



Sasol Technology R&D Coal and Gas Processing

sasol
reaching new frontiers



A DIAMOND IN THE GLOBAL WORLD OF CARBON



JC van Dyk, PS Baumann and V Bhimsan
Chief Scientist and Technical Specialist
Sasol Technology (Pty) Ltd*

The road ahead in the next 30 minutes.....



**3. Sasol Technology
C&GPT**

**4. C&GPT Technical
focus areas**

2. SASOL

5. Coal has a future....

1. South-Africa



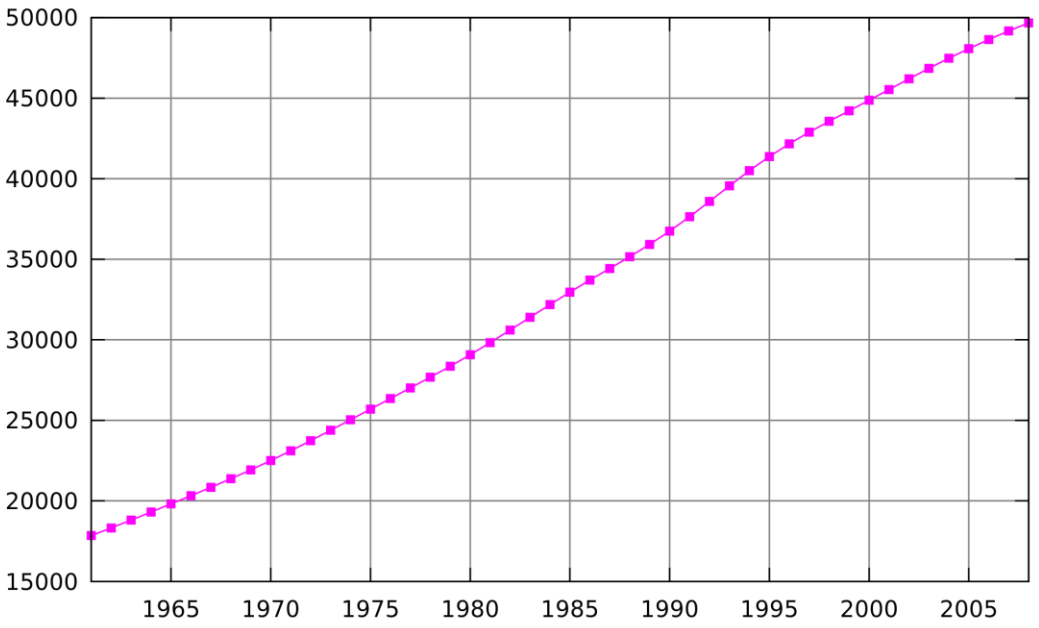
Population statistics



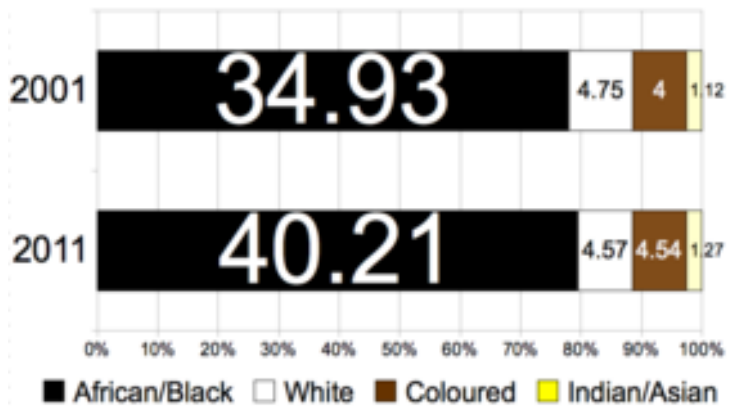
Population:	49,991,300 (July 2010 est.) ^[1]
Growth rate:	-0.051% ^[2]
Birth rate:	19.61 births/1,000 population (2010 est.)
Death rate:	16.99 deaths/1,000 population (2010 est.)
Life expectancy:	49.2 years (2010 est.)
–male:	50.08 years (2010 est.)
–female:	48.29 years (2010 est.)
Fertility rate:	2.33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

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.)



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



South-Africa in size comparison



South Africa occupies 4% of the continent's total landmass, covering an area of 1 221 040 square kilometres. The country is five times larger than Great Britain and three times the size of Texas.

<http://www.edusouthafrica.com/south-africa.html>



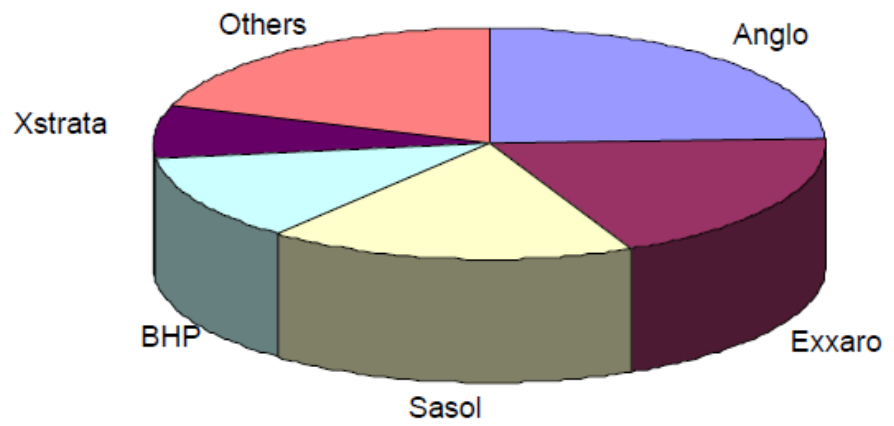
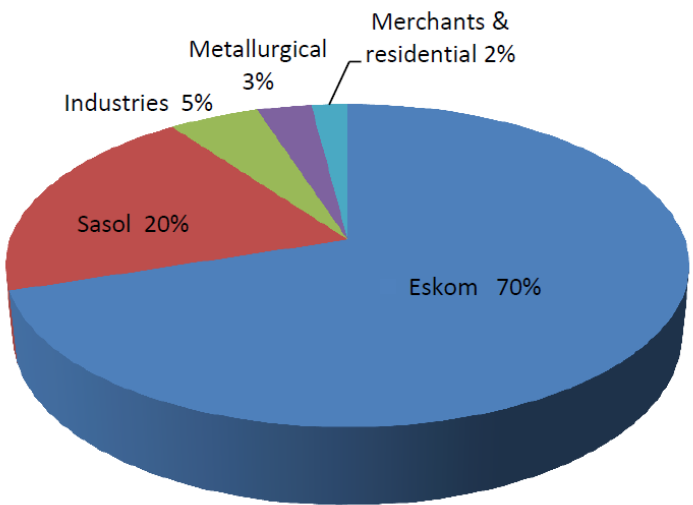
Coal utilization in South Africa (2010)



