"THE FUTURE OF COAL BEYOND POWER GENERATION"

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USES OF COAL

Electricity production

Coal is mainly used as fuel to generate electricity through combustion. Thermal coal is used in power stations to generate electricity.

Steel production

The steel industry is the second largest user of coal. Coal and iron are essential raw materials used in the production of steel, which is one the most useful metals products known to man.

Coking coal is used as a fuel to melt iron in furnaces to produce cast iron which in turn is further refined to produce steel. Coking coal is a solid carbonaceous residue derived from low-ash, low-sulphur bituminous coal.

Cement

Coal is used as an energy source in the cement industry given that the production of cement is extremely energy-intensive. By-products generated from burning coal are also used in concrete production.

Paper and aluminium industries

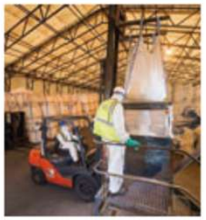
Both of these industries are energy-intensive. Given that coal is currently the most cost-effective source of energy, it is an essential input.

Chemical and pharmaceutical industries

Many chemical products are manufactured from the by-products of coal. Refined coal tar is used to make chemicals such as creosote oil, naphthalene, phenol and benzene.

Coal gas and coal liquid as transportation fuel

Coal can be converted into gas and liquid which can be used to fuel cars, motorcycles and ships.



Plant fertiliser

Coal can be turned into ammonia fertiliser by breaking it into carbon monoxide and hydrogen gas. The hydrogen mixes with nitrogen to make ammonia.

COAL ECONOMY LANDSCAPE

Current situation

- Production (2019) = 258.5 Mtpa valued at R141.4 Billion = 94 297 direct employment in mining (2nd largest employer in the mining sector).
- Total earnings and payments for direct employment = R25 634
- Local sales = 194 Mtpa valued at R86 Billion.
- 194 Mtpa = 120 Mtpa (Eskom) + 42 Mtpa (Sasol) + 34 Mtpa (other use)
- Final product – 212 190 GWh of electricity (85% of SA's electricity supply), value created R177.4 billion, 48 628 jobs (in Eskom).

- Final valued added products (Sasol): 2018
  - Synfuels 38.8 Mtpa valued at R55.8 billion
  - Gas sales 17.3 billion standard cubic feet
  - Polymers 1 246 Kt at R16.7 billion
  - Solvents 729 Kt at R9.7 billion
  - Explosives 247 Kt at R3.3 billion
  - Other (waxes, fertilizers, etc) R13 billion
  - R39.5 billion in taxes paid to South African government
  - Thus, 31 270 jobs, R181.4 billion in sales

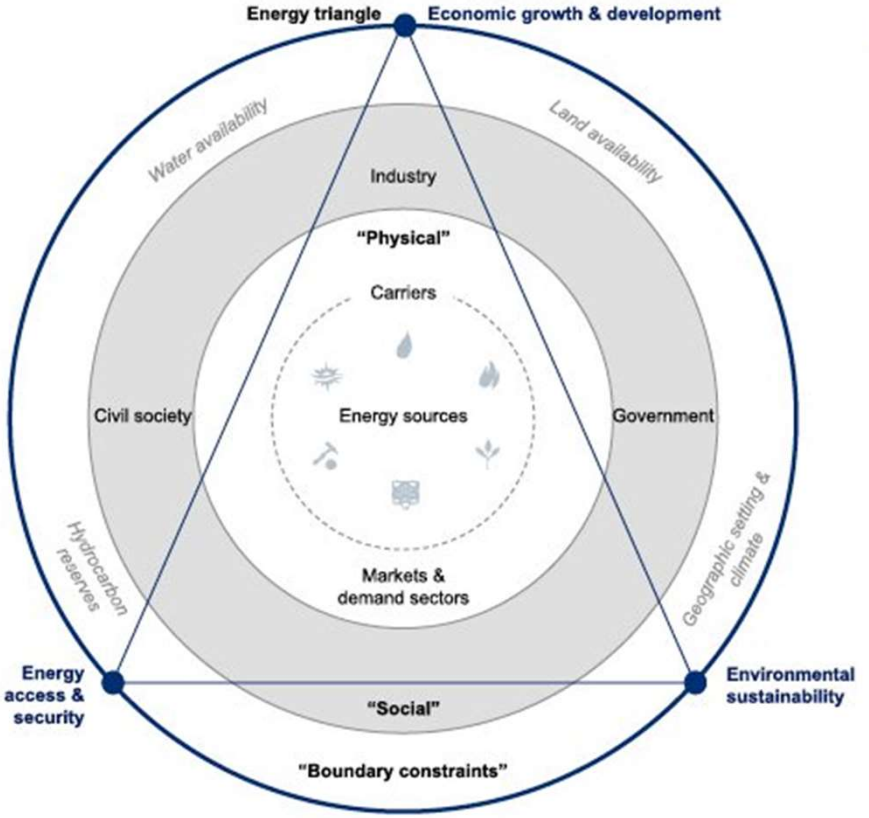
CHALLENGES AROUND COAL USAGE

JUST ENERGY TRANSITION

Just Energy Transition:

