2005 and 2011.
- **UK household** electricity prices have increased of over **80%** since 2005.
- The number of households affected by **energy poverty** in the UK, increased from **2 million to 5 million**.
- Green-energy policies in **California** have resulted in as many as **15 percent of households** falling into **energy poverty**.
- In the EU coal-fired power plants generate electricity at **half the price** of wind turbines and a **quarter of the price** of solar PVs

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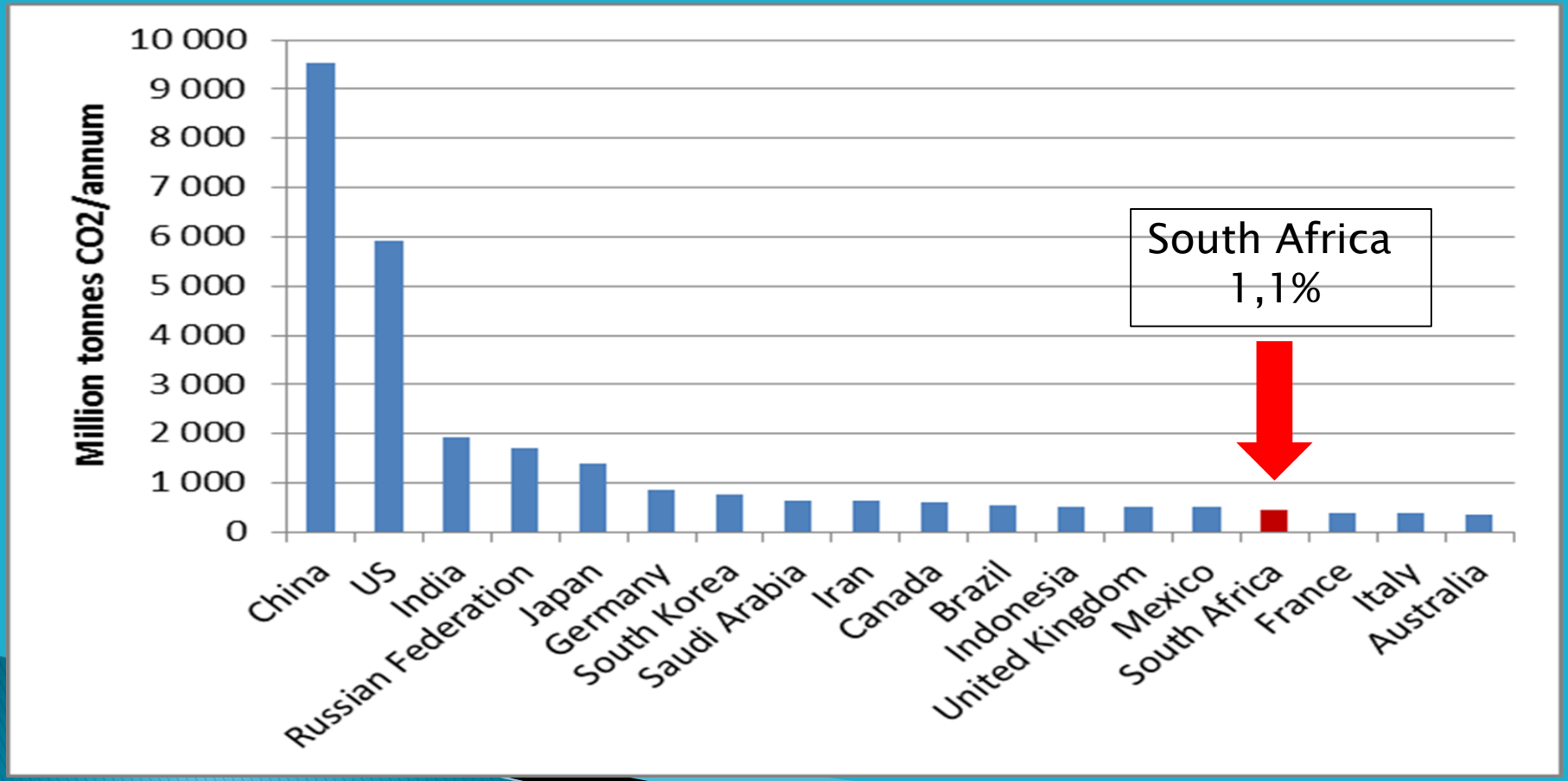
COP 21: PARIS OUTCOME

- The outcome of COP21 was an excellent agreement. What was important was not what was agreed but was not agreed.
- The agreement gave a set of sound long term global objectives. It asked for no commitments by any country.
  - Major countries either could not get agreement internally
  - Countries not going to make commitments were ASEAN countries, China, Russia, India, Vietnam, Korea and Poland
  - They were embarking on major expansions of coal and fossil fuels
- In summary, countries were expected to do what was in their **best economic interests**

CARBON DIOXIDE EMITTERS



CO2 EMISSIONS IN SOUTH AFRICA

	CO_2 conc	Mt CO_2/a
Coal to Liquids	**85%**	21,7
Power Generation	8-12%	**224,6**
Other industries	8-30	31,8

REDUCING EMISSIONS - THE ROLE OF TECHNOLOGY

- Raising global average **efficiency** of coal plants from **34% to 40%** with off-the-shelf cleaner coal technology
  - Would save **2 Gigatonnes of CO2**.
  - More than the annual CO_2 emissions of India- 4th largest emitter

- Initiatives needed to **cut 2 Gigatonnes of CO2** emissions
  - Run **EU Emissions** trading scheme for **53 years**
  - Run the **Kyoto Protocol 3X** over
  - Multiply the world's current **solar capacity 195X**