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)



The road ahead in the next 25 minutes.....



**3. Sasol Technology
C&GPT**

**4. C&GPT Technical
focus areas**

2. SASOL



5. Coal has a future....

1. South-Africa



Sasol's global presence (updated end 2011)



Southern Africa



Rest of Africa and Middle East



Central Asia, India and South East Asia



Western Europe



North America and Canada



Far East



▶ Manufacturing/production
 ▶ Office
 ▶ Exploration
 ▶ Project
 ▶ New projects
 ▶ Research

Sasol in South-Africa?

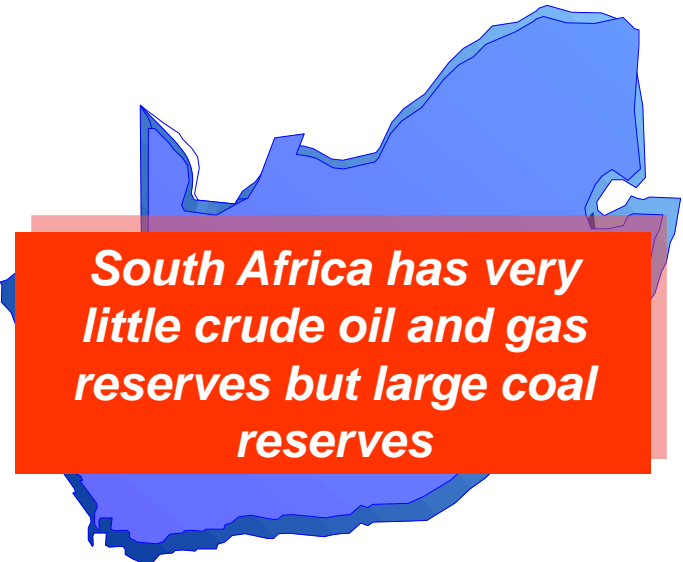


Birth of Sasol



South African Government investigated the production of oil from coal.
Decided to form a state-owned company

Sasol incorporated as a state owned company



South Africa has very little crude oil and gas reserves but large coal reserves



1950

Sasol's first board of directors

Government support was essential for the establishment of a Synfuels Industry



Construction of the first Sasol plant in Sasolburg completed at a cost of USD 132 million of the day

