

ENERGY CHALLENGES IN SOUTH-AFRICA - UCG AS TECHNOLOGY OPPORTUNITY IN A DEVELOPING COUNTRY



AFRICARY
African Carbon Energy

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***6th International Freiberg Conference on IGCC & XtL Conference
19 May 2014***

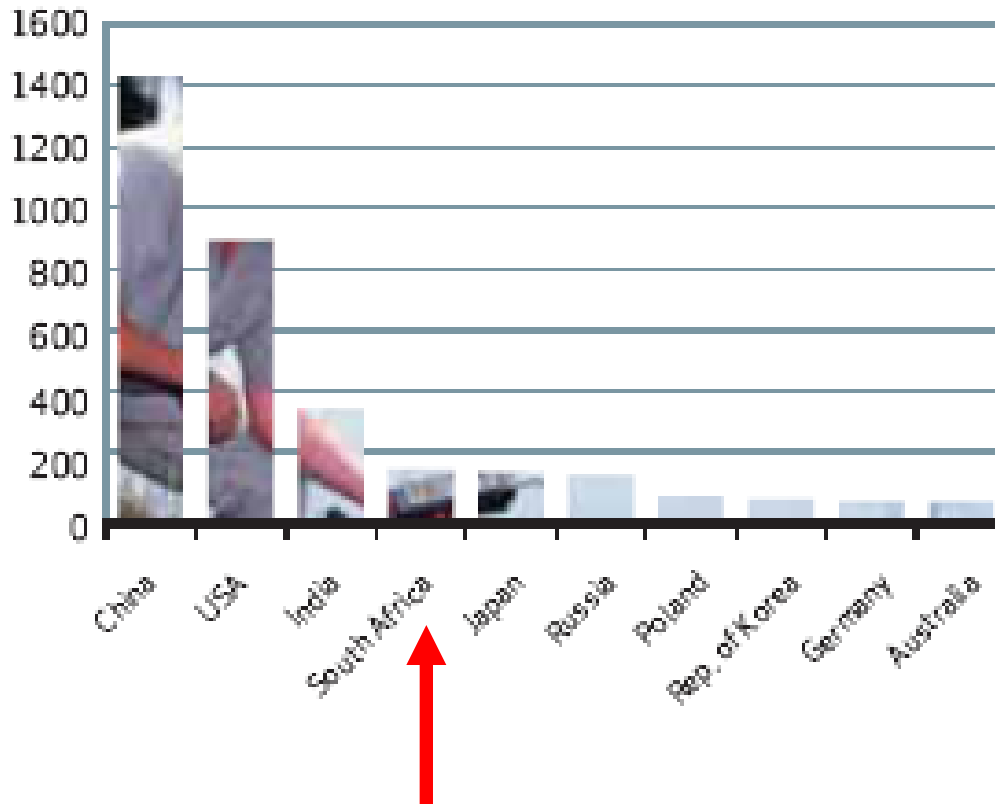
Roadmap of presentation

- ❑ *A global view on coal usage*
- ❑ *South-African demographics*
- ❑ *Energy mix and major coal consumers in South-Africa*
- ❑ *Challenges and opportunities*
- ❑ *Introduction to **AFRICAN CARBON ENERGY** and Theunissen UCG Project*
- ❑ *In conclusion, why UCG is the next generation technology for South-Africa?*

World coal usage

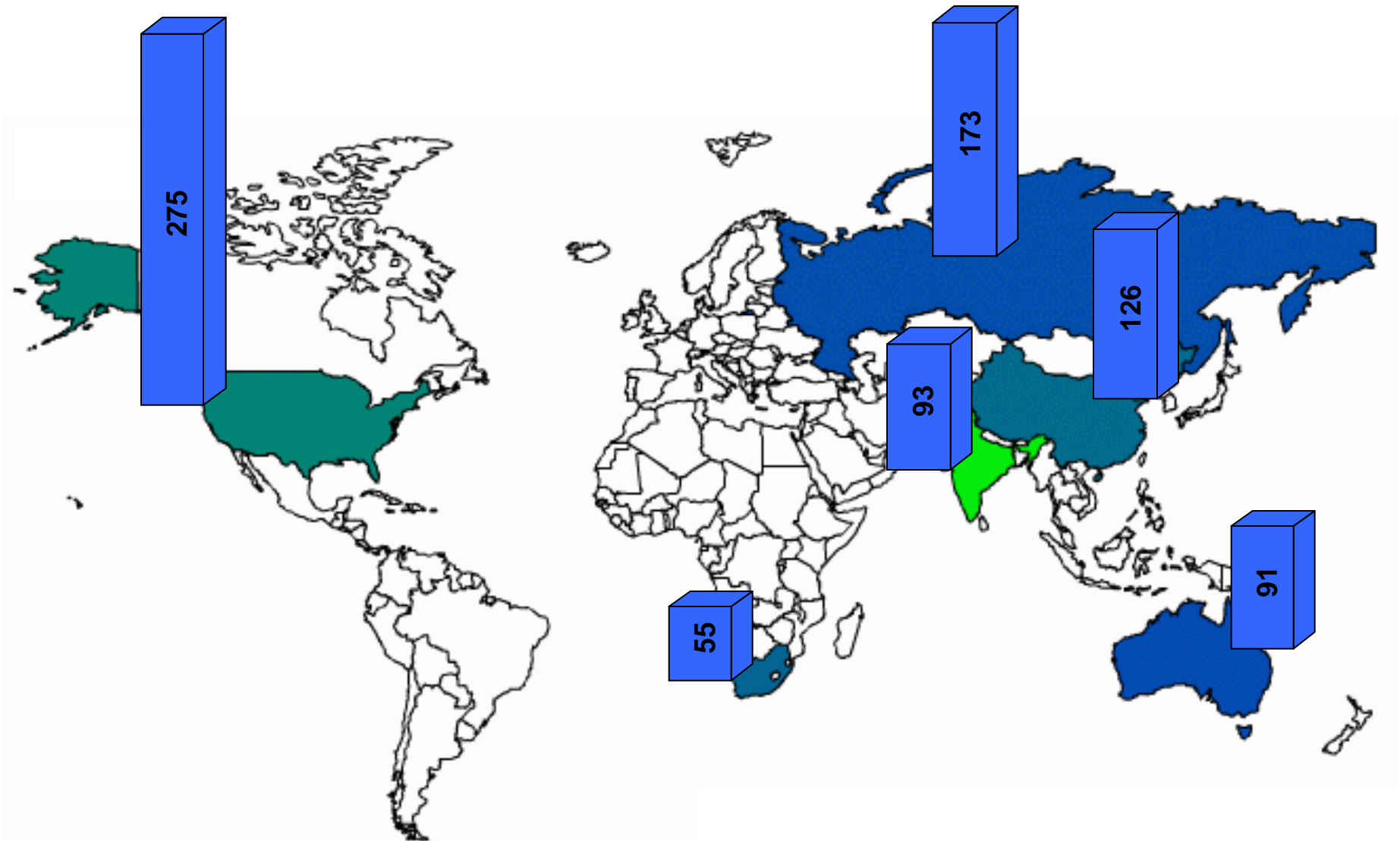
Top Ten Coal Consumers Worldwide, 2003 (Mt)

Source: IEA 2004



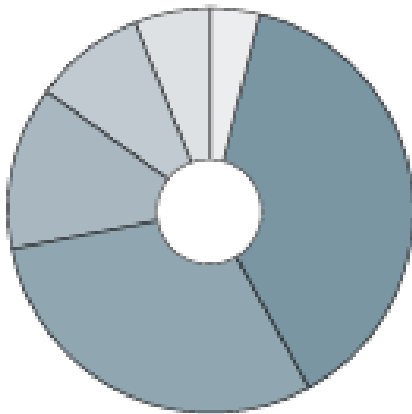
- ❑ *Coal is the world's most important source of energy...fuelling almost 40% of electricity worldwide*
- ❑ *In South Africa 92%*
- ❑ *1/3 of South Africa's liquid fuel is supplied by Sasol (gasify >30 Mt/annum)*

Regions with very large coal reserves (billion tons)



Importance of coal in 2030

Total World Electricity Generation (% by Fuel, projected for 2030)



■ Coal	38%
■ Gas	30%
■ Hydro	13%
■ Nuclear	9%
■ Other*	6%
■ Oil	4%

* Other includes solar, wind, combustible renewables, geothermal and waste

Source: IEA 2004

- ❑ *Coal meets approximately 30% of world's primary energy needs*
- ❑ *Coal used to produce approximately 40% of world's electricity*
- ❑ *Price of coal relatively stable compared to other fossil fuels due to its abundance*

South-African Demographics

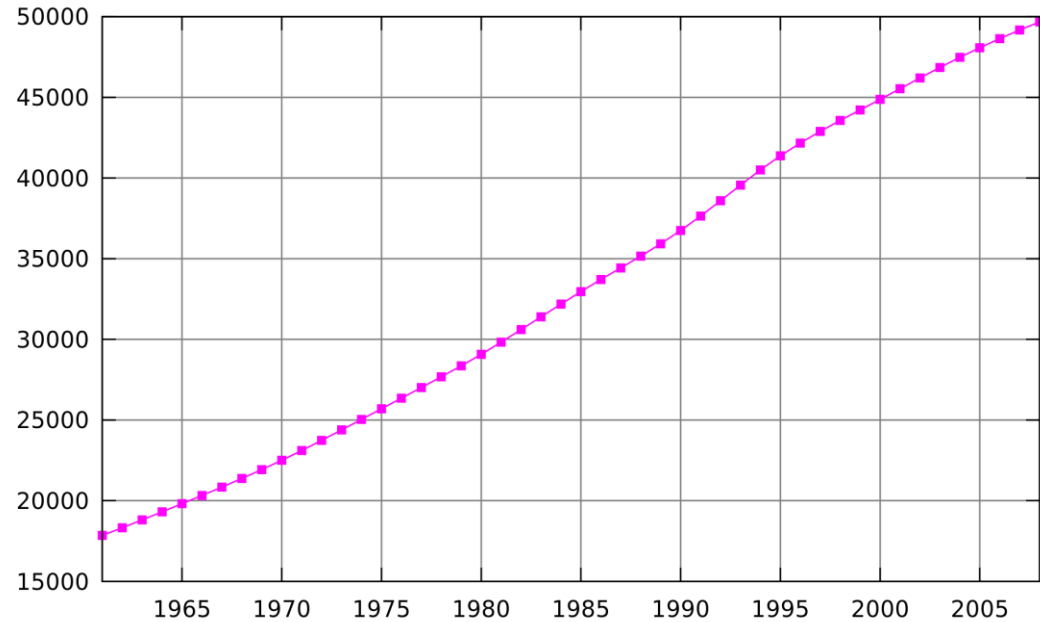


- Surface area of 1 127 000 km²*
- 1/8 of the size of the USA*
- 5 times the size of the UK*
- Population of 43.5 million (official)*
- 30% of population unemployed*

Population statistics



Population:	49,991,300 (July 2010 est.) ^[1]
Growth rate:	-0.051% ^[2]
Birth rate:	19.61 births/1,000 population (2010 est.)
Death rate:	16.99 deaths/1,000 population (2010 est.)
Life expectancy:	49.2 years (2010 est.)
–male:	50.08 years (2010 est.)
–female:	48.29 years (2010 est.)
Fertility rate:	2.33 children born/woman (2010 est.)
Infant mortality rate:	43.78 deaths/1,000