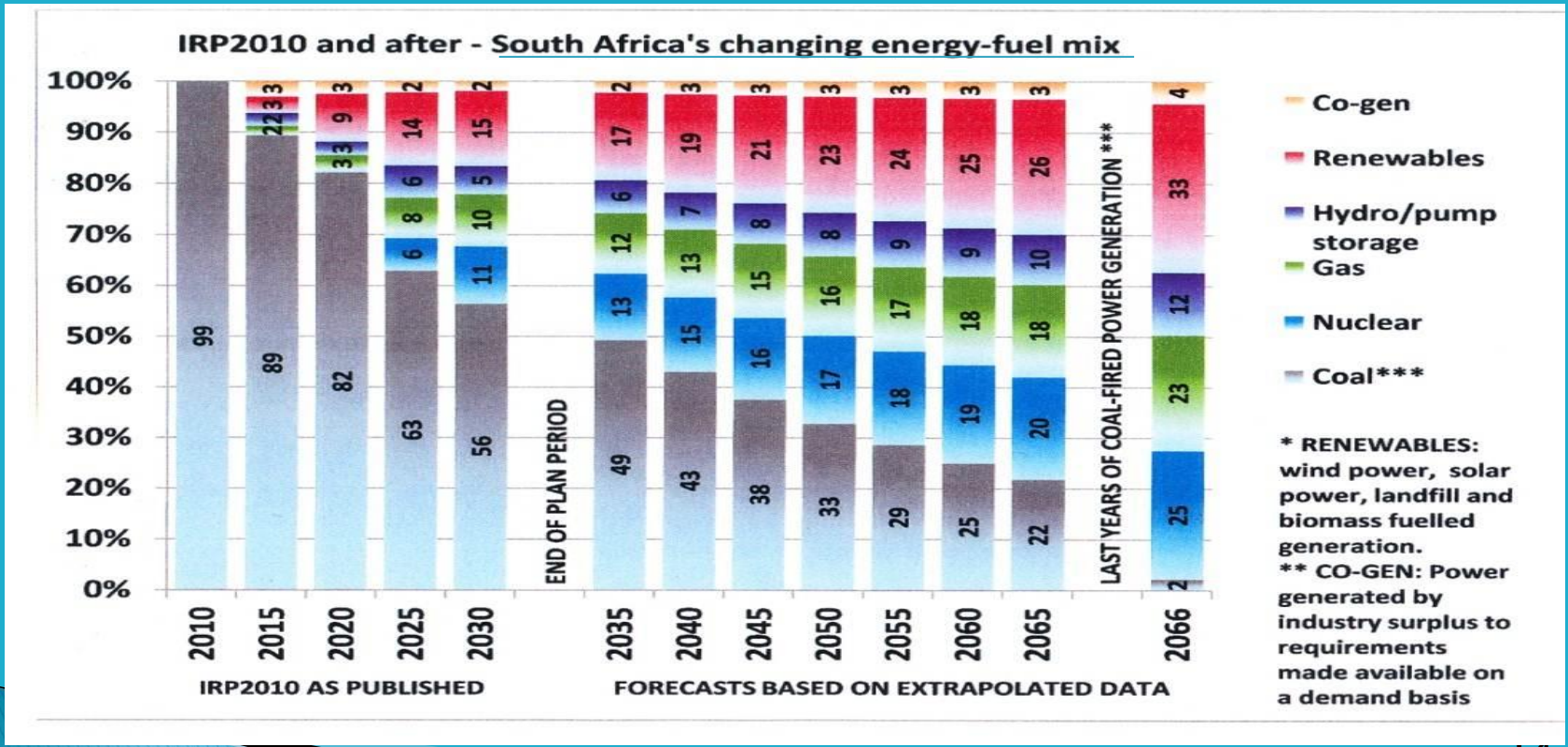
SOUTH AFRICA'S PROPOSED FUTURE CLEAN ENERGY FUTURE

- At the 2009 UN climate change talks, South Africa **undertook to reduce domestic greenhouse gas emissions trajectory by 34% by 2020, and by 42% by 2025**, subject to adequate financial and technical support

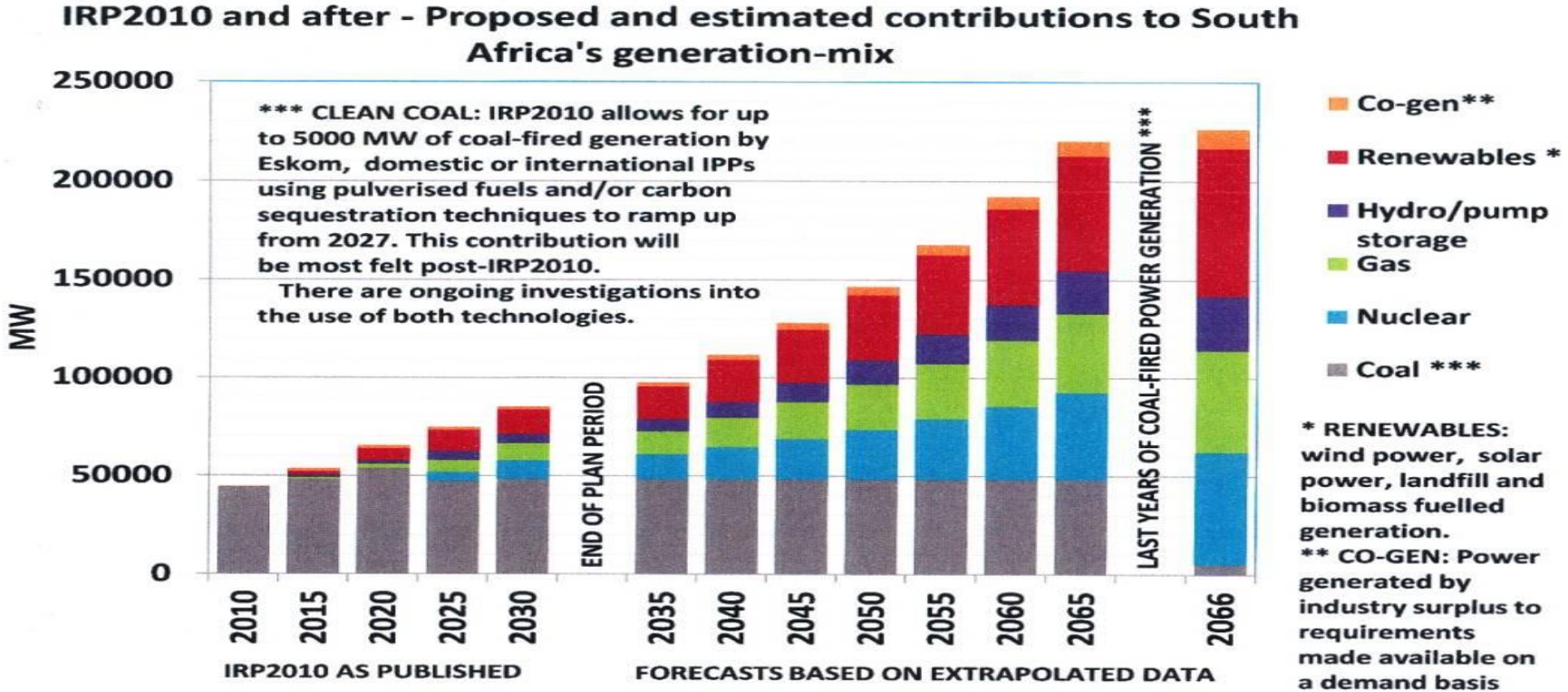
- South Africa introduced the **SA Renewables Initiative in October 2011 –** obtaining funds for climate change adaptation, energy-saving equipment, moderating the spike in the price of electricity generated from renewable sources