First petrol delivered to the market

Sasol became cash positive

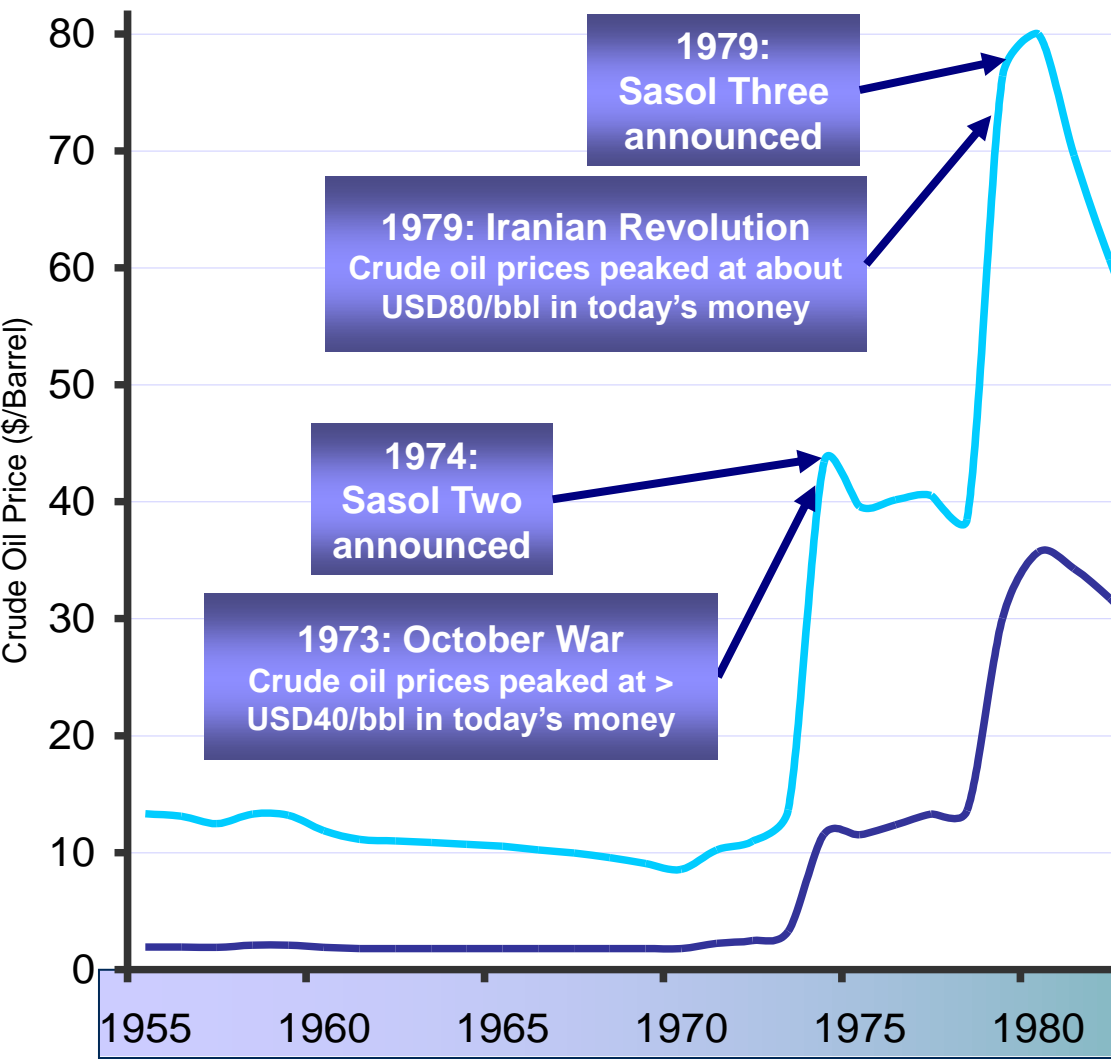
First profit



1954 1955 1958 1960

Initial Facility Profitable within 5 years of start-up

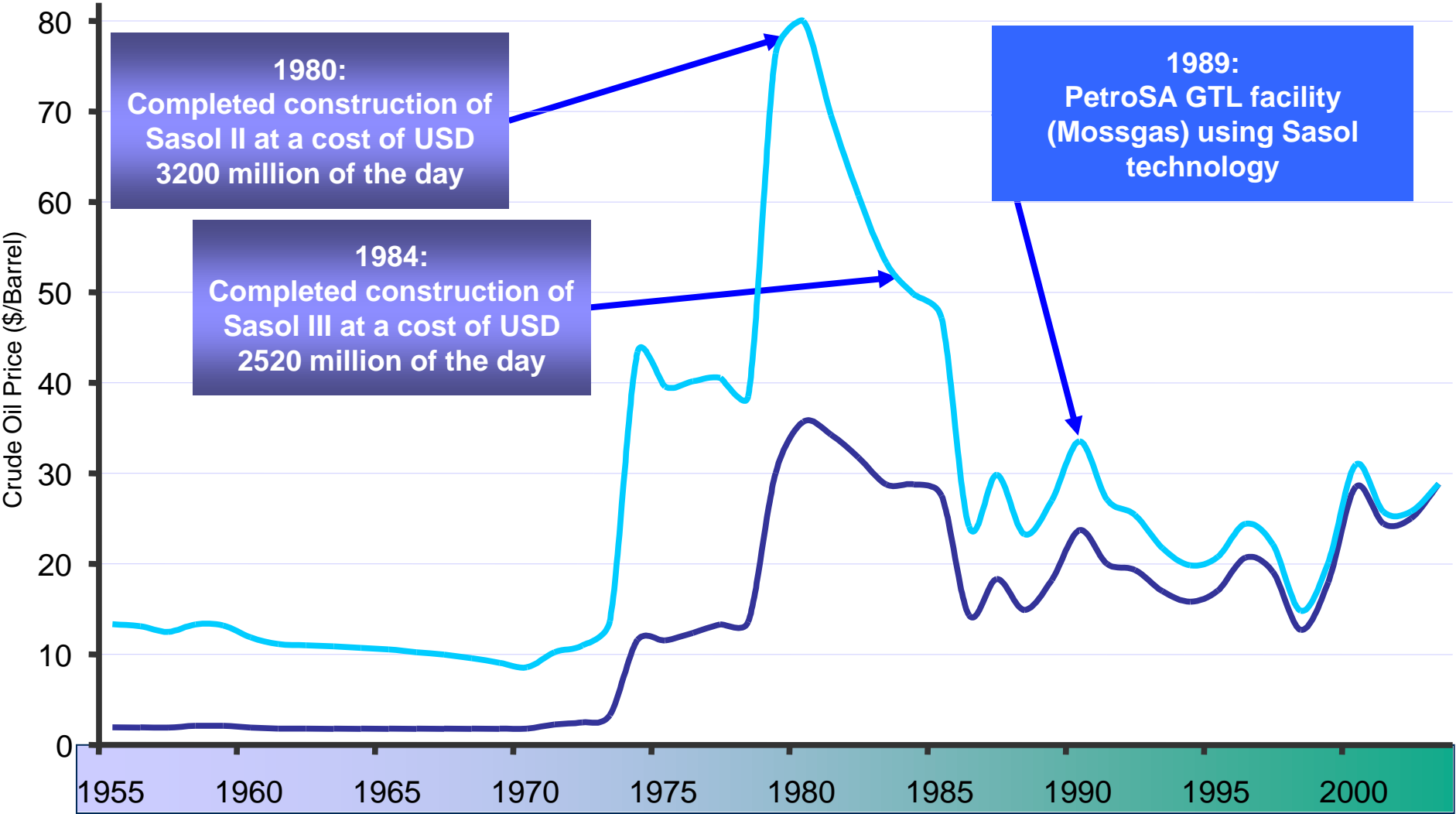
Sasol II & III

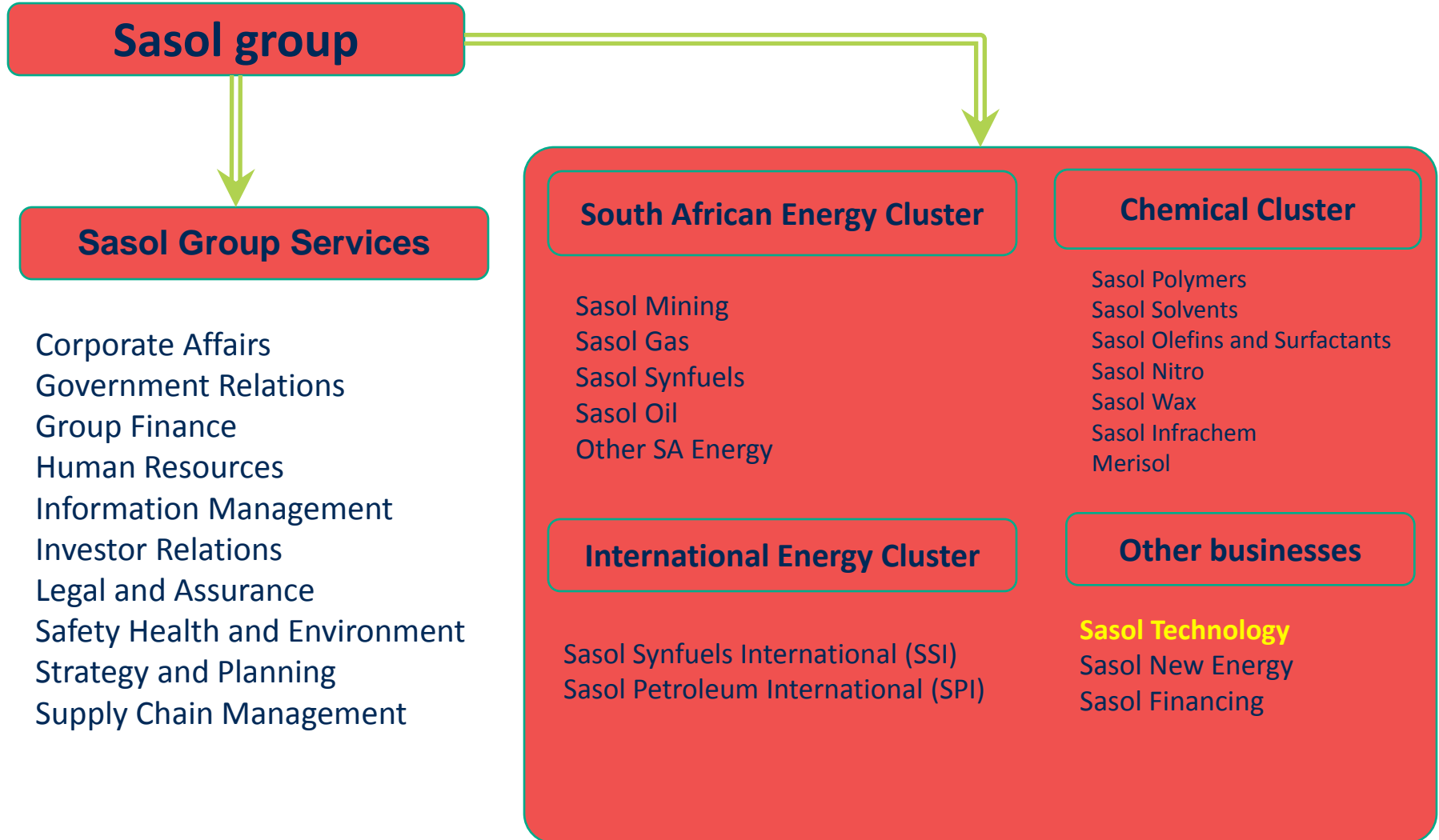


The location of Sasol's huge new factory, Secunda, is announced

High oil prices precipitated the establishment of a Large Scale Synfuels Industry

Sasol II & III completed





60 years of operating experience

sasol
reaching new frontiers



**Sasol's synfuels and chemicals plant in
Secunda, South Africa**



Since inception, produced more than 1.6 billion barrels of high quality fuels from coal and gas. More than 20 million gasifier operating hours. More than 1 billion tons of coal processed at Sasol Synfuels



Sasol's largest commercial facilities is the Sasol Synfuels operations in Secunda in South Africa

The Secunda plant is an equivalent of 160,000 bbd refinery