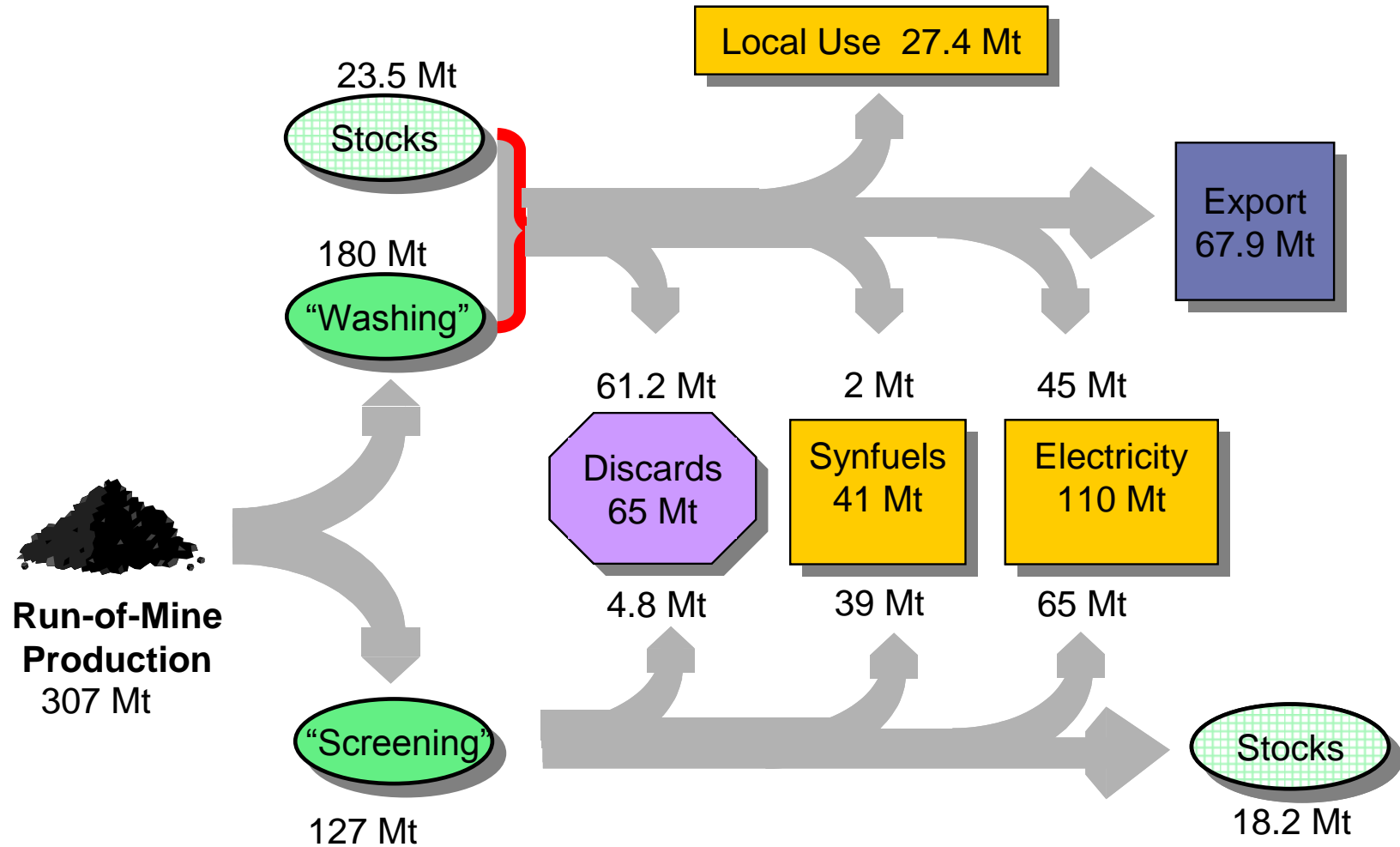
http://en.wikipedia.org/wiki/Demographics_of_South_Africa

Age structure

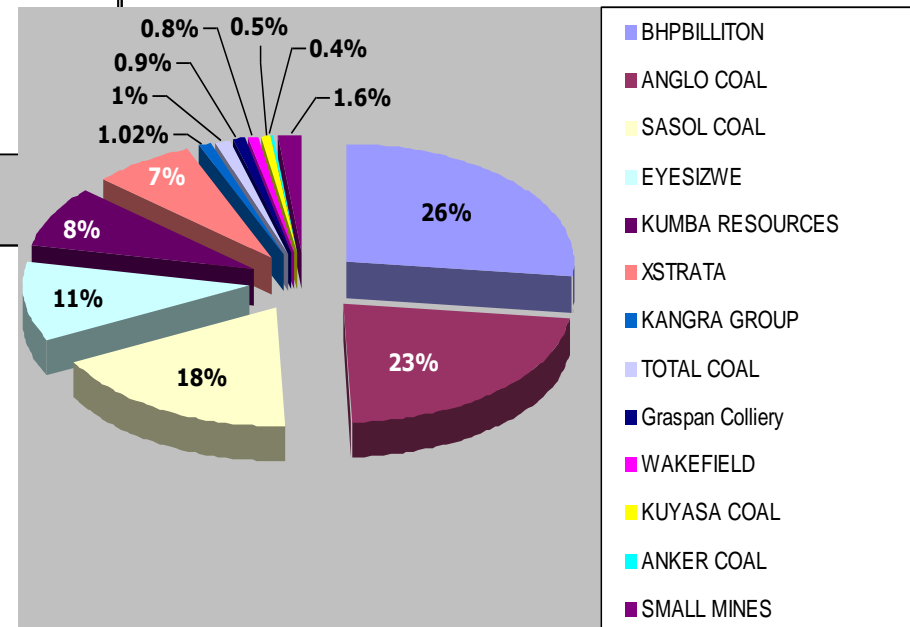
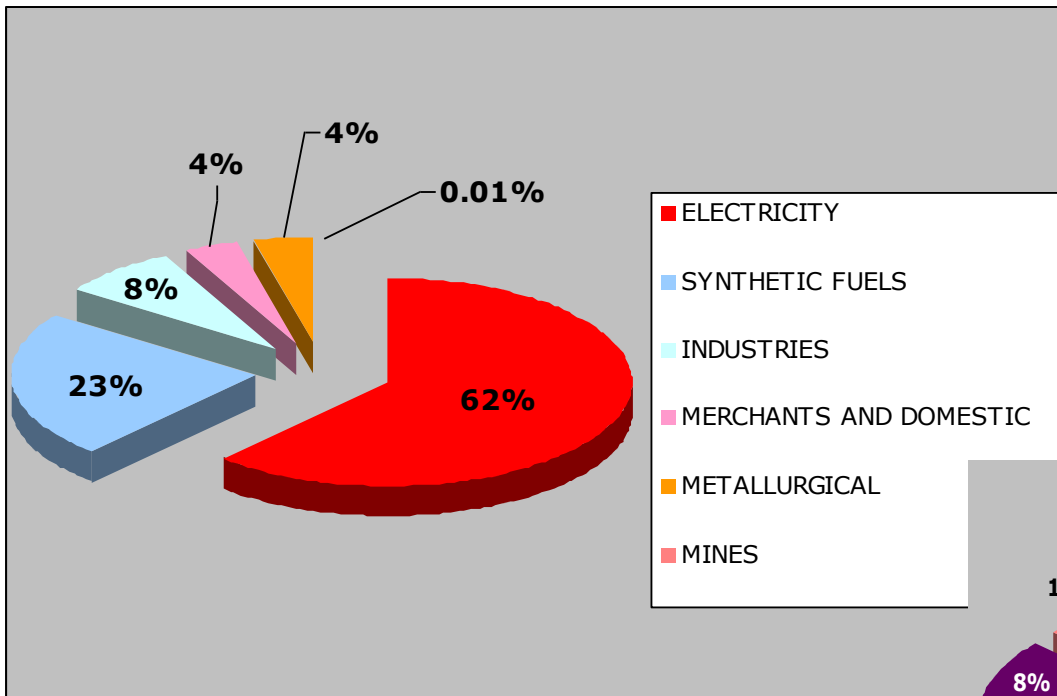
0-14 years:	28.9% (male 7,093,328/female 7,061,579)
15-64 years:	65.8% (male 16,275,424/female 15,984,181)
65-over:	5.4% (male 1,075,117/female 1,562,860) (2010 est.)



Coal Utilization in South-Africa



Coal usage per sector in South-Africa

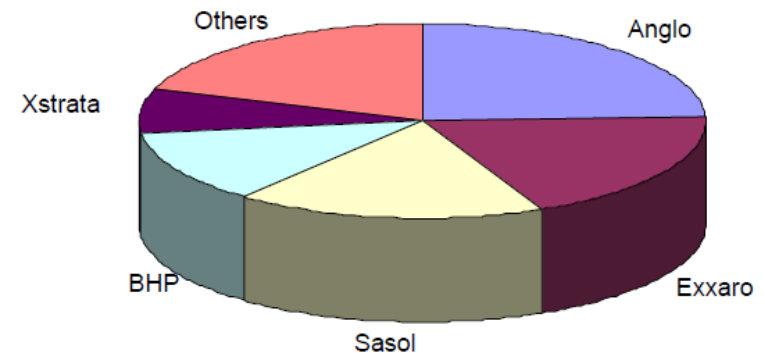
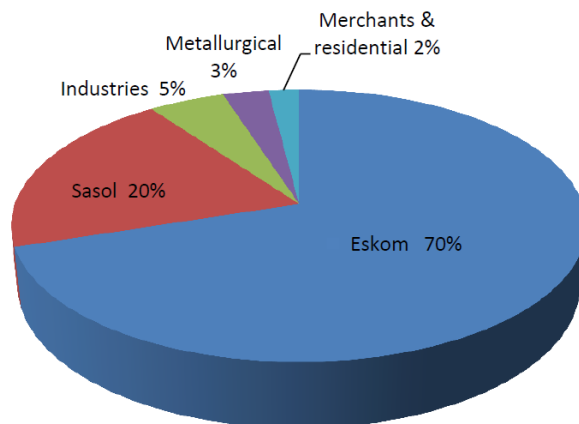


Coal usage per sector in South-Africa

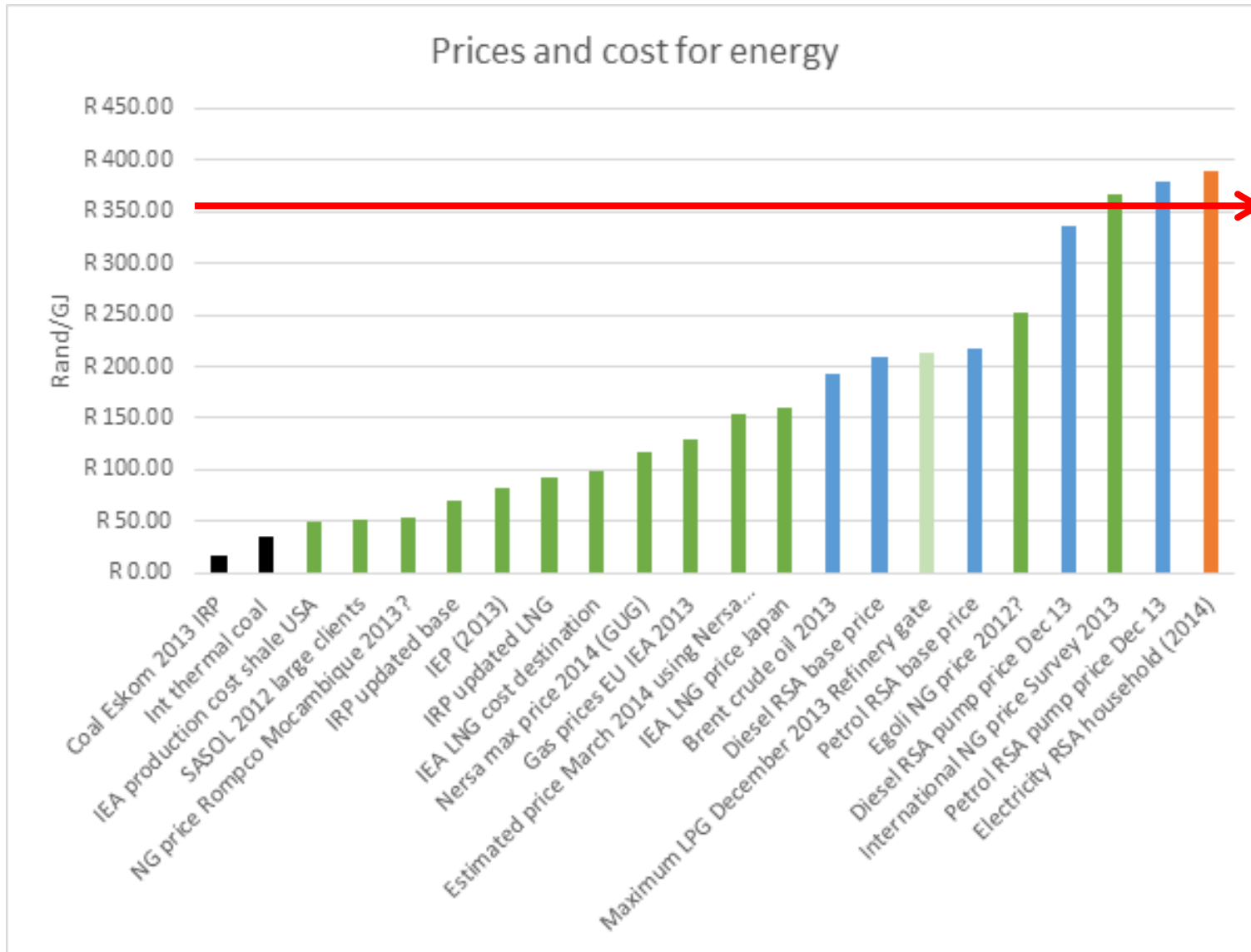
Producers	Mtce / annum
China	2 971
USA	919
India	526
Australia	335
Indonesia	263
South Africa	247
Russia	229
Kazakhstan	96
Poland	78
Colombia	73
Rest of World	253
World	5990

Exporters	Mtce / annum
Australia	262
Indonesia	230
Russia	116
Colombia	70
South Africa	67
USA	53
Canada	28
Vietnam	26
China	23
Kazakstan	23
Rest of World	47
World	944

Source: IEA (2010)



Increasing energy cost in South-Africa



R350.00 =

€25 ; \$34

As on 12/5/14

Increasing energy cost in South-Africa Announcement on 14/5/2014 - BEELD



82% hoër kragprys sal sake verlam

Werkverliese gevrees

Johan Eybers

'N Skokverhoging van so-wat 82% in elektrisiteitspryse kan op 1 Julie op ondernemings in Ekurhuleni wag.