- South Africa introduced the **Integrated Resource Plan (IRP) in 2010 – the IRP2010**, mixed sources of energy

LOW CARBON ECONOMY LEADING TO A REDUCTION IN CO_2 EMISSIONS IN SA - IRP2010 [Integrated Resource Plan 2010)



LOW CARBON ECONOMY LEADING TO A REDUCTION IN CO_2 EMISSIONS IN SA - IRP2010 [Integrated Resource Plan 2010)



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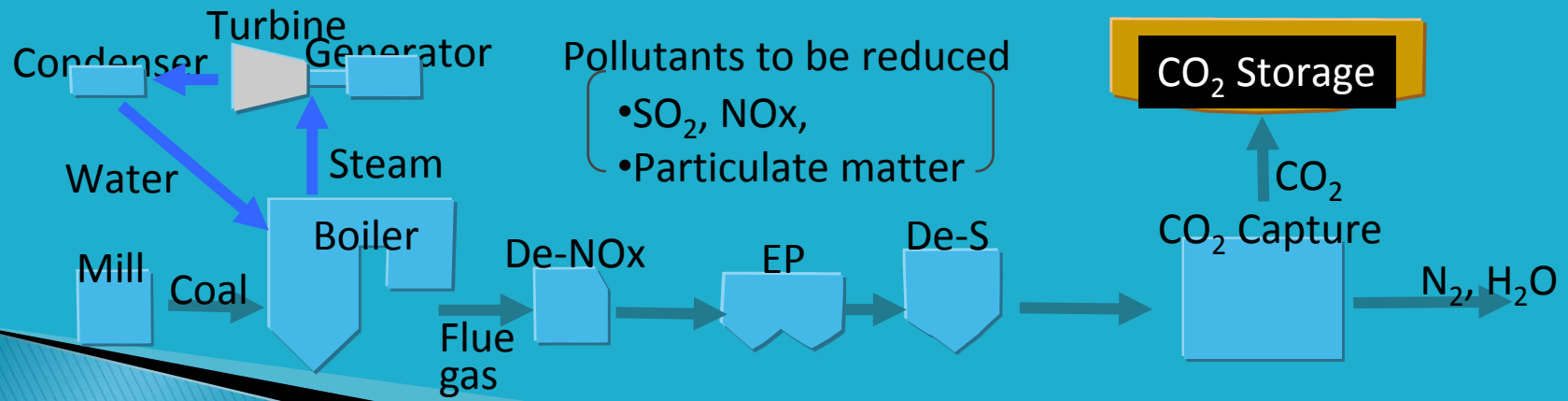
FUTURE TECHNOLOGIES FOR A LOW CARBON ECONOMY

TECHNOLOGIES TO REDUCE BOTH GHG AND NON-GHG (NOX, SO_2, PM) EMISSIONS – FOR CLEANER COAL UTILISATION

(1) Reducing coal consumption (increase efficiency)