Coal is first gasified in the Sasol® FBDB™ Gasification Process to produce synthesis gas

The synthesis gas is then converted into hydrocarbons and other chemicals utilizing Sasol's proprietary Hydrocarbon Synthesis technologies

Some Synfuels Facts from a Gasification Perspective

In excess of 1 billion tons of coal has been gasified

Total coal mined per year >41 million tons; 26 million tons to gasification

6 Coal Sources: 5 Sasol Mines + 1 mine as contracted coal supplier (High ash yield 25-35+ % AD)

84 Mk IV™ Sasol® Fixed Bed Dry Bottom™ Gasifiers producing > 3 million m_n³/h



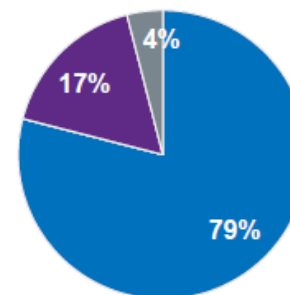


SA energy drives growth in group profitability

	2012	2011	% Δ
SA Energy	29,0	19,9	▲ 45
International Energy	(0,1)	1,6	▼ 103
Chemicals	6,5	8,7	▼ 25
Other	1,4	(0,3)	
Operating profit (Rbn)	36,8	29,9	▲ 23
Operating margin (%)	21,7	21,0	▲ 1
Earnings per share (R)	39,10	32,97	▲ 19
Dividend per share (R)	17,50	13,00	▲ 35
Cash generated by operations (Rbn)	47,9	38,6	▲ 24