Die ondernemings vrees nou dat die verlamende verhoging tot grootskaalse werkverliese en 'n uittoeg van ander ondernemings aan die Oos-Rand gaan lei.

Volgens die raad se konsepbegroting, wat volgende maand goedgekeur gaan word, sal ondernemings wat 700 kWh krag of meer per maand gebruik, van 1 Julie af 81,8% meer daarvoor moet betaal.

In teenstelling hiermee word 'n gemiddelde verhoging van 7,4% vir inwoners en ander ondernemings voorgestel. Ondernemings of huishoudings wat tussen 600 kWh en 700 kWh gebruik, sal 8% meer betaal. Dit is hoër as die Nasionale Energiereguleerder van Suid-Afrika (Nersa) se voorgestelde tariefverhoging van 7% vir munisipaliteite.

"Die verhogings is belaglik. Geen ondernemings sal dit kan hanteer nie," sê Attie Kolver, voorsitter van die Ekurhuleni-



Die raad fokus geweldig op die ontwikkeling van klein sake-ondernemings, maar ontmoedig dit nou met hierdie verhogings.

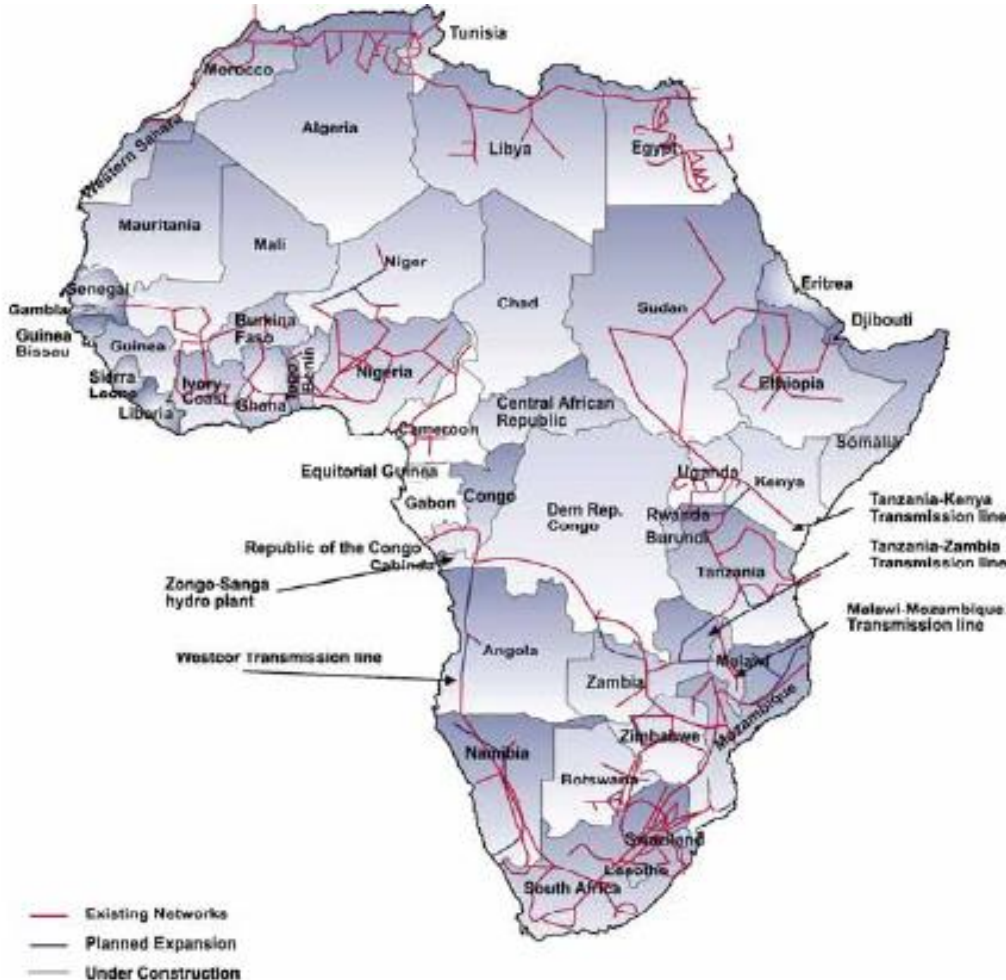
sakevereniging (EBA).

Volgens hom gaan die metro-raad bloot ondernemings uit die gebied dryf, wat tot reuse-werkverliese gaan lei.

"Die elektrisiteitsheffing behoort minder te wees vir ondernemings wat meer krag gebruik omdat hulle werk skep en 'n belegging is vir die steek. Die raad doen nou die teenoorgestelde deur ondernemings te straf wat meer krag gebruik," sê hy.

Kolver kritiseer ook die metroraad omdat hy nie met die georganiseerde sakesektor oor

Electricity supply (Eskom) – beyond the borders



Not only is Eskom the biggest electricity producer in Africa, it is also the seventh largest in the world. Our 24 power stations around the country are fueled by either coal, water, gas or nuclear and together they keep the lights burning throughout Southern Africa.

Domestic use of coal

- ❑ *±2 Mt Bituminous coal*
- ❑ *Space heating + stoves*
- ❑ *High sulphur + particulate emissions*



...early winter morning smog...



...smog “lifting” as the day heats up

Early morning



Mid-day



Challenges in South-Africa



- ❑ *“Slow progress on solving township smoke pollution”...3 Sept 2002, Mineweb*
 - ❑ Domestic coal use the main culprit of pollution...Y Scorgie.
 - ❑ Emissions from power plants stabilized and decreased over recent years.
 - ❑ Coal burnt in poorly ventilated houses and shacks...particulate pollution...winter months.
 - ❑ 1 Mt of coal burnt annually in townships causes high degree of particulate emissions...CF Reinecke.
- ❑ *“Pollution chokes SA”...6/12/2004, Ananzi News*
 - ❑ The burning of lower-grade coal is systematically poisoning South-Africans in large parts of the country, while the country’s top grade coal (clean coal) is being exported to Europe and Japan

SA environmental challenges / targets



- ❑ *RSA Renewable energy source targets are set:*
 - ❑ Increase from 2002's 9% renewable use by 5% to 14% by 2012

- ❑ *RSA Energy efficiency strategy March 2005/ Energy efficiency accord signed 29 April 2005*
 - ❑ Energy demand reduction target (industry and mining) of 15% by 2015

- ❑ *Both can also support the GHG reduction targets that will be set for developing countries beyond 2012 (Kyoto)*
 - ❑ Current EU non-compliance penalty 40E/t, beyond 2008 = 100E/tCO₂

SA environmental challenges / targets



- ❑ *Particulate emissions both direct & indirect, with tightening standards - **PM 2.5um** (2010) later **PM 1um***
- ❑ *Acid rain emissions - **NOx & SOx** – strong evidence of additional contribution to fine particulates in atmosphere*
- ❑ *Other **hydrocarbon** emissions into the atmosphere*
- ❑ *Control of emissions of 11 hazardous trace elements (**Be, Cr, Mn, Co, Ni, As, Se, Cd, Sb, Hg, Pb**) – most problematic being mercury (**Hg**)*
- ❑ *Total management of detrimental **discharges** to land & water from mining, transport AND end use*
- ❑ *Greenhouse gas emissions, principally **CH₄ and CO₂***

Why coal will remain important?

Proven reserves of fossil fuels will sustain the world for just over 300 years at current production rates

- Crude Oil 42 years
- Natural gas 62 years
- **Coal 224 years**

Figure 56. World Coal Consumption, 1970-2025



Coal will last twice as long as the combined crude oil and natural gas reserves at current usage rates

African Carbon Energy (“Africary”)



- ❑ *African Carbon Energy was established in 2007 as a BBBEE South African mining and minerals solutions company in order to fulfil the need for a alternative energy and commodities technology supplier in Southern Africa*
- ❑ *The company has available expertise in mining, exploration, gasification and specifically Underground Coal Gasification (UCG)*
- ❑ *Africary bought the Theunissen Coal field of 1 billion ton Inferred resource from BHP Billiton*
- ❑ *Africary completed the designs an permit applications to build and operate the first commercial 50 MW UCG power generation project in South Africa and will participate in the Base-Load coal PPA from the recently announced DoE programme*

What is UCG?

“Replace mechanical mining with chemical mining”

“Changes a coal field into a gas field”

- ❑ *Essentially, UCG is a process which unlocks the energy potential of stranded deep coal reserves*
 - ❑ through the injection of **air and oxygen** delivered via an injection well

- ❑ *In-situ coal conversion to Synthesis Gas ‘**Syngas**’,*
 - ❑ which is a fuel feedstock for power generation

- ❑ *This method utilises **directional drilling** techniques proven in the oil and gas industry*

- ❑ *Has numerous **environmental, safety and financial benefits***

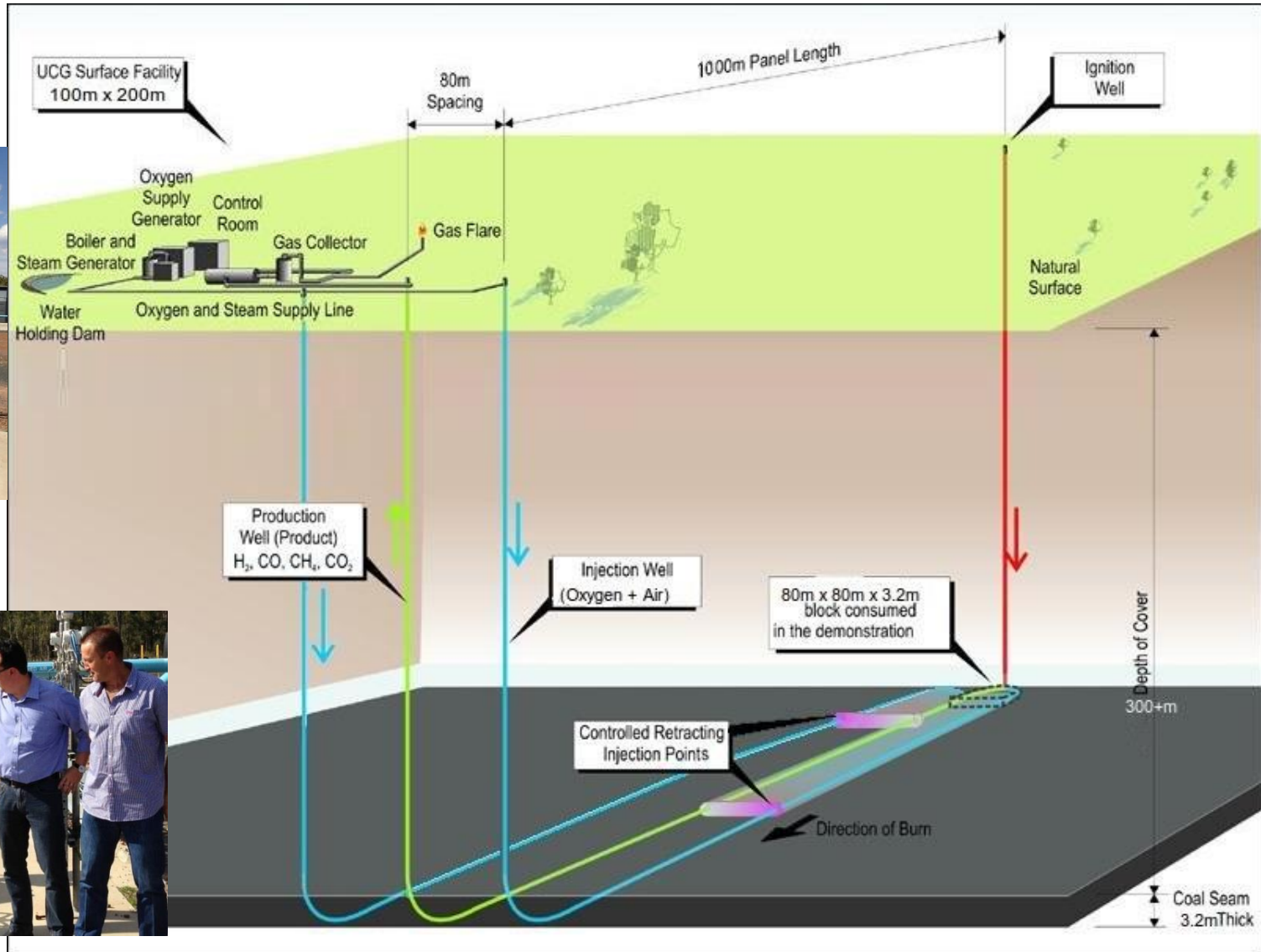
- ❑ *Requires very little of the infrastructure associated with large scale mines*