(2) Reducing non-GHG emissions

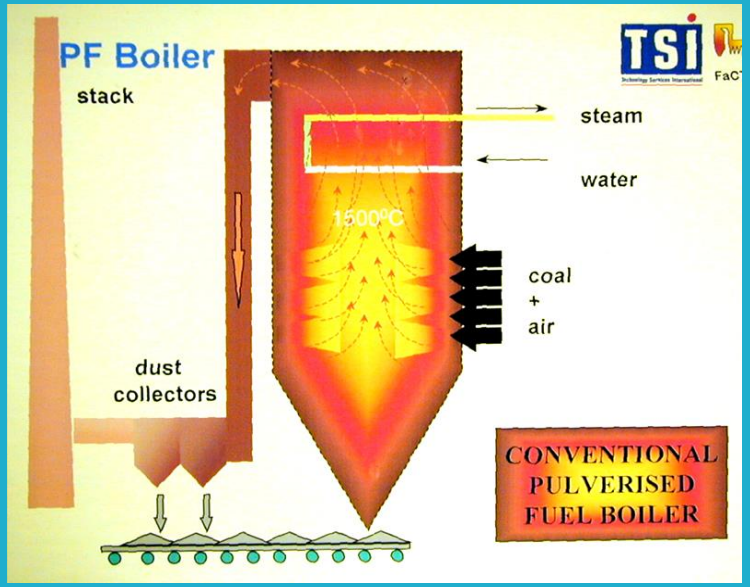
(3) Carbon Capture and Storage or use

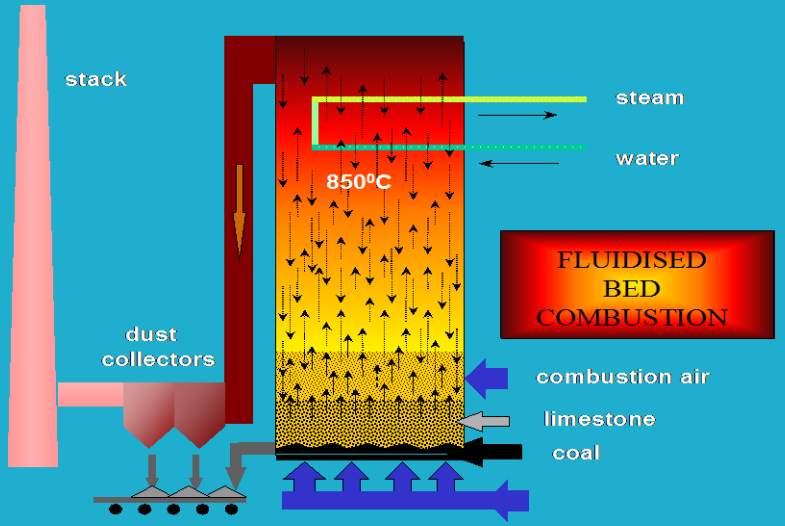


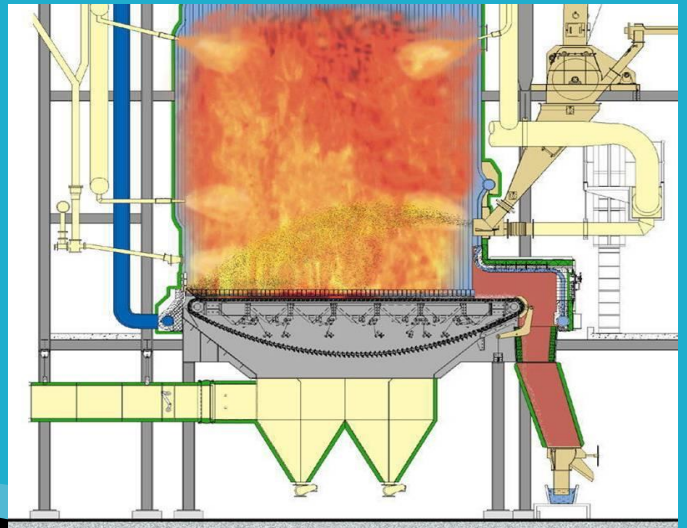
EP: Electrostatic Precipitator

After WCA / D Collins

CURRENT COAL-FIRED TECHNOLOGIES IN USE

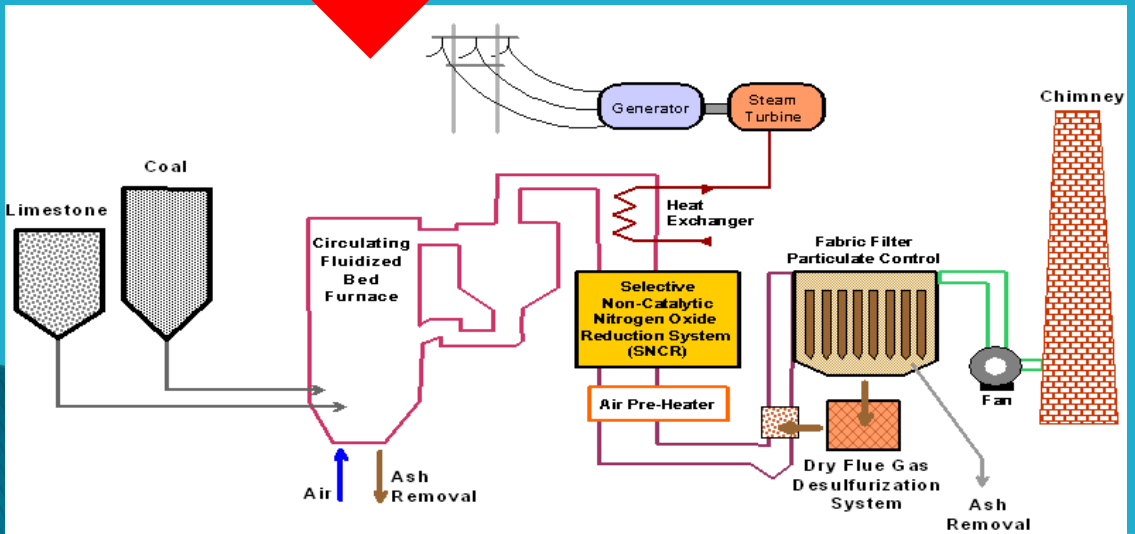


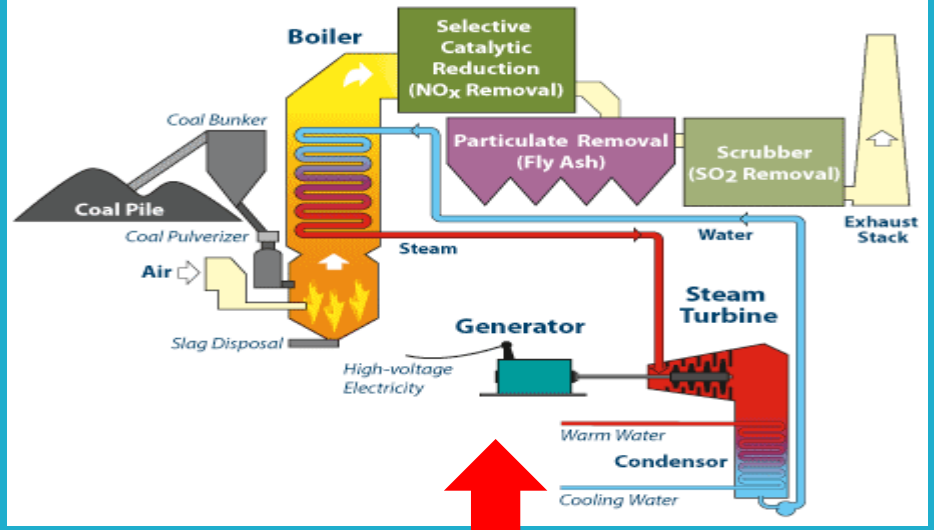




FUTURE COAL-FIRED TECHNOLOGIES FOR SOUTH AFRICA

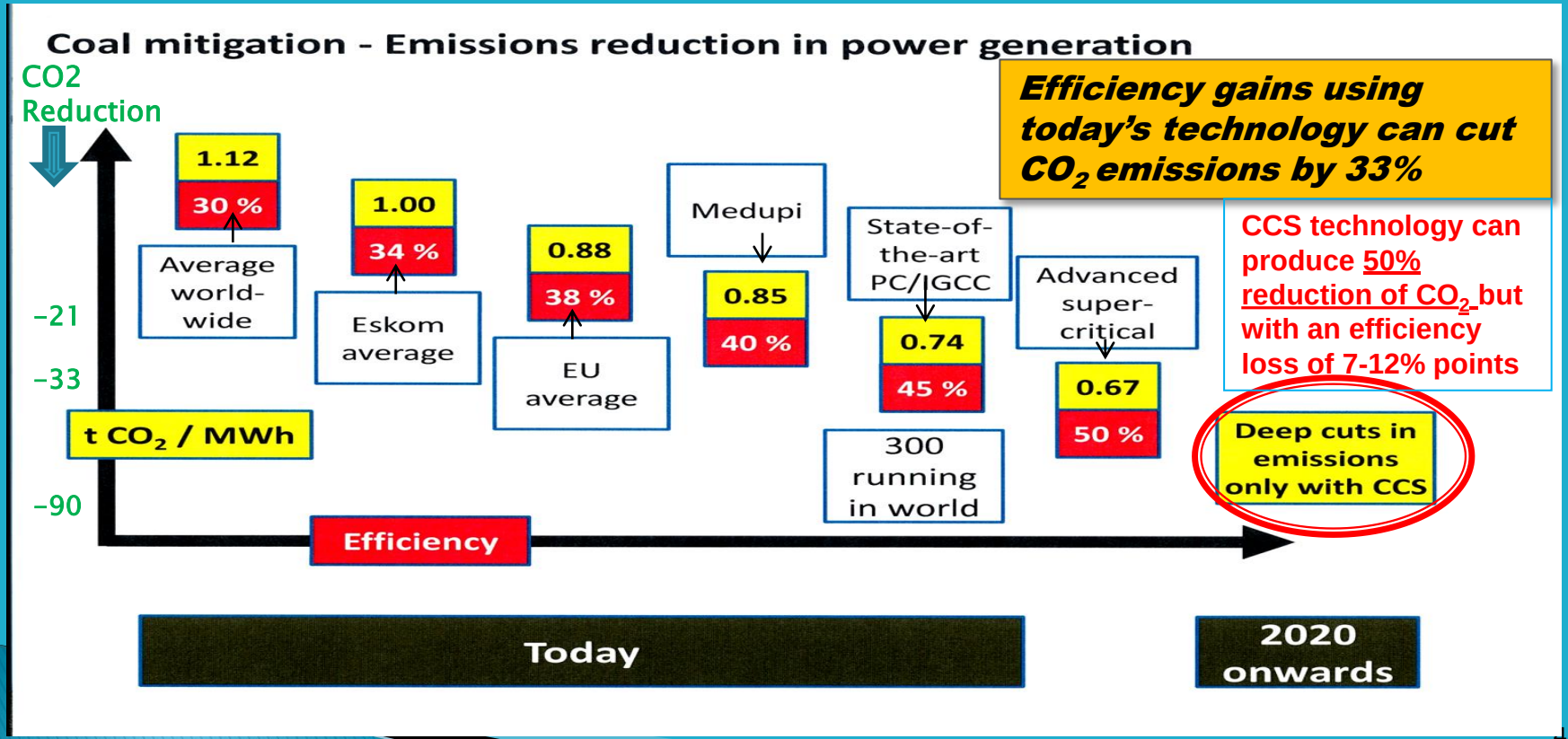
Circulating Fluidised Bed Plant with emission capture facilities