- Reliable baseload is needed to support the economic growth of the country.
- Enhanced by deployment of renewable energy technologies and more advanced power generation technologies (HELE) – to achieve a low carbon economy.
- New normal can be defined differently and the concept of "Just Energy Transition" is a diverse concept.

Figure 1: Energy architecture conceptual framework



Definitions

Physical elements: includes energy sources, their carriers and end markets

Social elements: includes political institutions, industry and civil society, which shape the physical elements

Energy triangle: ultimate objectives that the energy architecture is designed to support

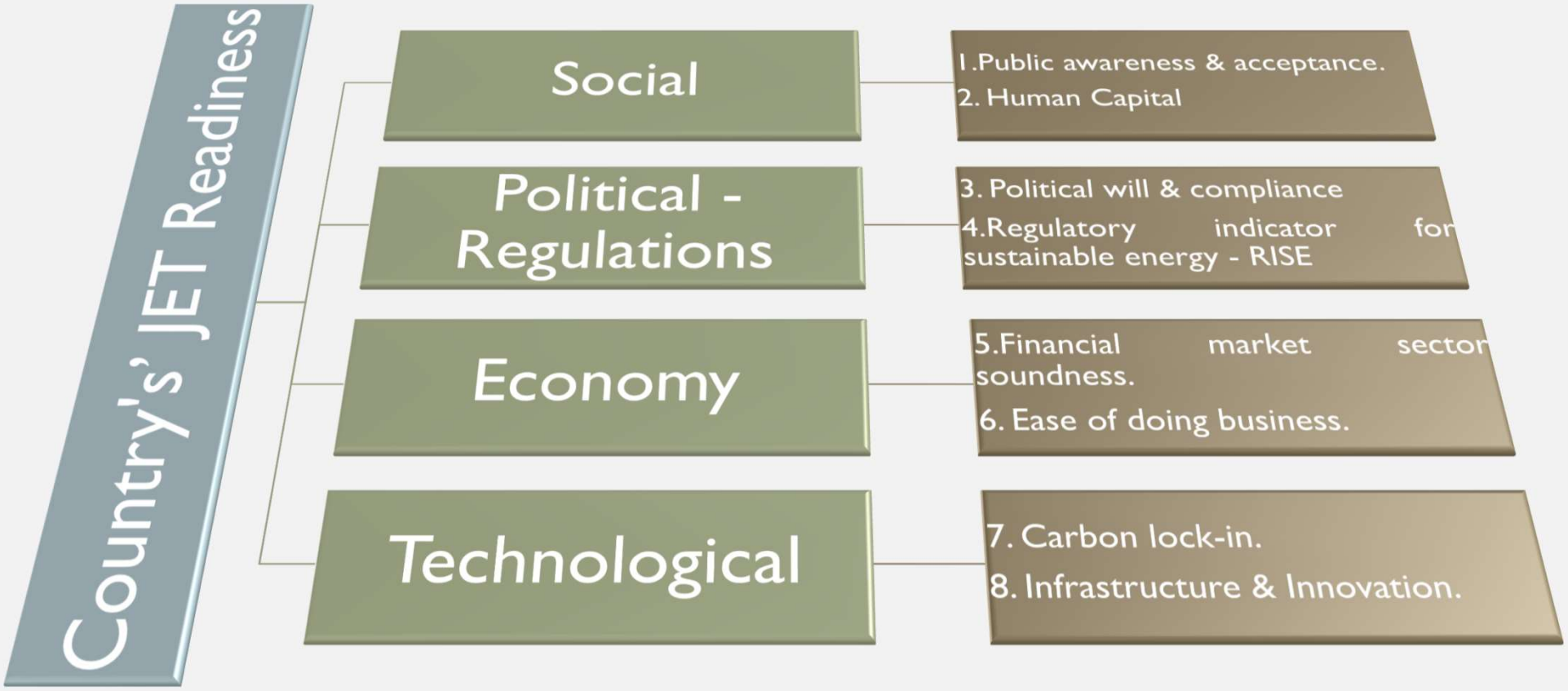
Boundary constraints: factors limiting performance against the energy triangle, both physical and social