Typical UCG Setup

Production well



Injection well



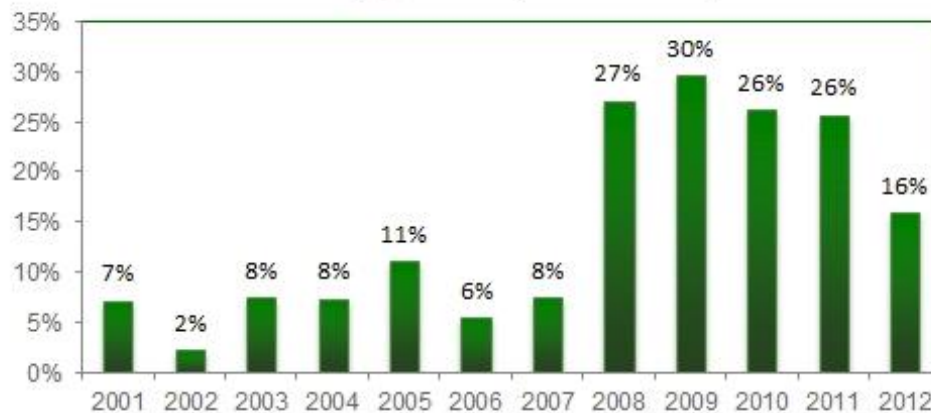
UCG Gas Engines in commercial operation



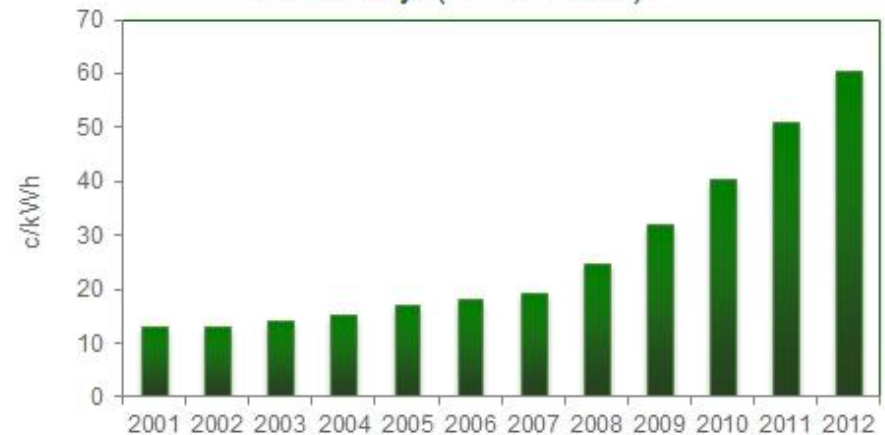
Why UCG in SA?

- ❑ *With Eskom's 7 years production experience – UCG is a proven technology.*
- ❑ *With increase in tariffs electricity generation by gas engines is cost competitive!*
- ❑ *The average annual selling price of Eskom electricity for the 2013 period was 60.66c/kWh,*
- ❑ *The graph below shows the increase in the average annual selling price of Eskom electricity from 12.98c/kWh in 2001 to 60.66c/kWh in 2012.*

Annual percentage increase in Eskom electricity prices (2001-2012)



Average annual selling price of Eskom electricity (2001-2012)



Coal gasification is an old concept

UCG has a long history...

- ❑ Coal gasification was used more than **150 years ago** to produce “town-gas” for lighting streets in the UK and the US
- ❑ Sasol (South Africa) has been gasifying coal for over **50 years** and currently produces about 40% of the nation's current liquid fuel requirements (160,000 bbl/day)
- ❑ Commercial UCG has been successfully operated for **more than 50 years in Angren, Uzbekistan** – supplying UCG syngas for power generation

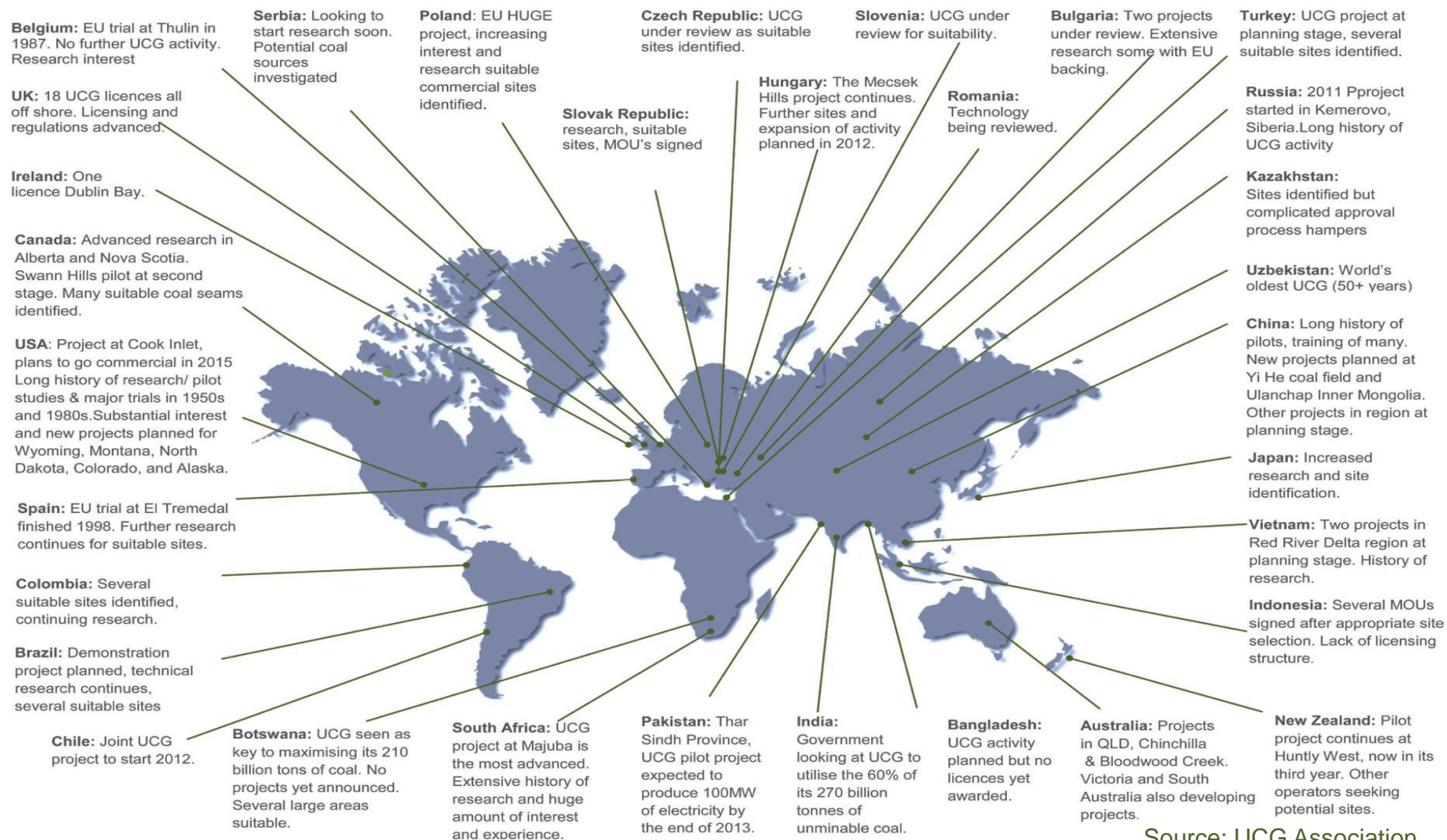
Most notable historical developments



>30 Countries Globally currently undertaking UCG trials

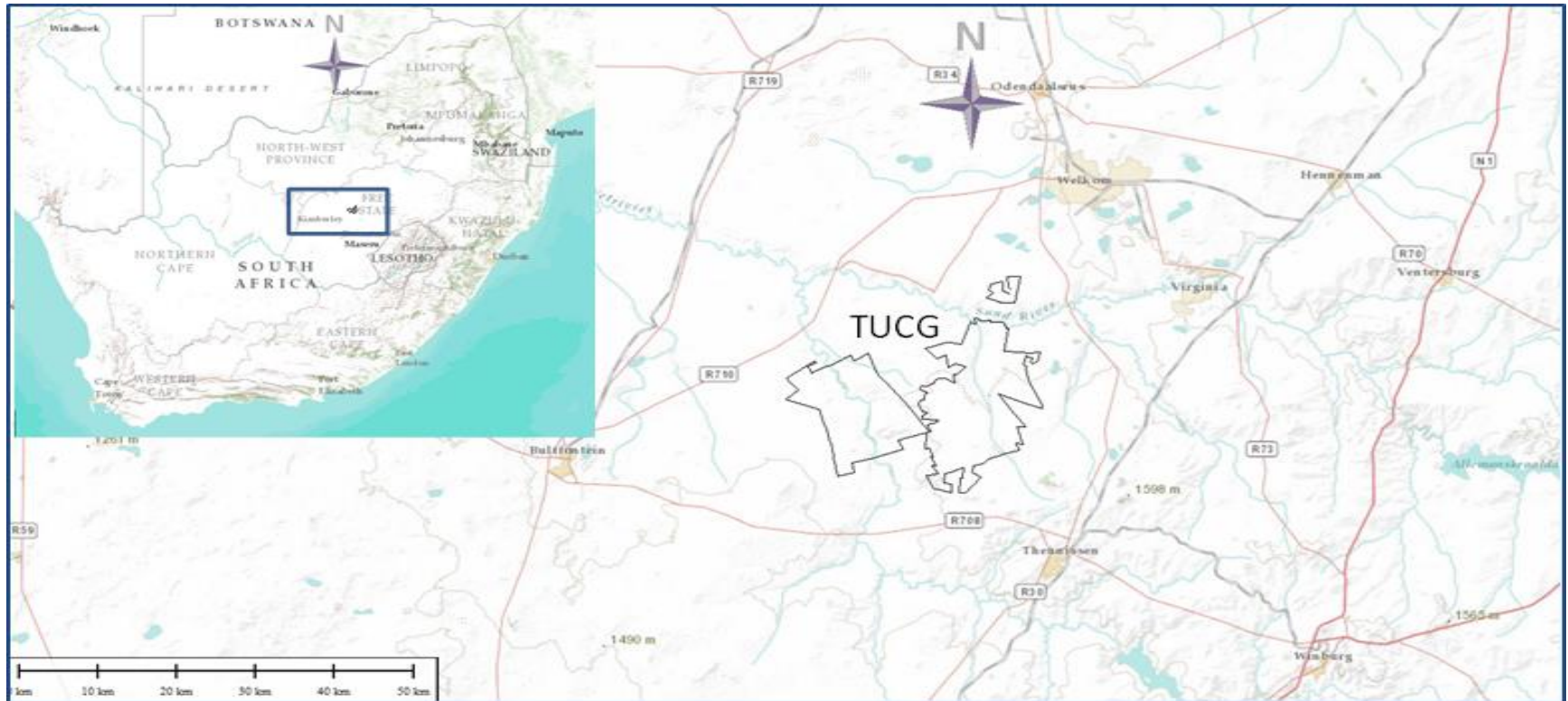


AFRICARY



Source: UCG Association

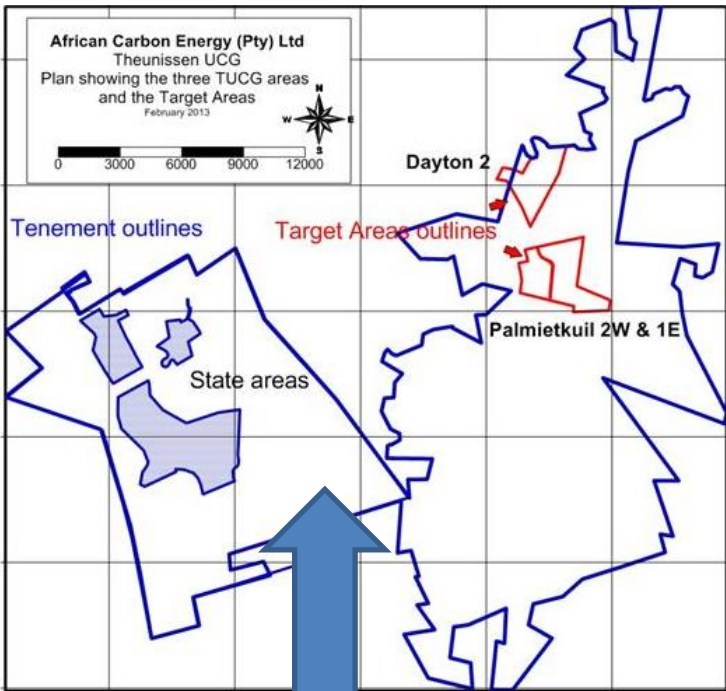
Where is Theunissen?