Ultra supercritical Pulverised fuel boiler with full emissions capture facilities

CO_2 EMISSIONS REDUCTION THROUGH INCREASED EFFICIENCY OF POWER PLANT – SOUTH AFRICAN SCENARIO



Source IEA CCC

CLEANER AIR AND REDUCING POLLUTION

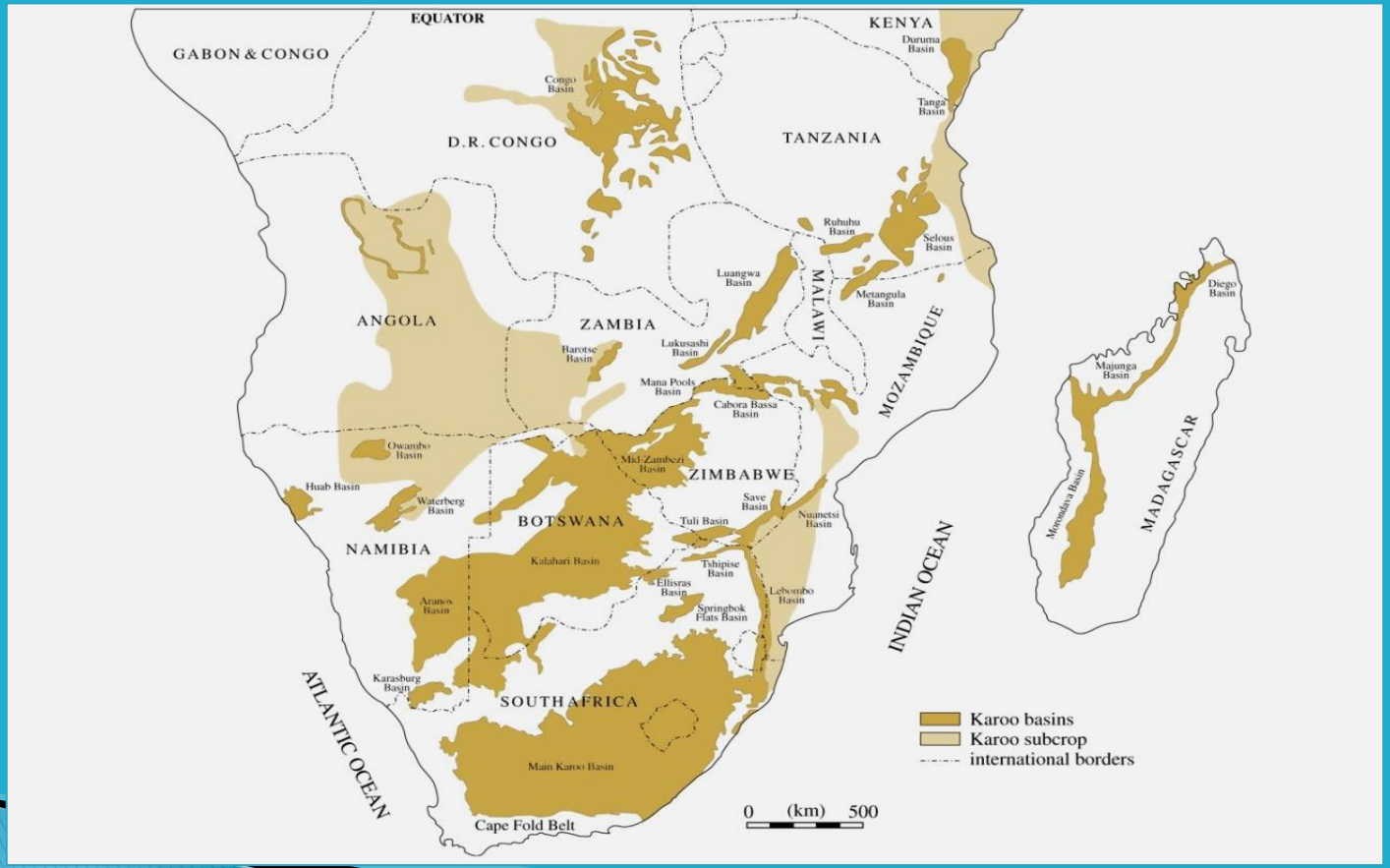
Eskom's drive for cleaner air

Our efforts to improve air quality focused on reducing emissions of particulates or ash. The relative particulate emissions from coal-fired power stations have reduced by more than 90% over the last 35 years, as can be seen in the graph below.