- Significant improvements in production performance in 2H12
- Operating profit negatively impacted by once-off charges of R2,1bn (FY11: R1,1bn)
- Robust performance from SA Energy
- International energy impacted by Canada non-cash costs
- Chemicals negatively impacted by lower demand and margin squeeze

Operating profit split



■ SA Energy ■ Intl Energy ■ Chemicals ■ Other

The road ahead in the next 20 minutes.....

sasol
reaching new frontiers



**3. Sasol Technology
C&GPT**



**4. C&GPT Technical
focus areas**

5. Coal has a future....

2. SASOL

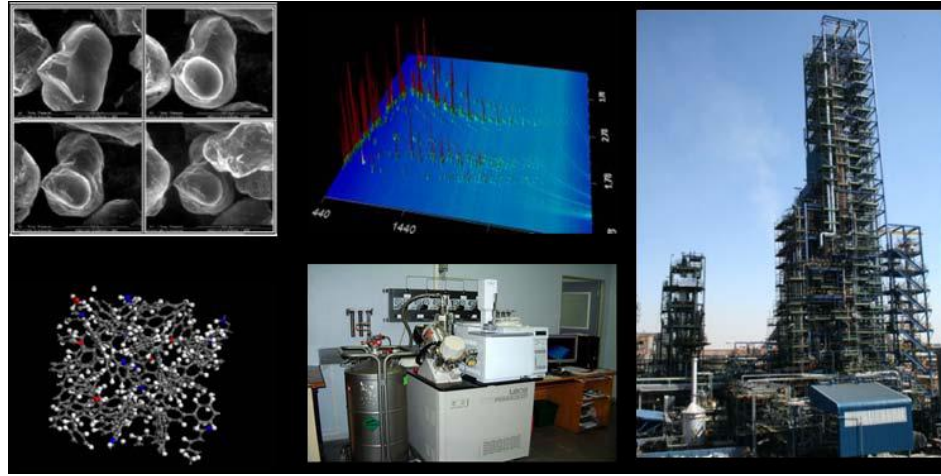
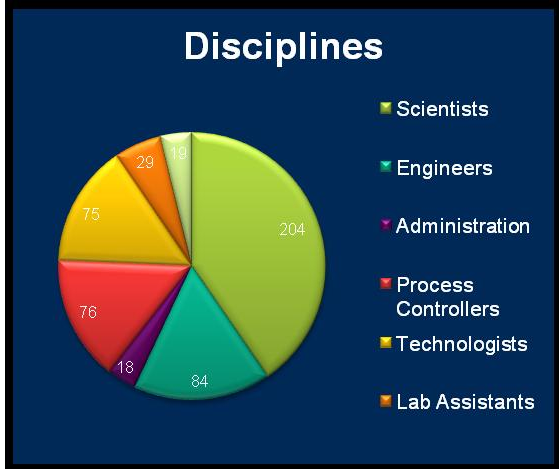
1. South-Africa





- Corporate R&D located mostly in Sasolburg (590)
- Also centers in Secunda (30); Netherlands (9); Scotland (22)
- Extensive R&D Infrastructure
- Laboratories & Pilot Plants
- Design; Construction; Commissioning & Operation
- Main R&D Focus Areas

Coal & Gas Processing Technologies
 Fischer Tropsch
 Chemicals
 Environment
 Refinery Technologies
 New Energy





2011 / 2012 Budget

- *Operating budget R 785 million (US\$112M)*

Facilities in Sasolburg

- *Laboratories*
- *Analytical equipment*
- *Pilot Plants*
- *Library*
- *Maintenance workshops*

External Liaison

- *Local Universities*
- *Foreign Universities*
- *Various Research Institutes*



The road ahead in the next 15 minutes.....