The Africary Rights include all coal exploration licences previously owned by BHP Billiton. The Rights comprise an area of 302km² and consist of:

- A northern (14km²) coal resource area
- A southern (173 km²) coal resource area
- A western (122 km²) coal resource area

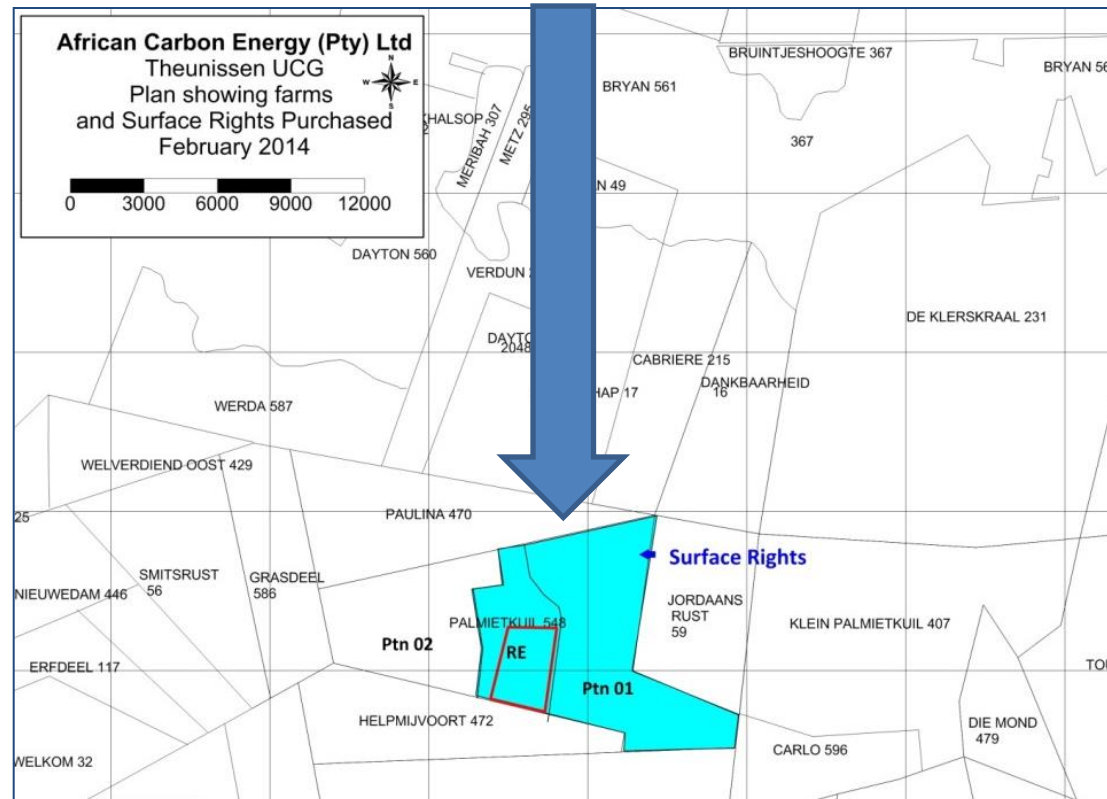
Coal Target Blocks



The coal tonnage in the rest of the resource is Inferred at 976 million tons

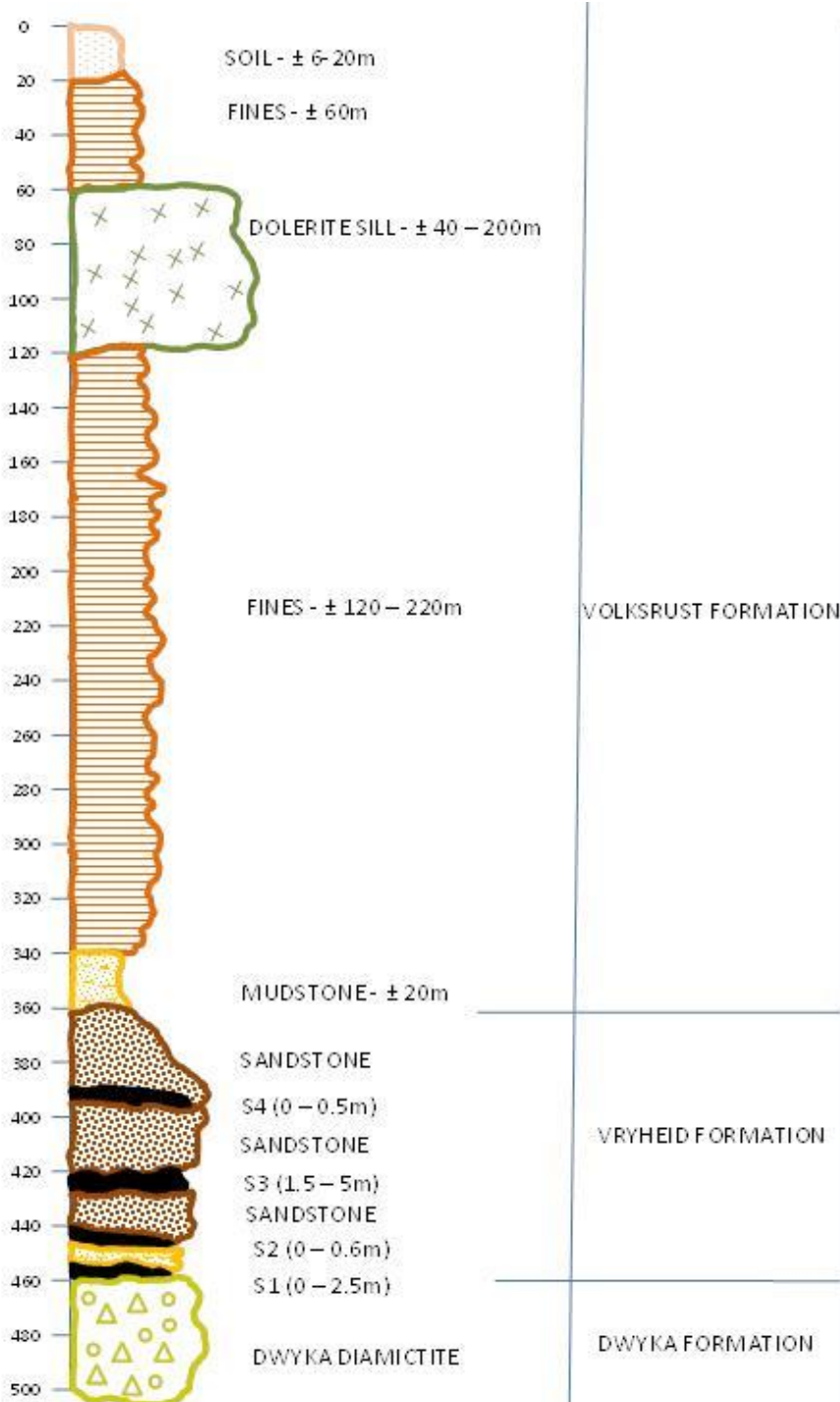
The coal tonnage (gross-in-situ) in the target farms are:

- *Inferred as 20.5 million tons*
- *Measured as 3.7 million tons*



3 Seam Reserve (within owners surface rights)

Target Area 3 Seam Resources					
Block	Area	Gross Tons In-Situ	SAMREC	Gross Tons In-Situ	SAMREC
South01	435 001	2 757 943	Measured		
South01	128 450			317 934	Inferred
South02	30 000			221 606	Inferred
South03	20 000	355 282	Measured		
South03	2 253 751			12 022 152	Inferred
North01	81 250	610 723	Measured		
North01	572 501			2 785 106	Inferred
North02	1 058 752			5 207 513	Inferred
Total Measured		3 723 948			
Total Inferred				20 554 312	
Total				24 278 260	



Schematic coal seam



Africa Carbon Energy

TUCG Project

Borehole Name: TUC602

Drilling Company: PDI Drilling

Geologist: AAR & LDM

Date: 23/10/2013-11/11/2013

Final depth: 369.24m

Wireline Final depth: 369.28m

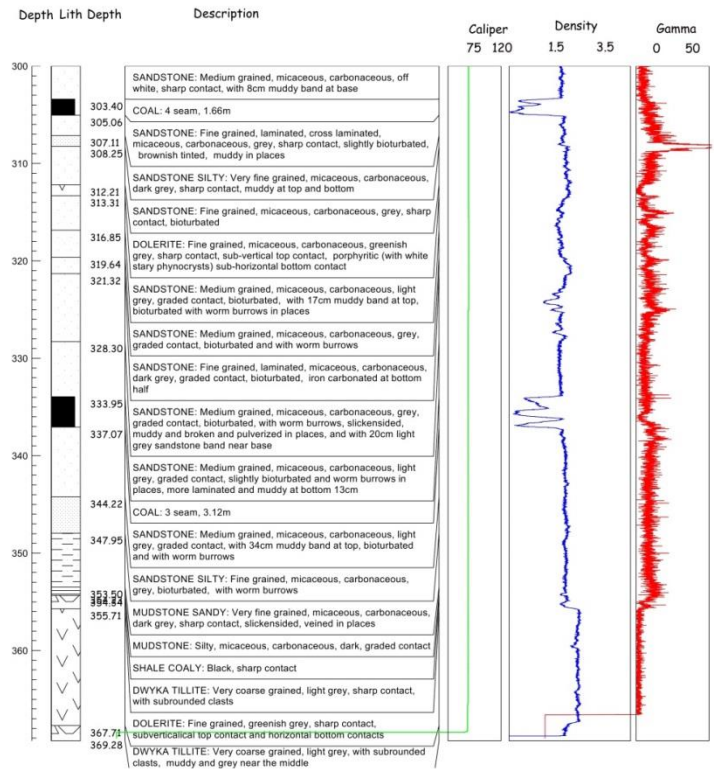
Casing depth: 21.15m

Coordinate System:

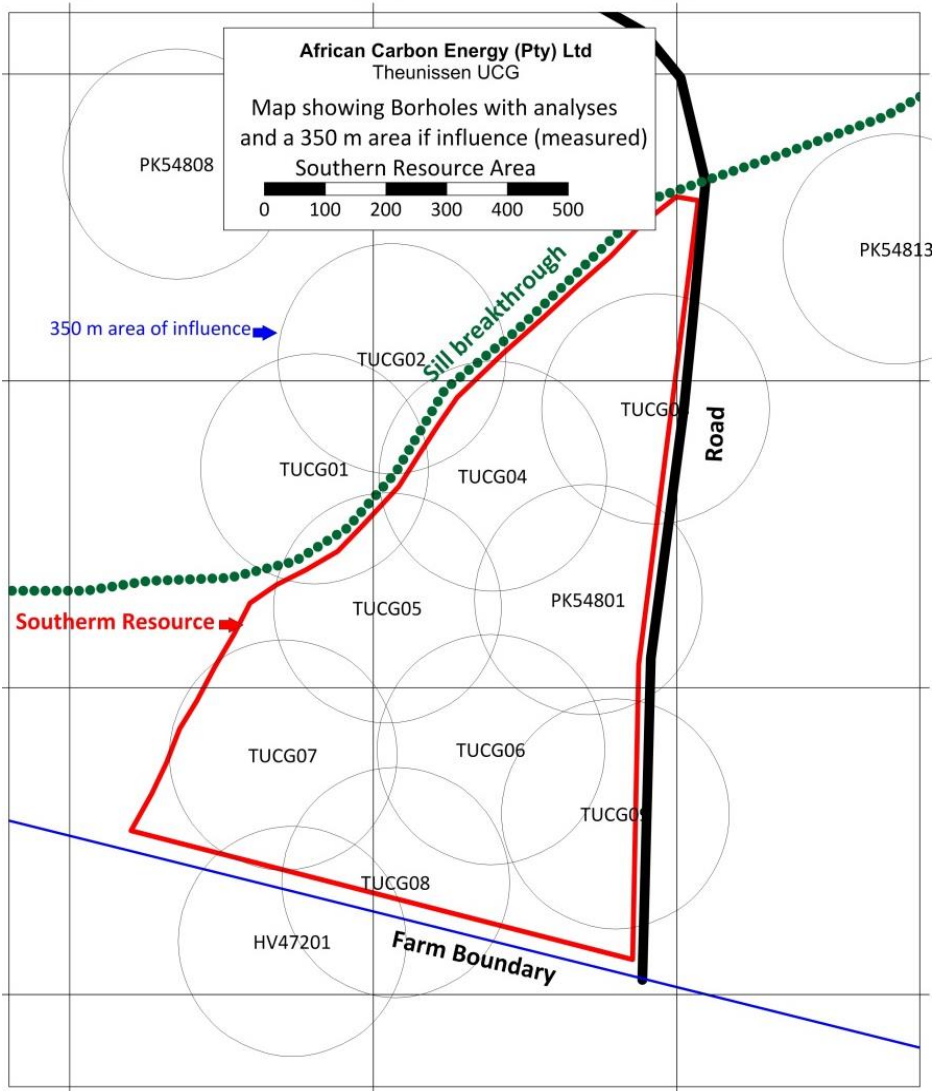
X Co-ordinates:

Y Co-ordinates:

Collar:



Recent completed drilling



350m radius classification



Analytical summary of core characterization



ANALYSES

PURPOSE

Proximate analysis: Moisture, Volatile matter, Ash, Fixed Carbon*

Total Sulphur*

Gross Calorific Value*

True relative density

Ultimate: C, H, N & O (by difference)

Forms of sulphur: Pyritic, Sulphate & Organic

AFT (oxidizing conditions)

Ash composition: SiO_2 , Al_2O_3 , Fe_2O_3 , TiO_2 , MgO , CaO , Na_2O ,

K_2O , P_2O_5 , SO_3

Fischer Assay: Char, Liquid hydrocarbons, Water, Gas (by difference)

Petrographics: Maserals and rank (COAL DEFINITION)

Mineral composition

Trace elements analyses

Chlorine, Cl

Fluorine, F

Crucible swelling number

Gieseler fluidity

Self-heating and Spontaneous Combustion

Pore size and surface area

Mass balance, ash content, water

Environmental, gas cleaning design

Efficiency of process

Mass balance on coal, measured resource classification

Mass balance, oxygen consumption, gas quality

Speciation, environmental, gas cleaning

Gasifier operating window

Influence acid/base ratio of ash, slagging, trace element capturing

Liquid hydro carbon yields, tar and oil

Reactivity, coal classification, tar yields, and much more

Type of minerals and not composition, i.e. clay, sulfates, carbonates

Environmental, gas cleaning design

Environmental, gas cleaning design, corrosion

Environmental, gas cleaning design, corrosion

If coal is caking coal / plasticity

If coal is caking coal / plasticity

Rate of combustion, start-up

Reactivity, cavity formation, gas velocity expected

MEASURED RESOURCE

ENVIRONMENTAL + *

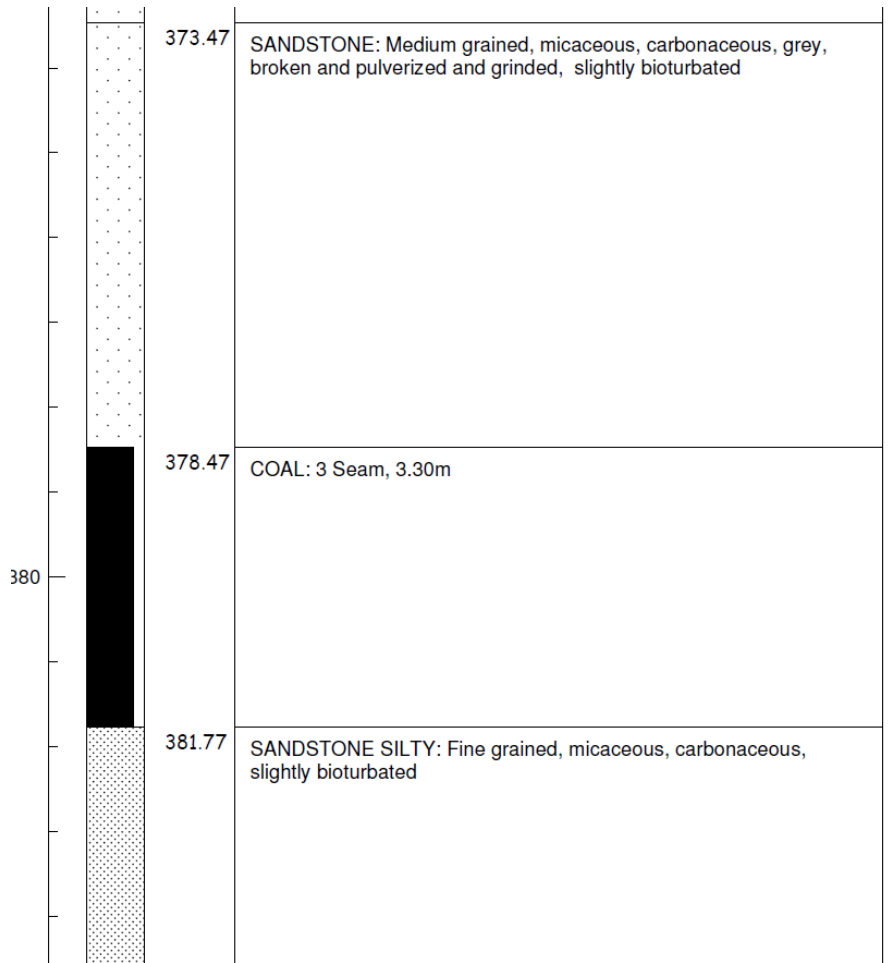
MASS AND ENERGY BALANCES + *

GASIFIABILITY AND RATE OF GASIFICATION

Detail discussion on test procedures and explanation to follow in coal characterization reports

Detail resource characterization

SEAM 3



- RoV = 0.58 (medium rank)
- Ash content = 28.5%
- Low sulphur content < 0,7mass %
- Good gasification characteristics
- Low Cl and F content
- CV = >21MJ/kg

TUCG09 3 Roof 378.17-378.47 (0.3m)

TUCG09 3 (1) 378.47-379.77 (1.13m)

TUCG09 3 (2) 379.77-380.53 (0.76m)

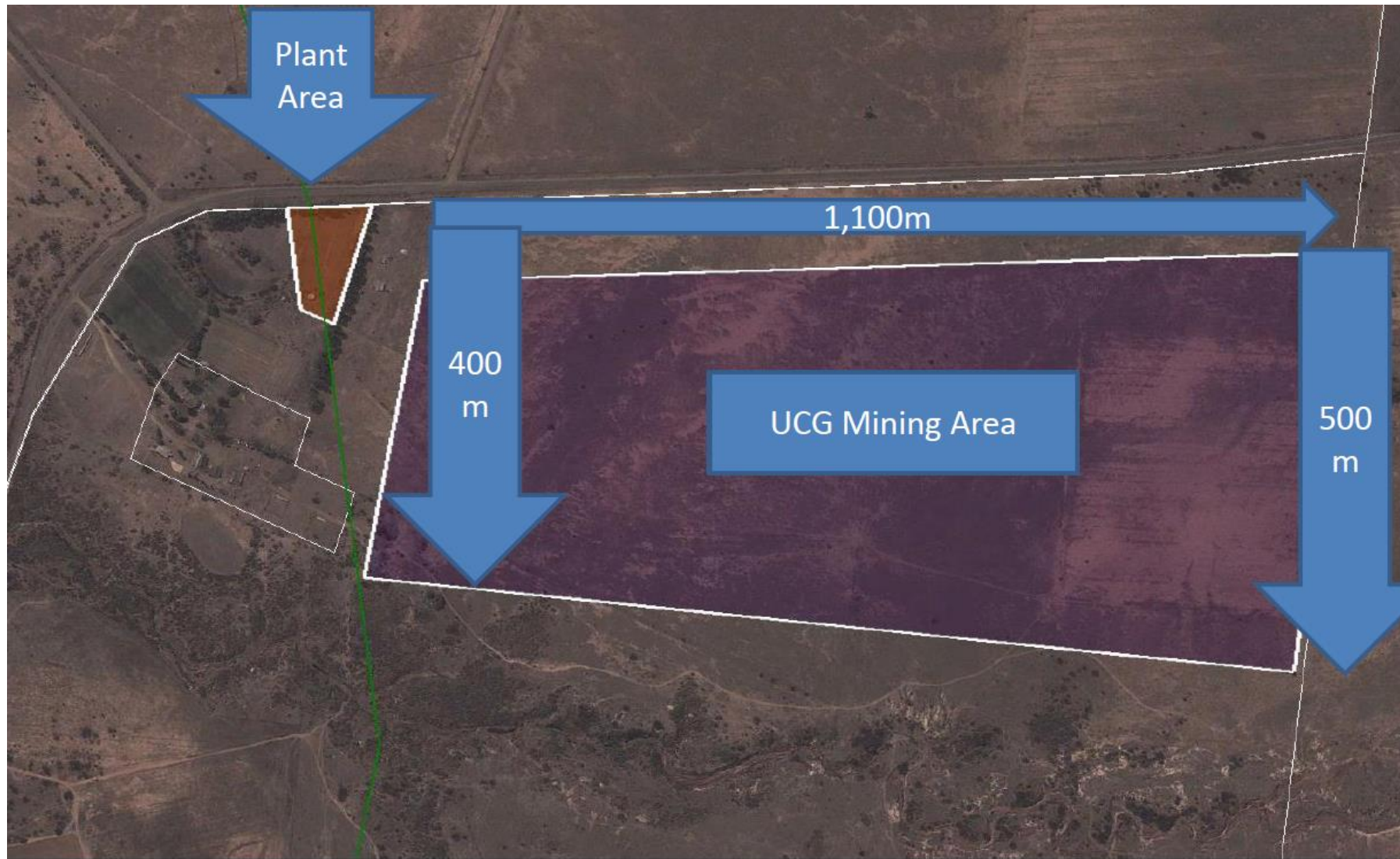
TUCG09 3 (3) 380.53-381.30 (0.77m)

TUCG09 3 (4) 381.30-381.77 (0.47)

TUCG09 3 Floor 381.77-382.07 (0.3m)