Reduction in relative particulate minimum emissions from Eskom's power stations from 1982 to the present, due to the decommissioning of older power stations and commissioning of more efficient technology.

FACTORS AFFECTING EFFICIENCY OF SOUTHERN AFRICAN COALS

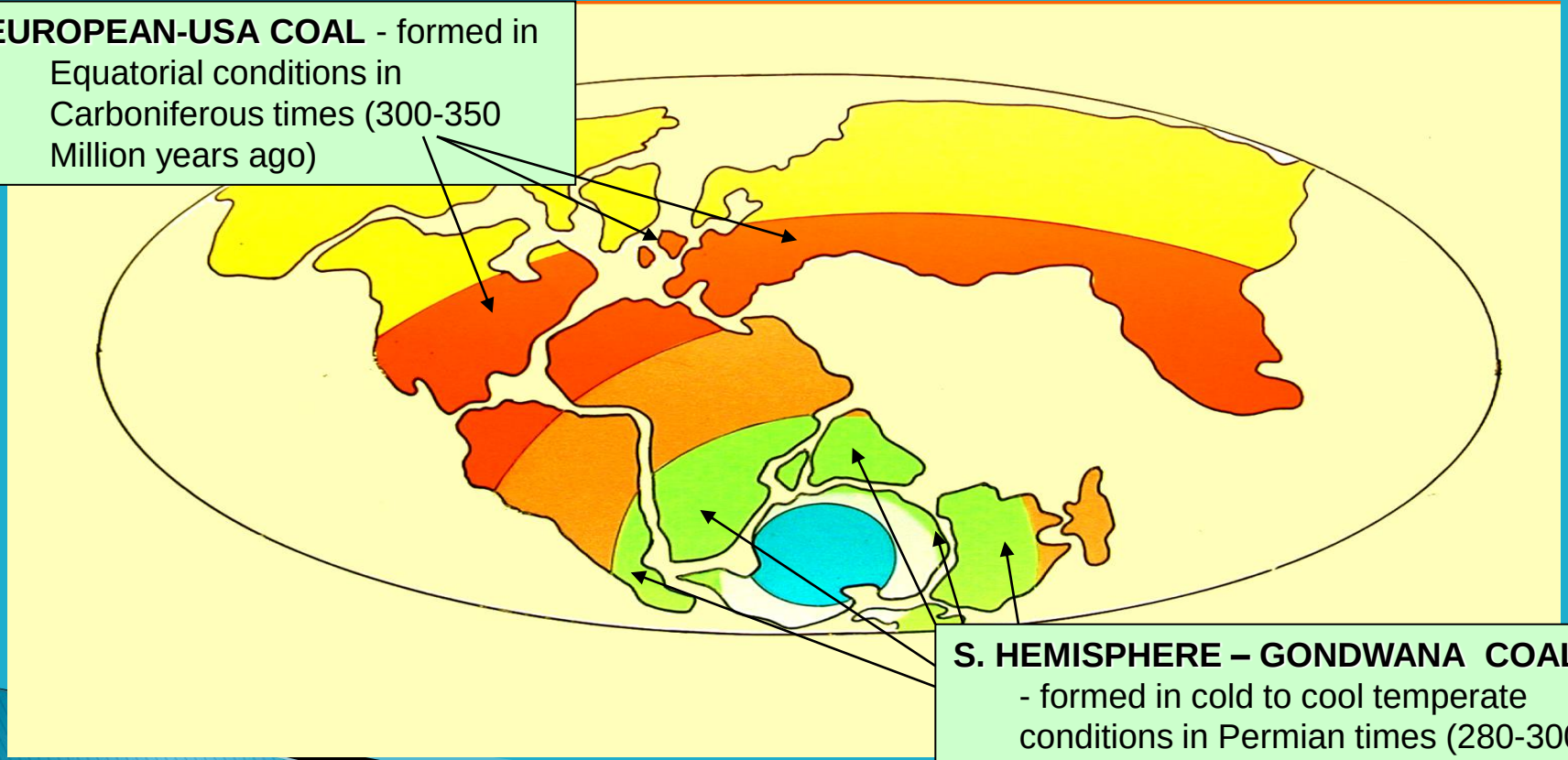
COAL-BEARING KAROO BASINS OF SOUTHERN AFRICA (



AFTER CATUNEANU *ET AL.*, 2005)

DIFFERENCES BETWEEN NORTHERN HEMISPHERE (LAURASIAN) COALS AND SOUTHERN HEMISPHERE (GONDWANALAND) COALS

EUROPEAN-USA COAL - formed in Equatorial conditions in Carboniferous times (300-350 Million years ago)