**3. Sasol Technology
C&GPT**

**4. C&GPT Technical
focus areas**



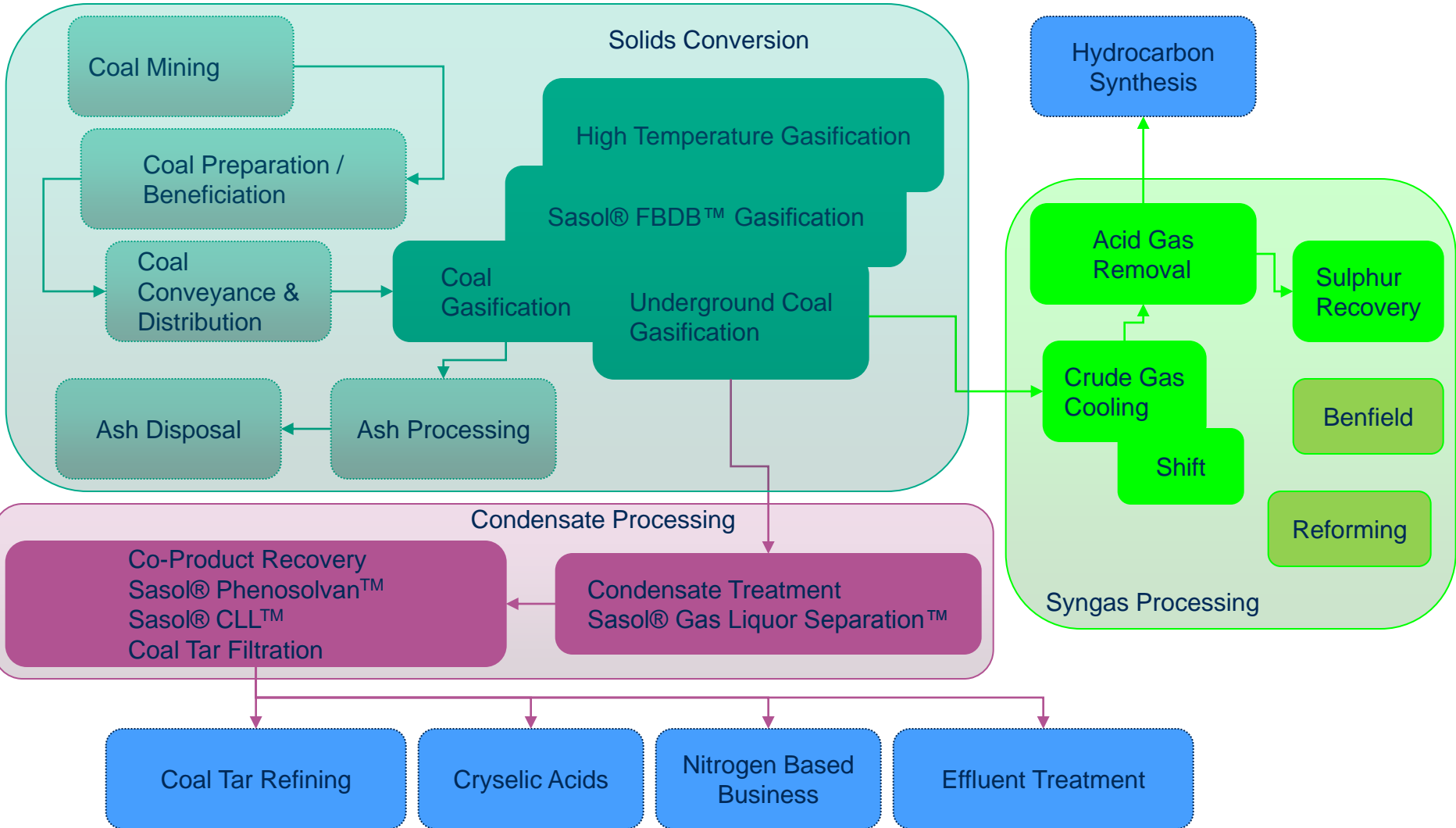
2. SASOL

5. Coal has a future....

1. South-Africa



Coal & Gas Processing Technologies - Value Chains



- Coal Tar Refining
- Cryselic Acids
- Nitrogen Based Business
- Effluent Treatment



Coal Characterisation & Processing

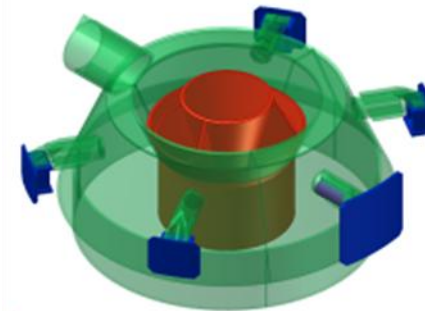
- *Physical and chemical properties*
- *Coal processing and beneficiation*
- *Coal agglomeration*

Gasification Technologies

- *Sasol ® Fixed Bed Dry Bottom™ Technology*
- *Underground Coal Gasification*
- *High Temperature Gasification*
- *Fluidized Bed Gasification*

Synthesis Gas Treatment

- *Gas Cooling, Cleaning & Conditioning*



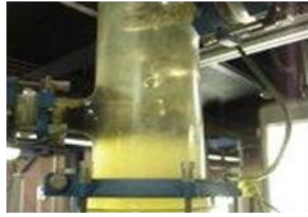
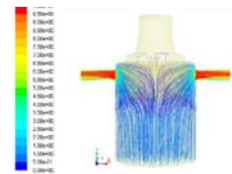
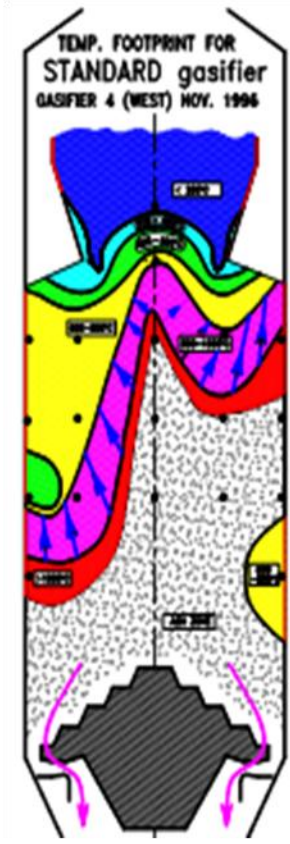


Co-product Processing

- Sasol® Gas Liquor Separation™
- Sasol® Phenosolvan™
- Sasol® CLL™ Ammonia Recovery
- Coal Tar Filtration