Site optimization

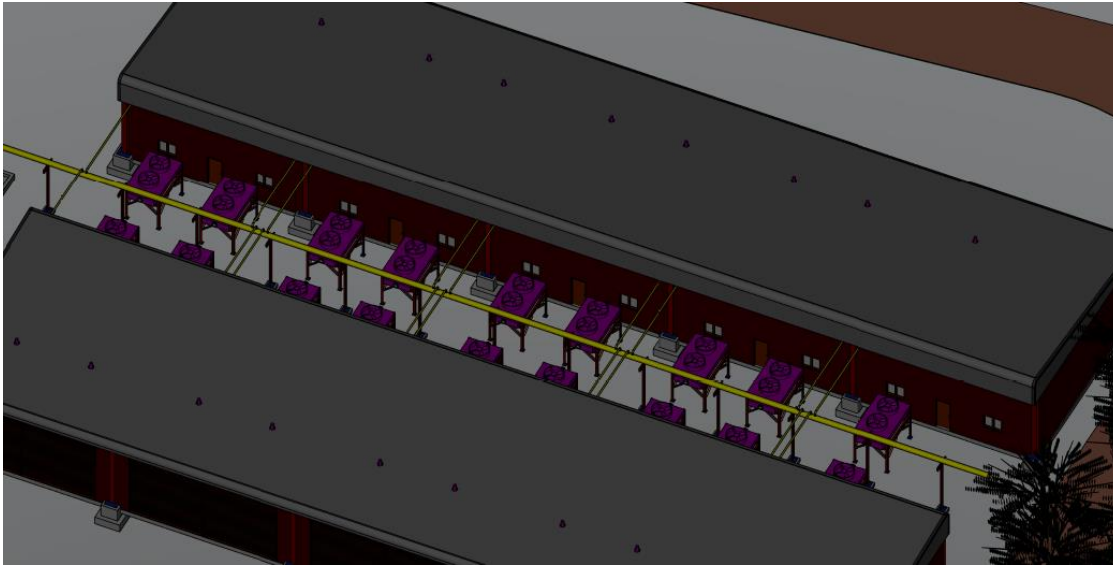


Areal overview of plant



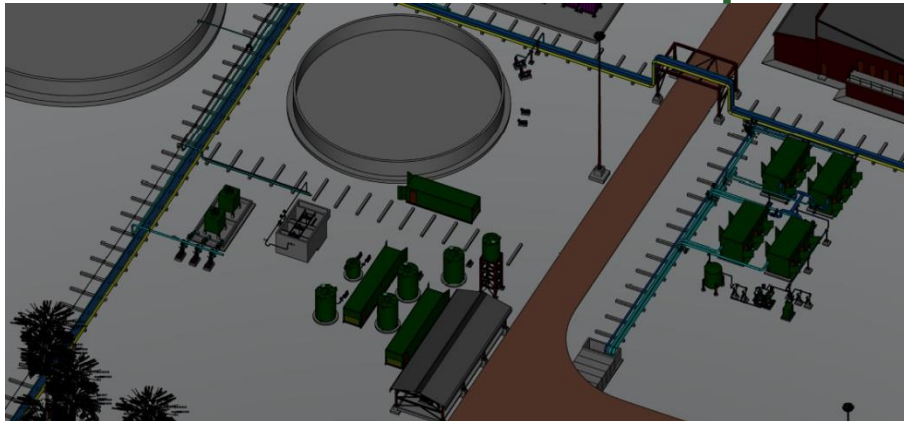
Plant sub-buildings

Engine buildings

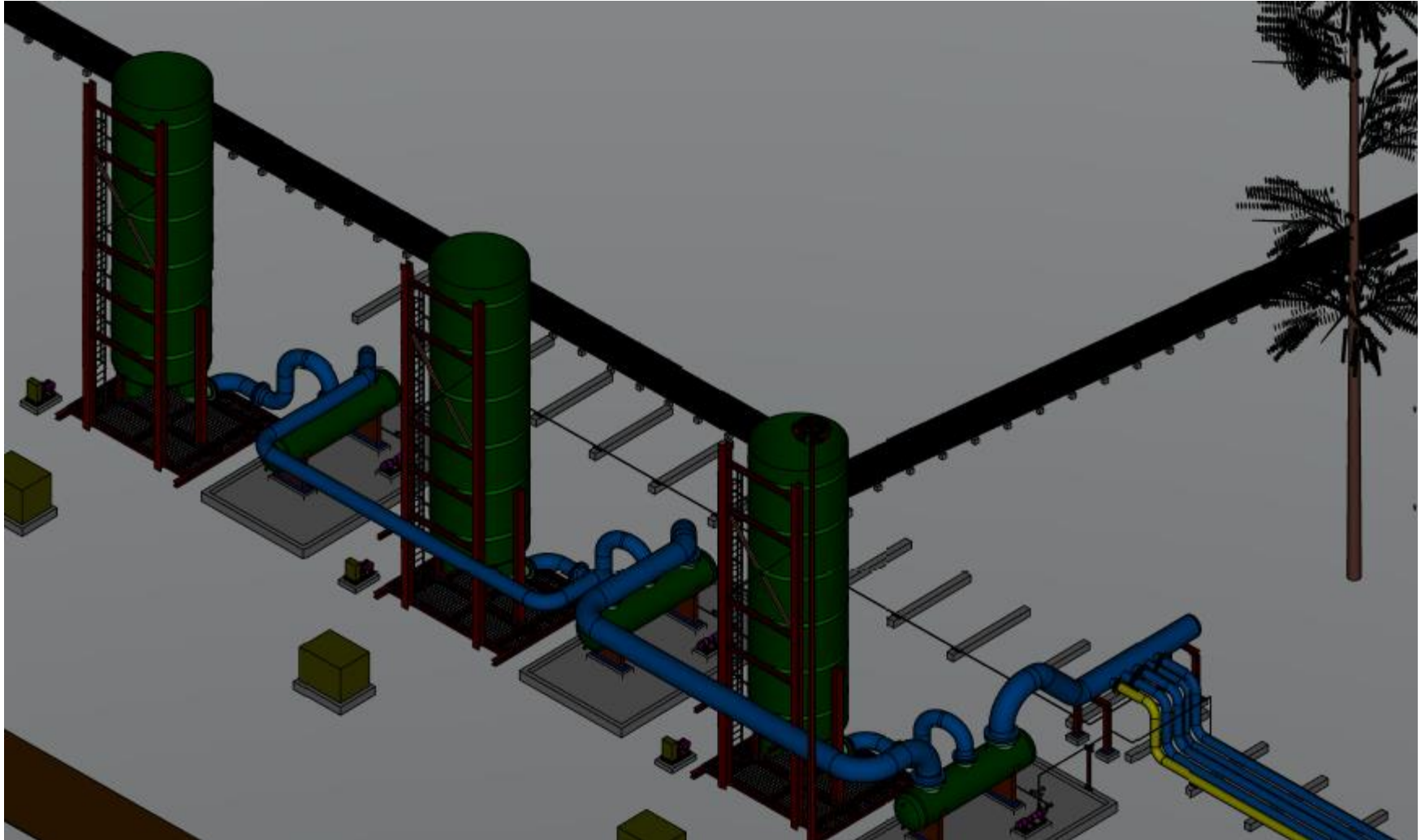


24 x GE-Jenbacher
Gas Engines to operate
on Syngas

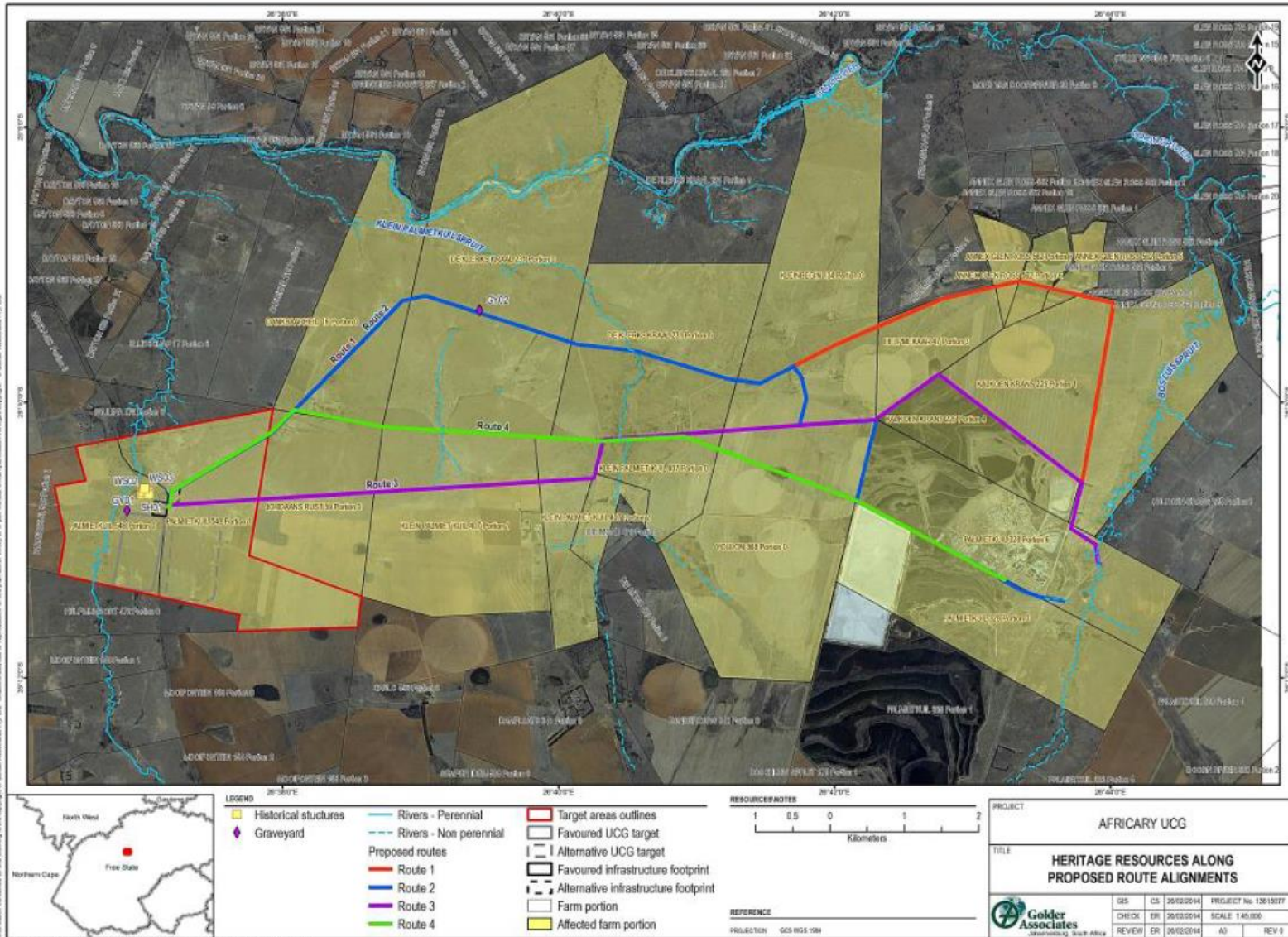
Waste treatment and air compression



Flare system



Possible 132kV Power Line Route



SandVet Water Supply Agreement



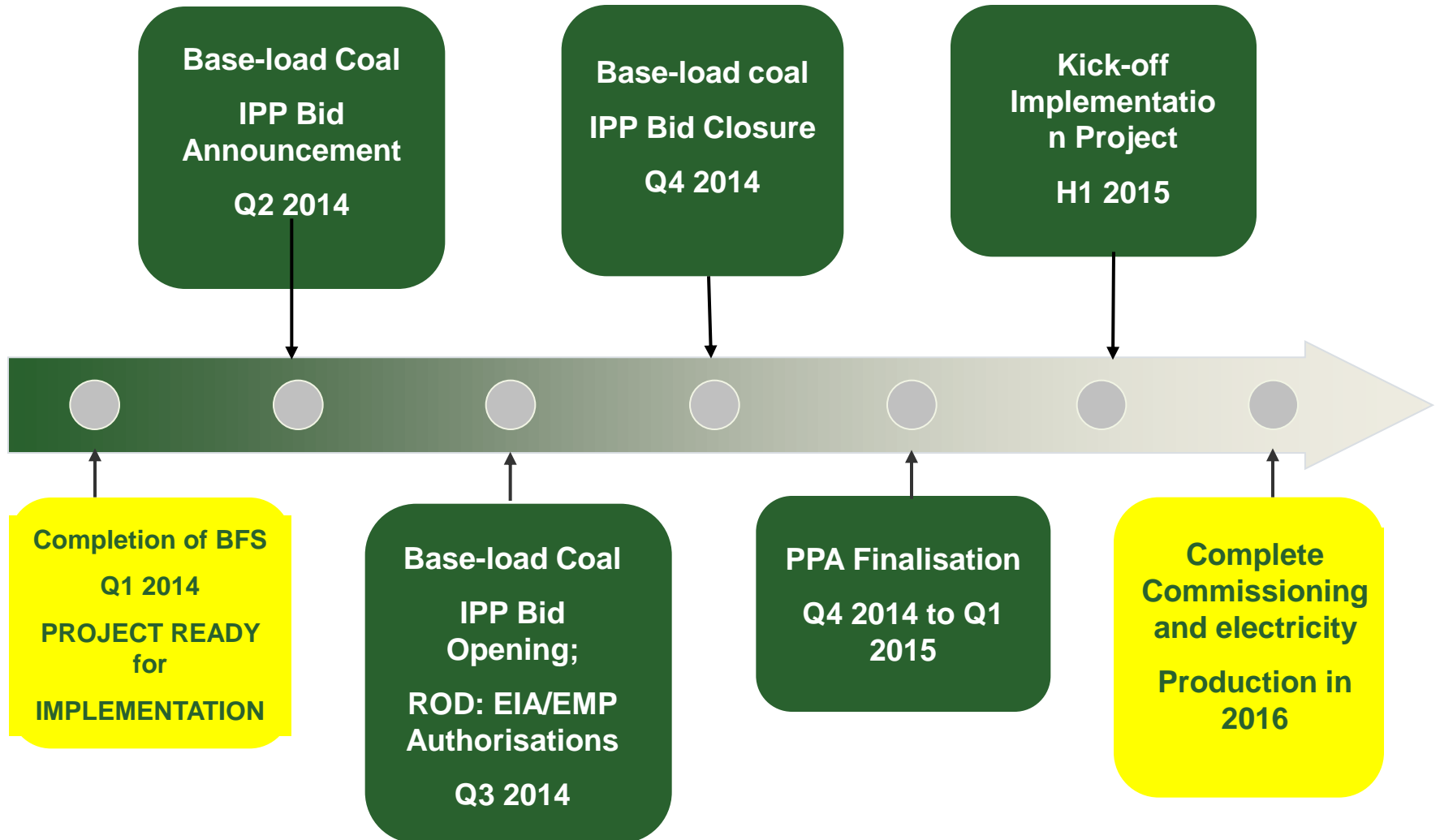
- In negotiations to source water from SandVet*
- Will benefit Aldam canal*
 - Buy some water rights that are not being used*
 - Regular water testing*
 - Adhere to regulatory and environmental procedures*

Economic Development Plan



Economic Development (planned)	
Job Creation	
Person months performed by citizens of the RSA as of total person months	50.0%
Person months performed by RSA based black employees as of total person months performed by citizens of the RSA	30.0%
Person months performed by skilled black employees as of total person months performed by skilled employees	18.0%
Person months performed by citizens from Local Communities as of total person months performed by citizens of the RSA	12.0%
Local Content	
Value of local content spend as of total project value	40.0%
Ownership	
Shareholding by black people in the electricity selling company	12.0%
Shareholding by Local Communities in the electricity selling company	3.0%
Shareholding by black people in the construction contractor	8.0%
Shareholding by black people in the operations contractor	8.0%
Socio-economic Development (SED)	
Socio-Economic Development Contributions as a percentage of revenue	1.0%
Adjusted Socio-Economic Development Contributions adjusted for localness as a percentage of revenue	1.0%

Key Milestones



In conclusion...