The Global Energy Architecture Performance Index Report 2013

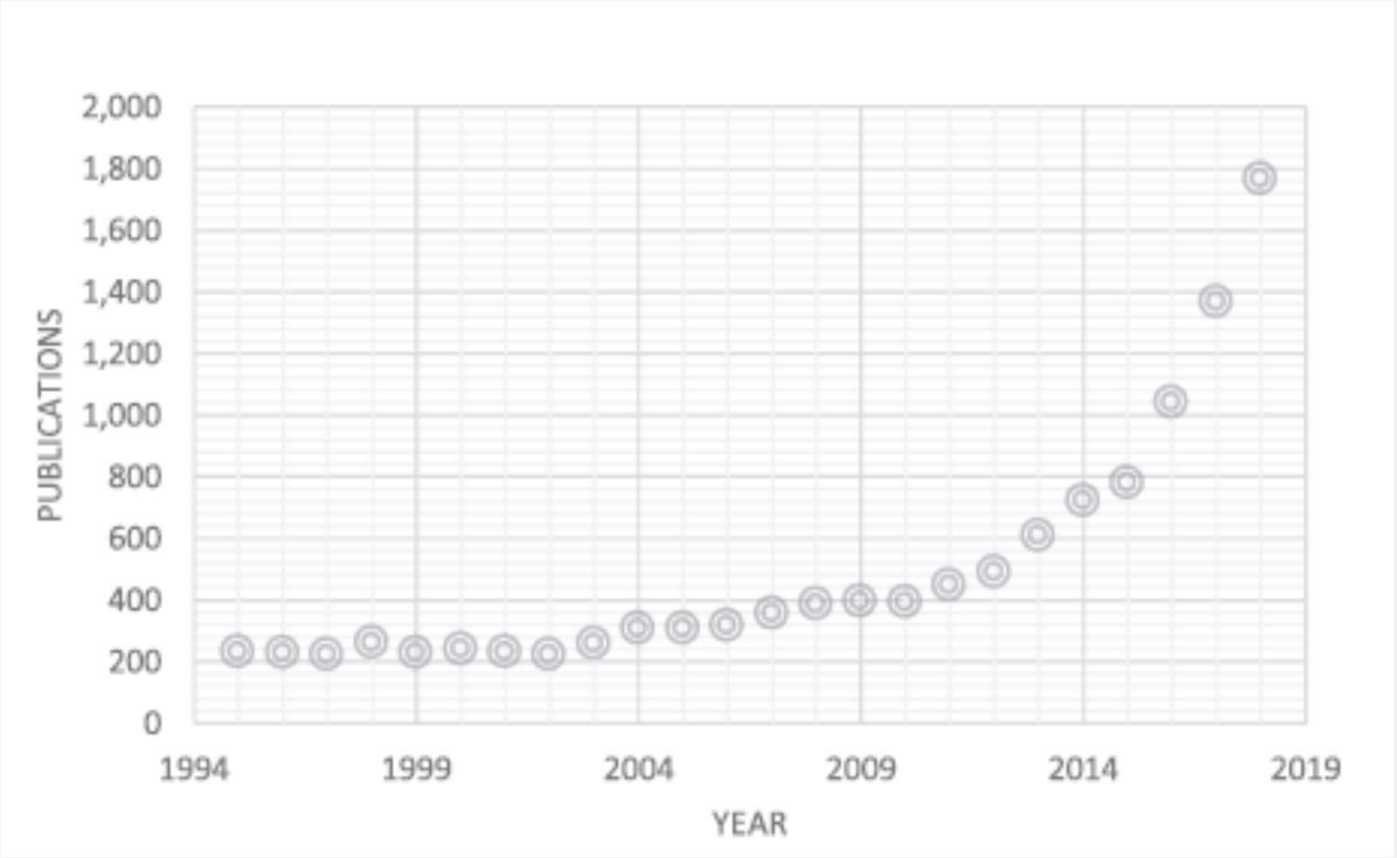
MANAGING THE ENERGY TRANSITION

- Just Energy Transition (JET)is not a fixed set of rules but a vision and process based on a dialogue between social elements.
- Analysing the impact of JET is crucial more especially on jobs and economic development of the country.
- Aim to green economy should make sure it eradicate or reduce poverty in the coal hub Provinces.
- What would determine if SA is ready for a JET?

JET READINESS



PUBLICATIONS MENTIONING JET ON "SCIENCEDIRECT"



FUTURE OF COAL IN SA

1. POLITICAL WILL: IRP 2019

- SA contributes 2.0% (41 435MW) of the world's coal fleet (15th CO_2 emitter).
- 2030 – Eskom will still be using 110 Mtpa of coal.
- 2040 – Eskom will be using 61 Mtpa of coal (55% coal usage).