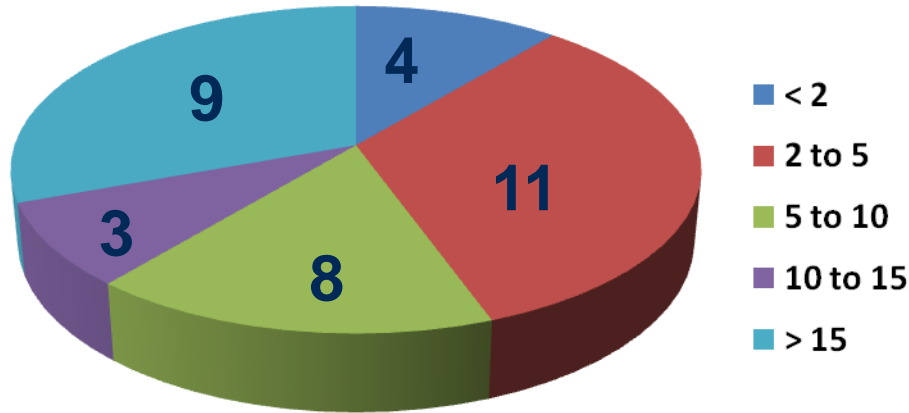
Supporting

- Direct Coal Liquefaction
- Pyrolysis
- Coal Combustion
- Process Modeling





Years with Sasol



Qualifications

PhD = 16

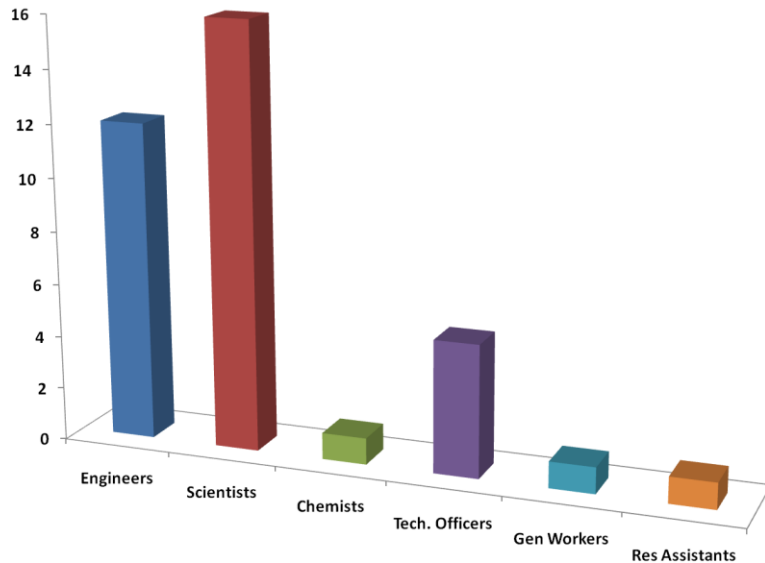
MSc=9

BSc (4yrs)= 2

BSc (3yrs) = 1

Diploma = 2

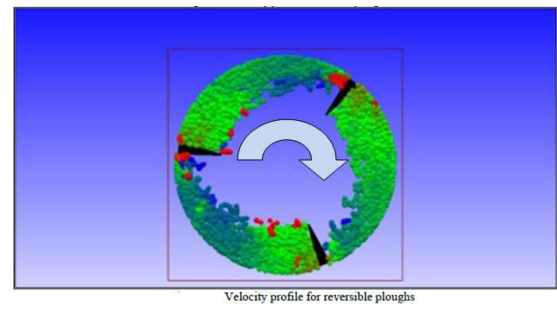
Matric and below = 5



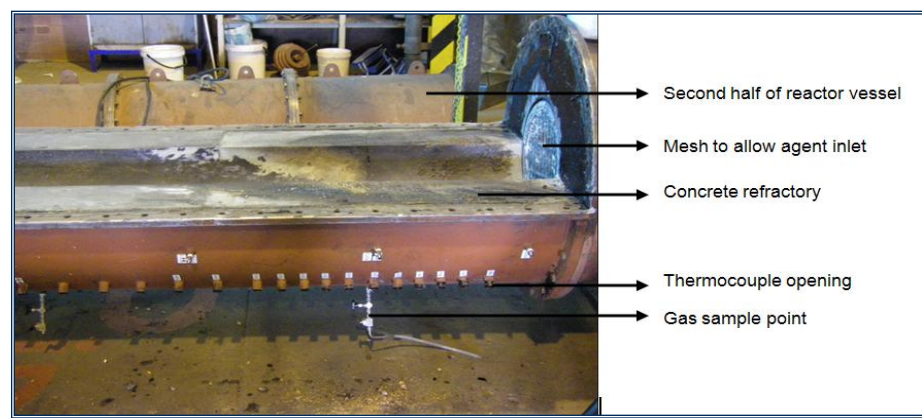
Specialized skills tools to assist R&D programs



- Discreet element modelling (DEM)



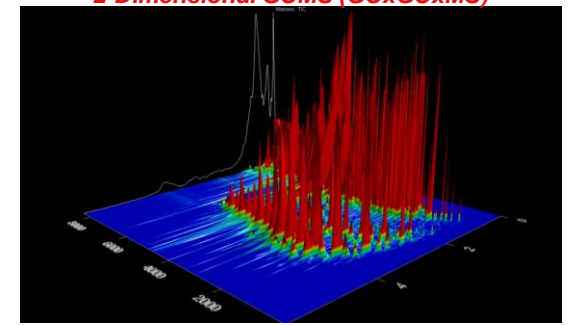
- Lab scale atmospheric reactor s(i.e. pipe reactor)



- Sasol Proprietary Pyrolyzer (Koekebakker™)

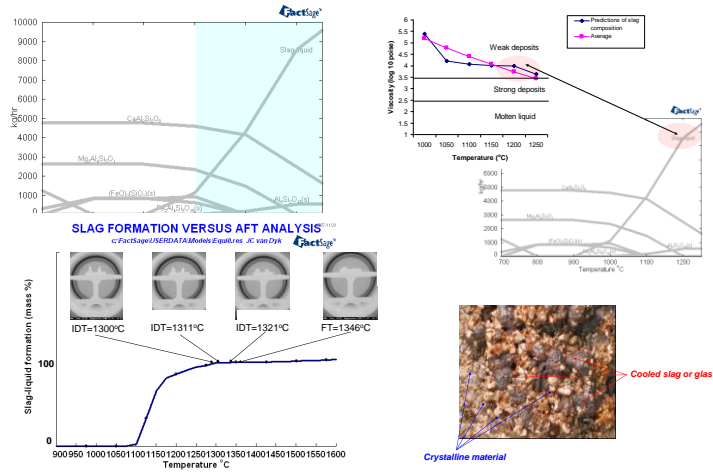


2-Dimensional GCMS (GCxGCxMS)