S. HEMISPHERE – GONDWANA COAL - formed in cold to cool temperate conditions in Permian times (280-300 Million years ago)

CHALLENGE OF COAL QUALITIES: LOW GRADE COALS HIGH IN ASH

LOW ASH COAL – HIGH VOLATILES
100% VOLATILES COMBUSTIBLE

CLEAN COAL
Vitrinite - no visible minerals

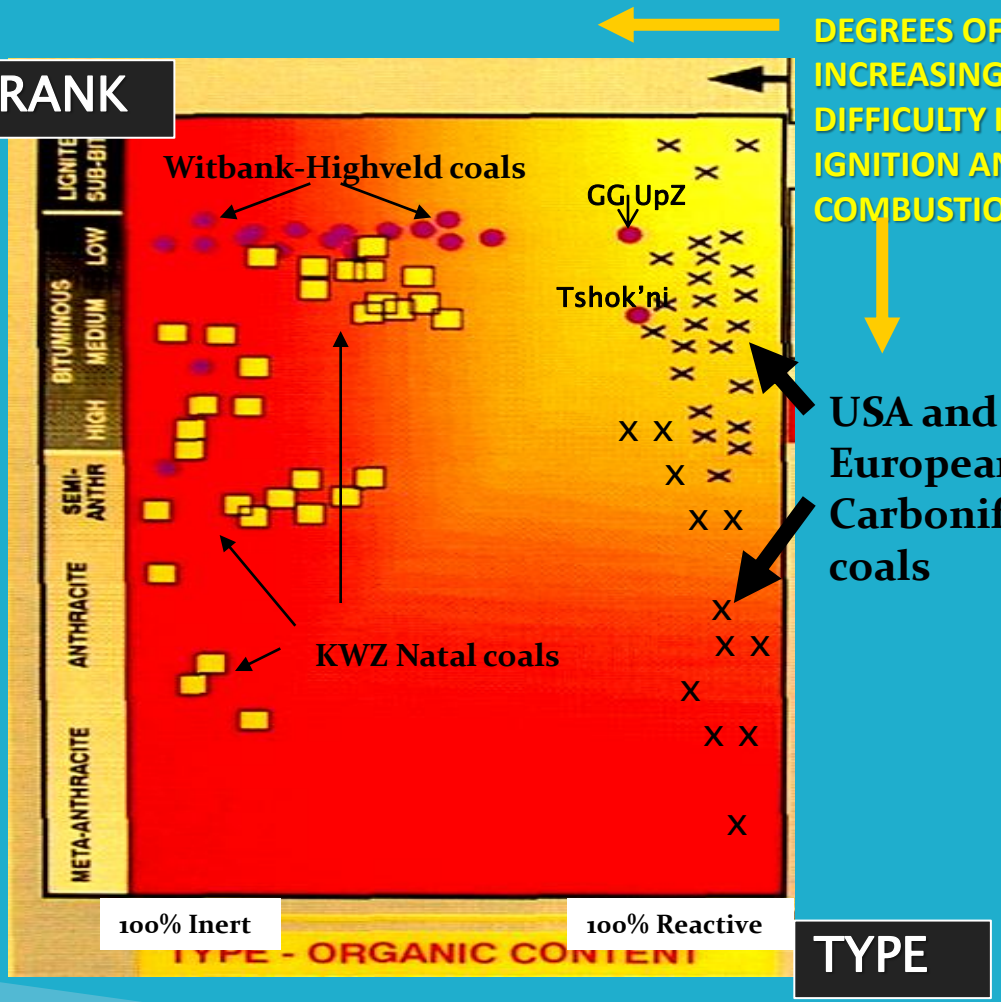
HIGH ASH COAL (CLAYS) – HIGH VOLATILES
30-40% VOLATILES INCOMBUSTIBLE

DIRTY COAL
Vitrinite + abundant layered clays (black)

Scale – width of each photo is 200 microns

CHALLENGE OF COAL QUALITIES: TYPE AND RANK

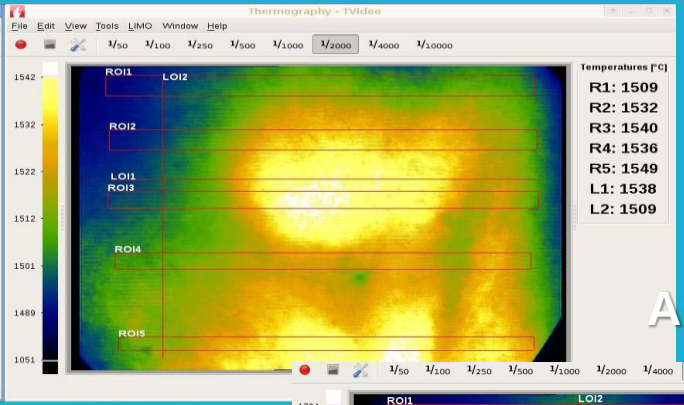
Variations in RANK and TYPE of Coals from different Regions



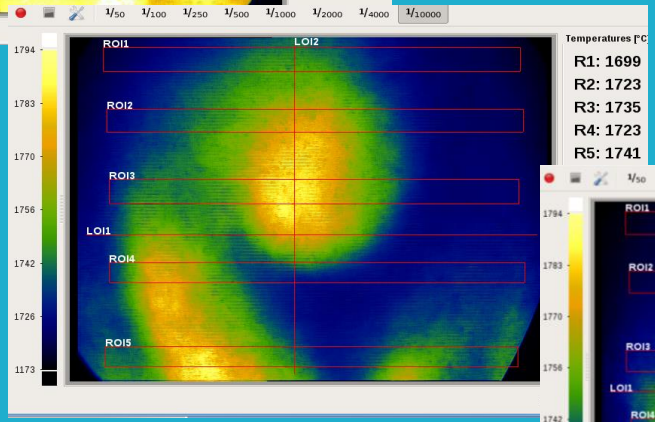
EFFECT OF VARYING ORGANIC MATTER ON COMBUSTION TEMPERATURES AND FLAME CHARACTERISTICS