- ❑ *Clean coal power production that can be done safely and in an environmentally acceptable way*
 - ❑ *Uses 10 times less water than conventional coal*
 - ❑ *Has 20% higher energy efficiency than conventional boilers*
 - ❑ *Has no particulate emissions and low environmental impact*

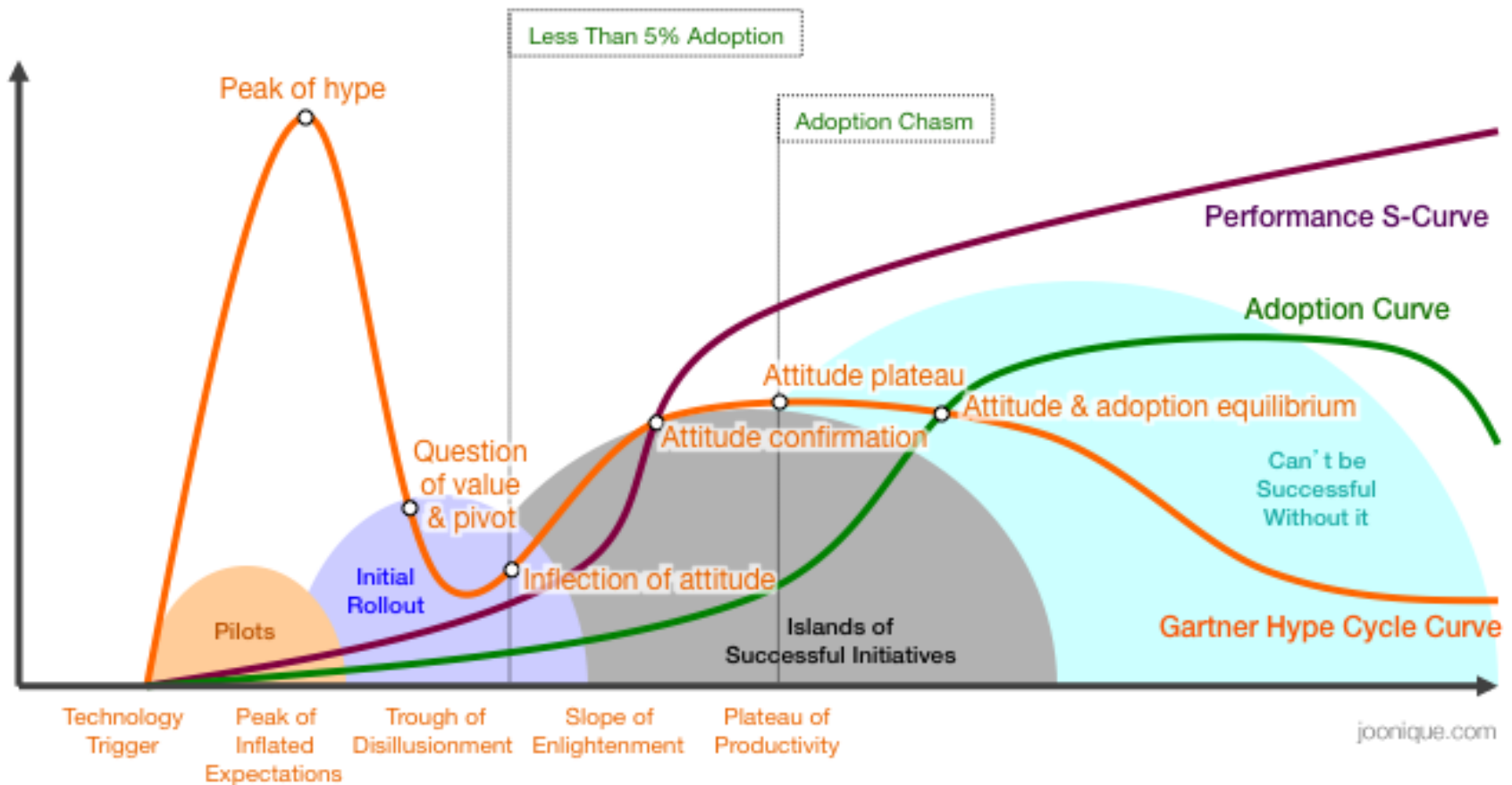
- ❑ *Is proven world-wide*
 - ❑ *Eskom - South Africa – Majuba Project*
 - ❑ *Australia*
 - ❑ *USA*
 - ❑ *Canada*
 - ❑ *Former Soviet Union*
 - ❑ *China*
 - ❑ *New Zealand*

Gartner Hype Cycle

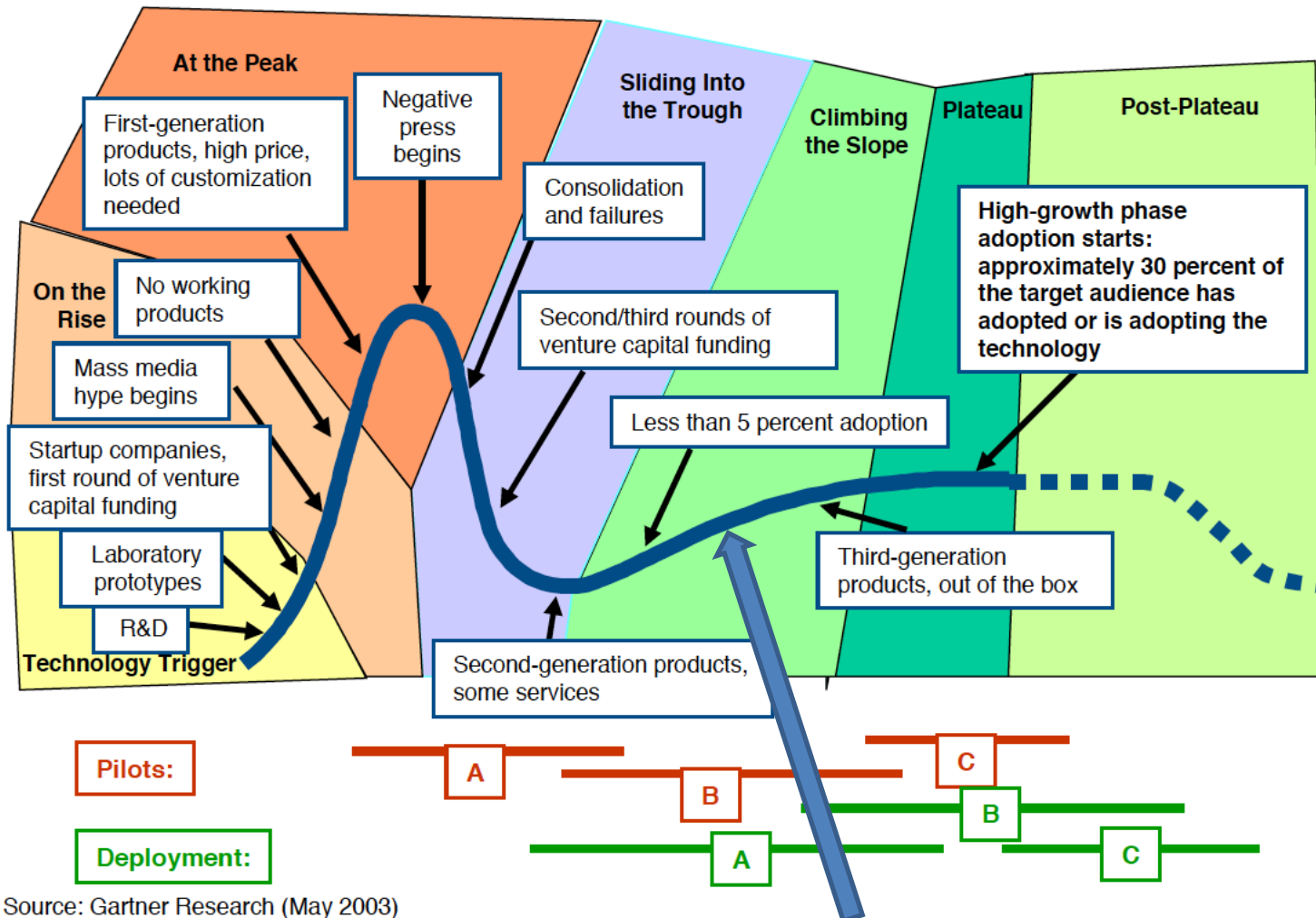
UCG is on the "Slope of Enlightenment"



Gartner Hype, Performance, Adoption, & Scopes Dynamic Relationships



Gartner Hype Cycle - explained

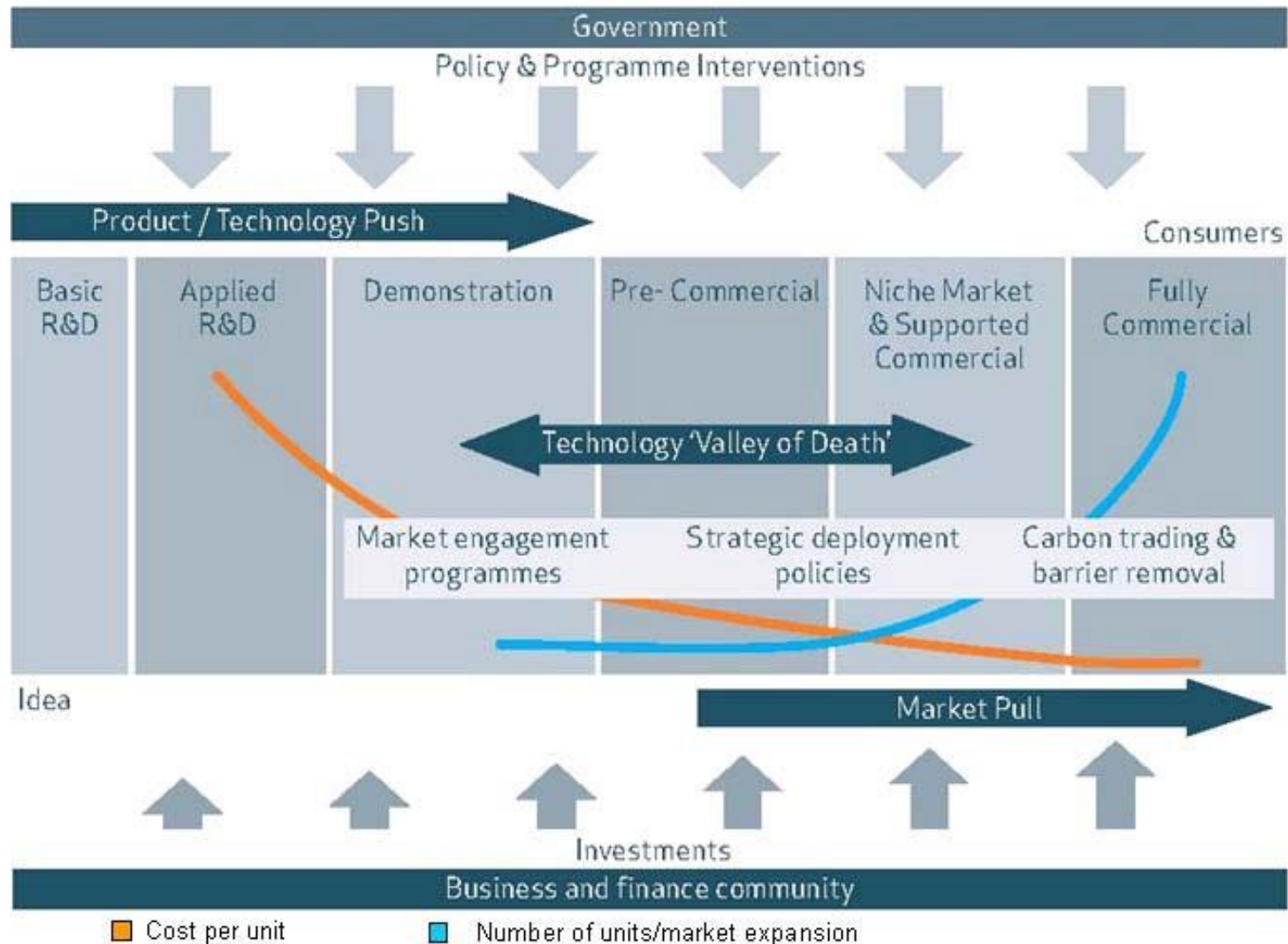


Source: Gartner Research (May 2003)

Africary has 3rd Generation designs on UCG

Technology Valley of Death

UCG needs a “Niche Market” commercial application in SA



Why can UCG play a role in SA ?

- ❑ *Coal will remain an important part of the energy mix for decades to come*
 - ❑ *Cleaner coal options such as UCG need to be evaluated alongside other energy options*

- ❑ *UCG can access coal resources that are not mineable conventionally or not-economical to extract*
 - ❑ *Potential to more than double recoverable coal resources*

- ❑ *UCG is an in-country energy solution, independent of exchange rate and oil price*

- ❑ *SA is at the forefront of UCG development in the world with a number of active projects*

IN MEMORY OF THE LATE

Eliphus Monkoe

10 October 1959 to 6 May 2014



AFRICARY
African Carbon Energy

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CEO

Email: Johan.Brand@Africary.com