Therefore, SA has 19 years to come up with solutions on upskilling & sustaining the economy generated from the coal "power generation" industry.

A CLEAR COAL RESEARCH AND DEVELOPMENT STRATEGY IS NEEDED.

2. Possible options for SA to sustain the current Coal Economy (Just Energy Transition):

- Clean Energy - Extraction of REEs from Coal for clean energy and 4IR products (electronics).
- Coal mine rehabilitation programmes to recover the land damaged through mining for economical development – Land use (Agriculture).
- Gas Opportunities:
  - *Coal Bed Methane (can be explored in coalfields with deep coal seams)*
  - *Underground Coal Gasification (Eskom pilot project next to Majuba Power Station).*
- Circulating Fluidised Bed Combustion (IPP) – can manage to deal our low quality coals.
- Carbon capture, Utilisation and Storage produced by Eskom and Sasol into various products.

CRITICAL RAW MATERIALS (CRM) AND RARE EARTH ELEMENTS (REE) OPPORTUNITIES

- Meta… …r spatial area and are a…
- Sour…
  - Co…
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- Criti…
- **US (…**

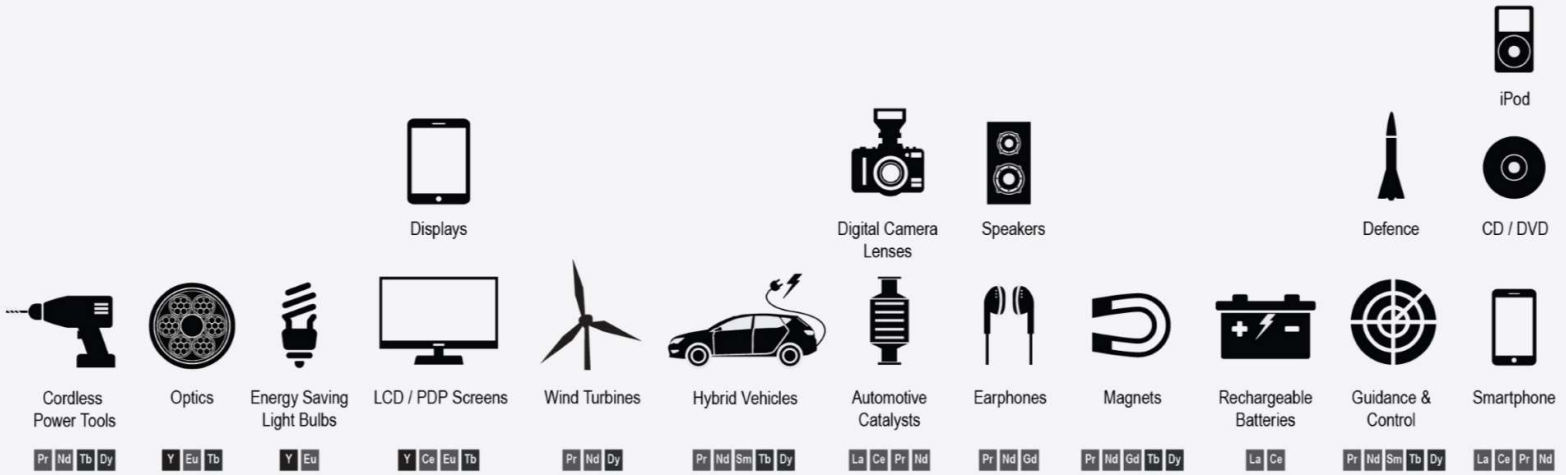
Global Distribution of Rare Earth Elements

Mine, deposit or occurrence location

equivalent)

RARE EARTHS AT A GLANCE

APPLICATIONS



CLASSIFICATION

21 Sc	39 Y	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Scandium	Yttrium	Lanthanum	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium
		Light Rare Earth Elements (LREE)								**Heavy Rare Earth Elements (HREE)**						

Source: UNCTAD Secretariat from Great Western Minerals Group Ltd, US Geological Survey, 2011, http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/, Commodities at a Glance: Special issue on rare earths, UNCTAD 2014, http://projourno.org/elemental-table_610x2186-1/