4 South African coals

- CVs - 25,5 to 26,9 MJ/kg
- Ash - 15 to 17% ad

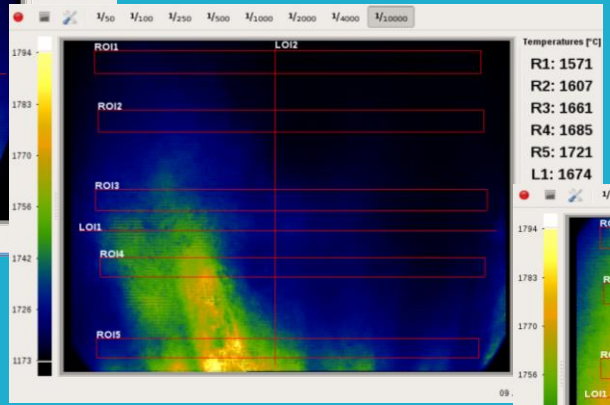


A: Excellent combustion –1549ºC

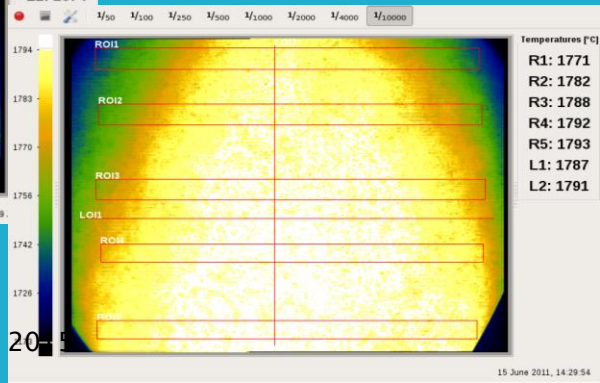


B: Irregular combustion –1789ºC

IRREGULAR EFFICIENCY



C: Poor ignition on grate –1721ºC



D: Massive ignition, throughout chamber –1793ºC

Source: R Taole , M Andrews 2013

CLEAN COAL TECHNOLOGIES IN SOUTHERN AFRICA

- **Coal beneficiation of low grade coals – dry systems**
- **Subcritical pulverised combustion - low NOx burners , dry cooling**
- **Ultra-supercritical pulverised combustion +FGD – two new power stations**
- **Co-firing of coal and biomass – currently in agricultural industry**
- **Co-generation – use of industrial waste heat**
- **Underground coal gasification – successful demonstration**

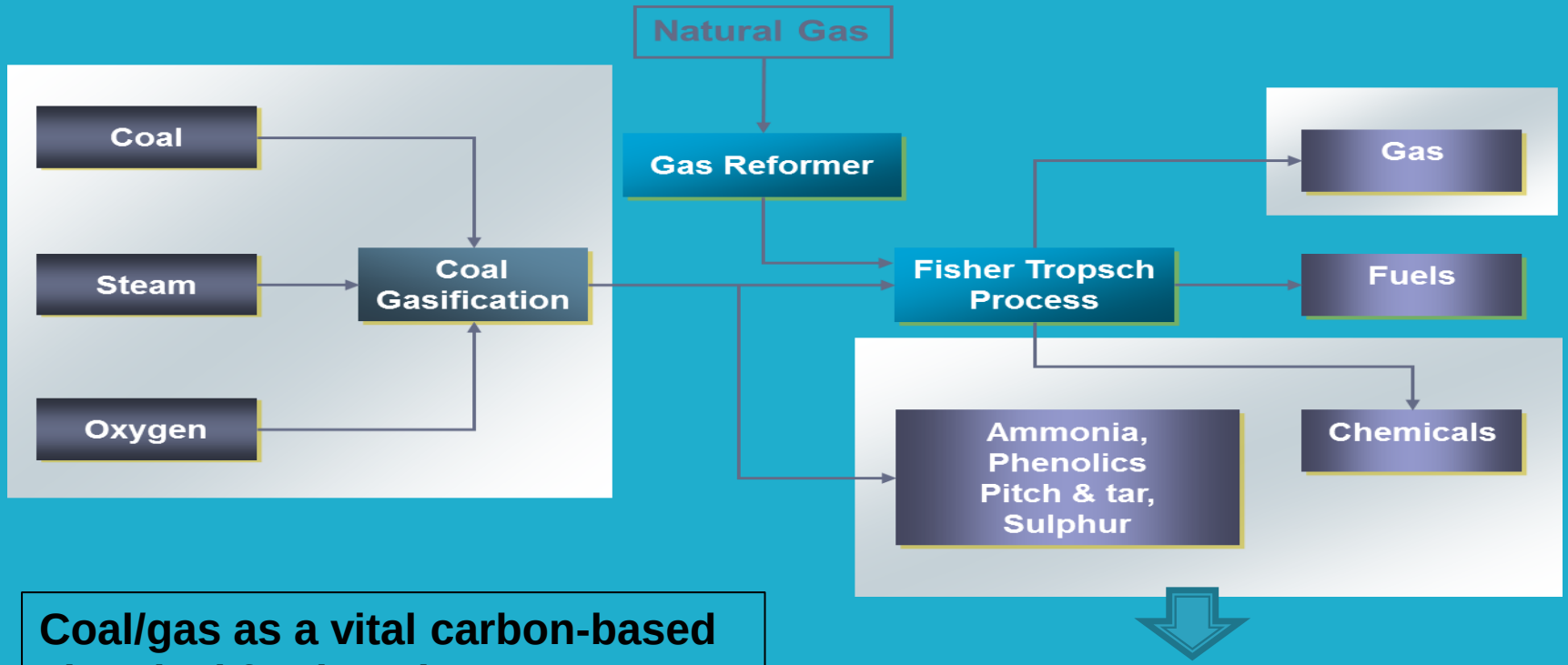
Future systems

- **Circulating Fluidised bed boilers - in-bed reduction of SOx and NOx**
- **Hybridisation – solar + coal-fired power**

THE VALUE OF COAL in SOUTH AFRICA

- **SOUTH AFRICA**
  - **7th largest producer of coal in the world**
  - **7th largest exporter of coal**
- **COAL IN SA ACCOUNTS FOR**
  - **1st highest foreign exchange earnings in the country**
  - **1st highest minerals income earner , beating gold , pgms**
  - **95% of SA energy production**
  - **>90% of carbon reductants in the metallurgical industry**
  - **>30% of liquid fuel, petrol and diesel requirements**
  - **>200 major chemicals for 1000s of carbon-based products**

THE TRUE VALUE OF COAL



Coal/gas as a vital carbon-based chemical feedstock

Petrol, diesel, liquid fuels,
Explosives, fertilisers, plastics
Food, materials, cosmetics, sulphur
Tars, pitch, bitumen, petcoke +

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THE NECESSITY FOR FOSSIL FUELS

- India China Bangladesh Indonesia Russia have major coal and Fossil Fuel expansion programmes
- COP 21 deliberately requires no commitments so that countries can decide to do what is in their best interests
- **Unless emerging countries use Fossil Fuels they will heavily prejudice their future growth and result in increased unemployment and poverty**
- **This will detrimentally effect the economic political and social structures of many emerging nations**

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CONCLUSIONS

- **Energy, Electricity leading to increased GDP and Employment Growth are the keys to Southern Africa's -**
  - **Future Economic, Social and Political Prosperity**
  - **Sustainability,**
  - **Stability and**
  - **Individual Economic Freedom**

  Where the country and the region's coal reserves play a vital part.


THANK YOU

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University of the Witwatersrand,

Johannesburg, South Africa

Econometrix

Johannesburg