Source: USGS

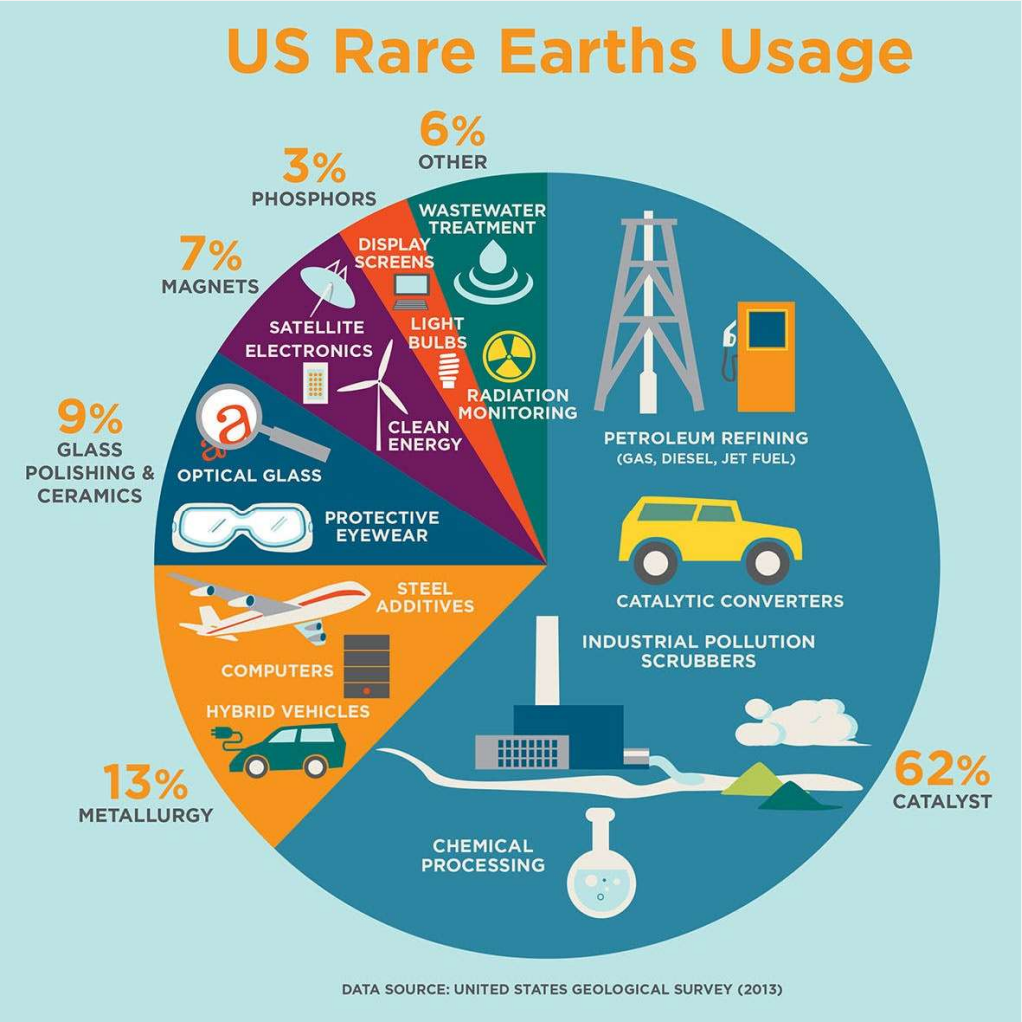
Note: Top pro

tratfor 2019

VIETNAM

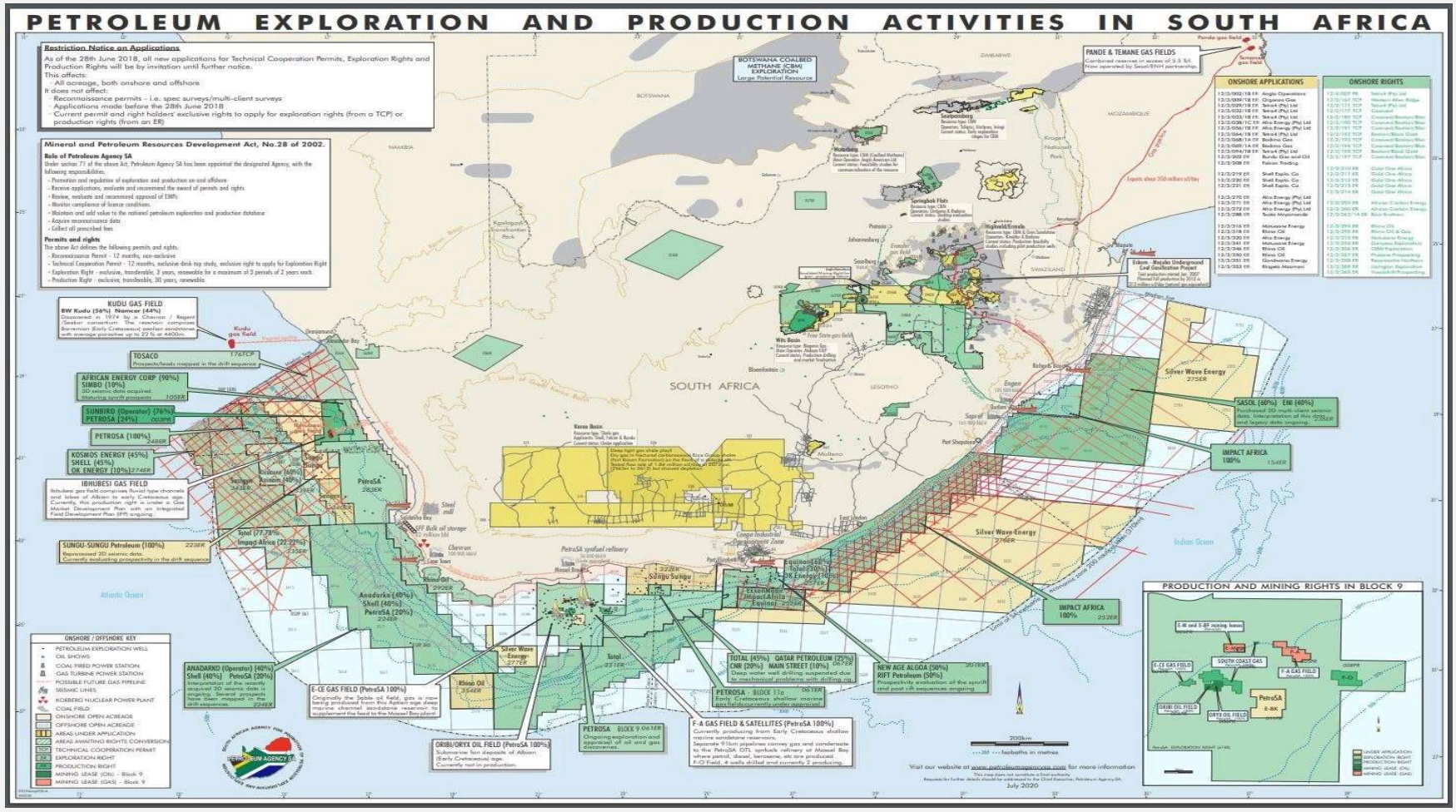
2 million

CLEAN ENERGY DEMANDS A LOT REE'S

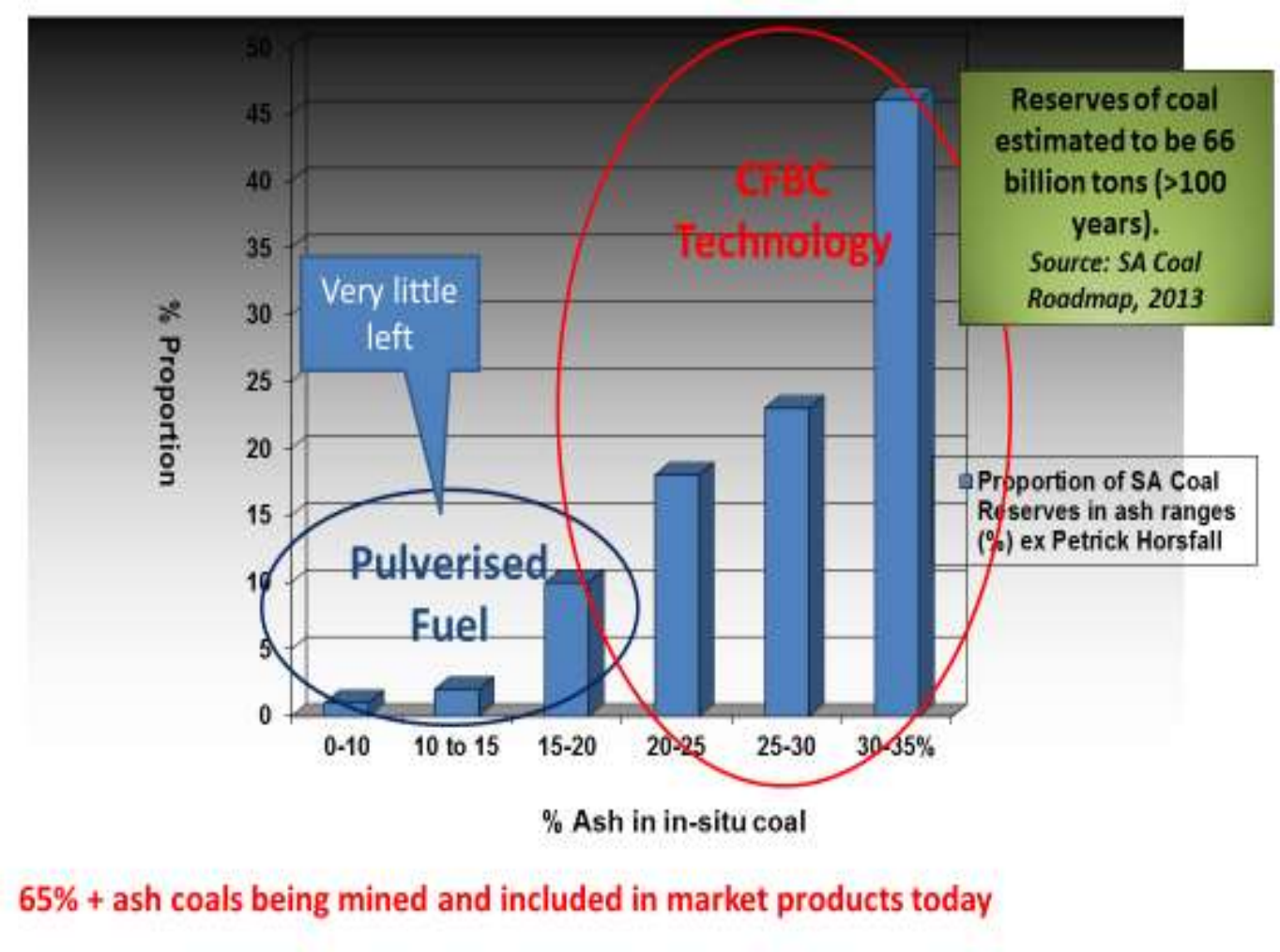


USA Rare Earth Element Advanced Coal Technology Act (2019)
Annual budget of $23 million to 2027
Department of Energy and the National Energy Laboratory (NETL)

GAS OPPORTUNITIES



CIRCULATING FLUIDIZED BED COMBUSTION (IPP)



SAMCHEOK GREEN 550 MW_E POWER PLANT, SOUTH KOREA

The world's most advance ultra-supercritical CFB Commercial operation in 2024

Fuel: Indonesian coal and biomass
Boilers: 4 × 550 MW_e CFB
Net plant efficiency (LHV): 42.4%

THE POWER STATION WILL MEET STRINGENT EMISSION VALUES STATED BELOW

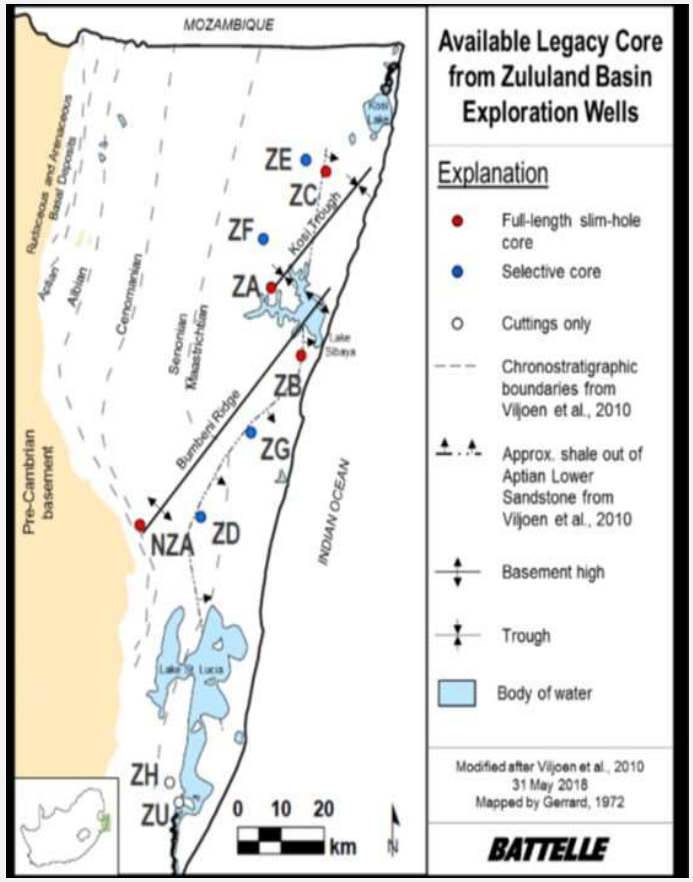
Item	Unit	Limit value	Method to meet
SOx	ppm (as SO_2)	Max. 50 (6% O_2)	Limestone injection to furnace; no back-end desulphurization equipment needed
NOx	ppm (as NO_2)	Max. 50 (6% O_2)	SCR between economizer and air heaters
Particulate matter	mg/m^3n	Max. 20 (6% O_2)	ESP

ULTRA SUPERCRITICAL POWER GENERATION USC IN AFRICA

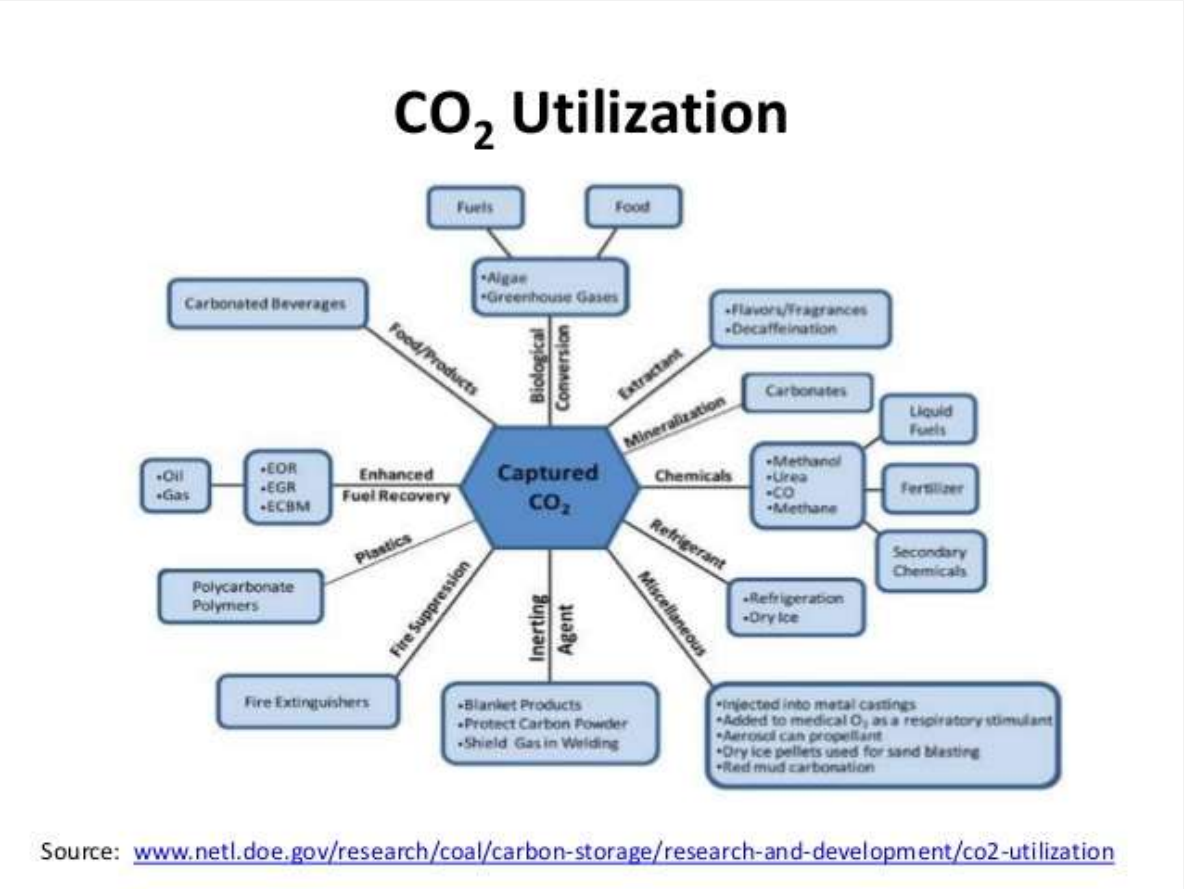
Kenya's Amu "Clean Coal" Power Station:

- **Highest efficiency in the world - up to 49%** (world av 33%)
- **Reduces SOx and NOx and particulates by >99%**
- **Lowers CO_2 by 512 000 tons annually** (re to Supercrit plants)
- **Below emissions Standards of the World Bank and OECD**
- **Lowest non-subsidised tariff** in the country – **7.81/kWh**
- **Reduces power generating costs by 12-36%**
- **Cost of projects $2 Billion**
- **Will provide 30% country power, extensive employment**
- **Highly flexible operation for daily demand**
- **Similar sized plants in Germany, Malaysia and Dubai**

CARBON CAPTURE, UTILIZATION AND STORAGE



SA potential geological storage site



Source: www.netl.doe.gov/research/coal/carbon-storage/research-and-development/co2-utilization

CO2 Utilization

CONCLUSION

- "Just Energy Transition" is a diverse concept which can be interpreted differently.
- The coal industry still has almost 2 decades to figure out a strategy towards coal economy.
- Raw materials for green economy can be extracted from coal – reduce imports.
- Dynamic link between coal and coal-gas-to-power technology.
- Cleaner Coal Technologies and gas are part of "Just energy transition" – Power Generation.
- Refocus: look at Coal beyond "Power Generation" – more industries from coal and CO2 generated during coal processing.
- Coal economy can still grow if there is a will from the policy makers and investors.