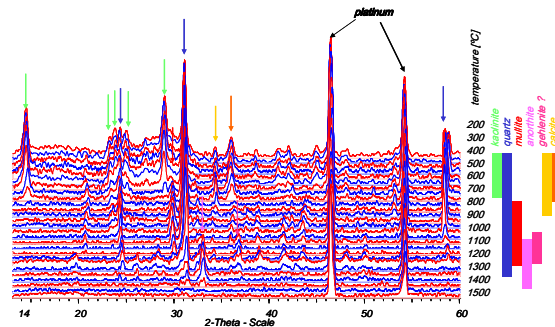




Inorganic simulation of mineral matter

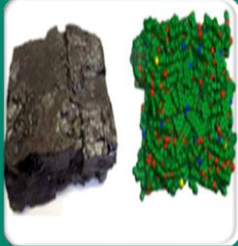


HT-XRD – mineral characterization



Spectroscopy lab

Typical C&GPT programs Team



Coal Supply Value Chain

- On-line Coal Quality Measurements & Gasifier Performance Monitoring
- Particle Size Distribution Optimization
- Coal Characterization
- Mineral Transformation
- Coal Agglomeration



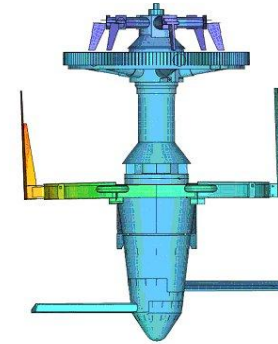
Coal Conversion

- Intensification of Sasol® FBDB™ Process
- Optimization of mass flow behaviour
- Reactor Development
- Alternative Gasification Technologies
- Underground Coal Gasification

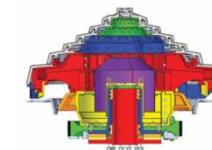


Coal Derived Condensate & Gas Treatment

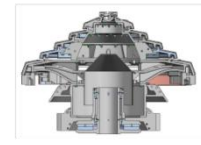
- Coal Derived Condensate Characterization & Prediction
- Alternative Phenol recovery
- Sulphur Recovery Optimization
- Reduction of Environmental Footprint



Sasol Coal Stirrer-Distributor™ for Caking Coal

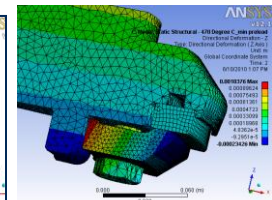
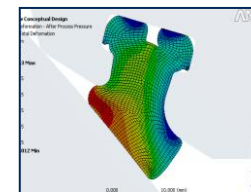


Mk I™ Grate



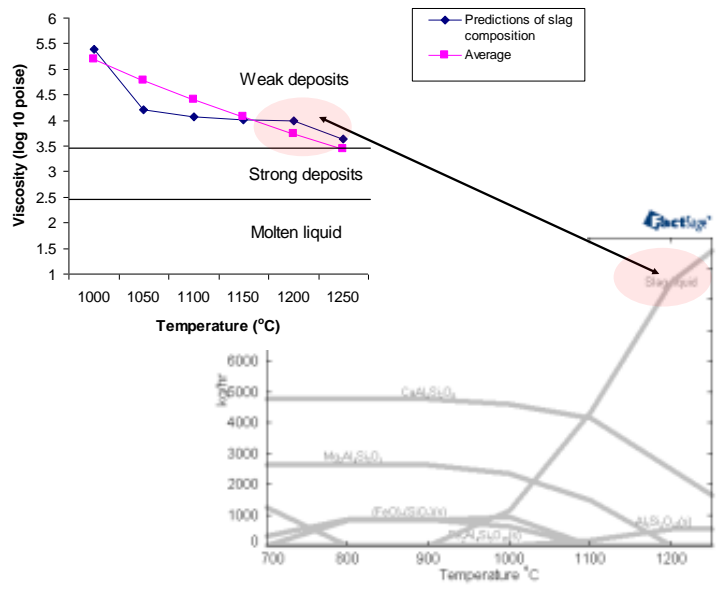
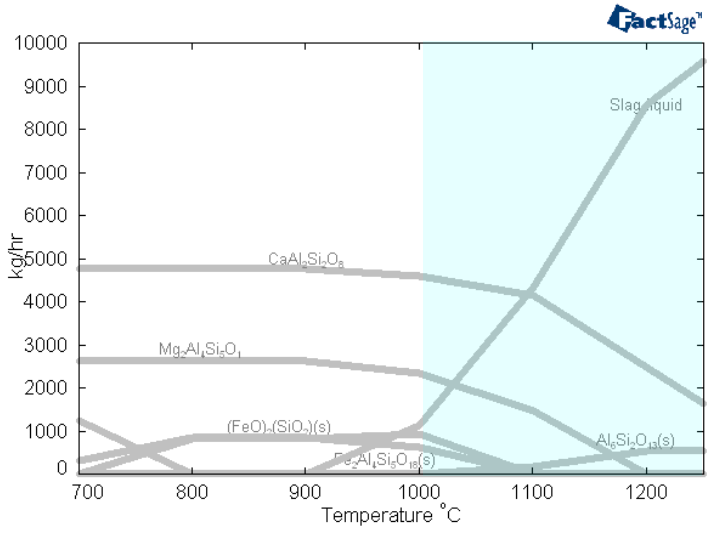
Mk IV™ Grate

Enhanced Mk V™ Gasifier Internals

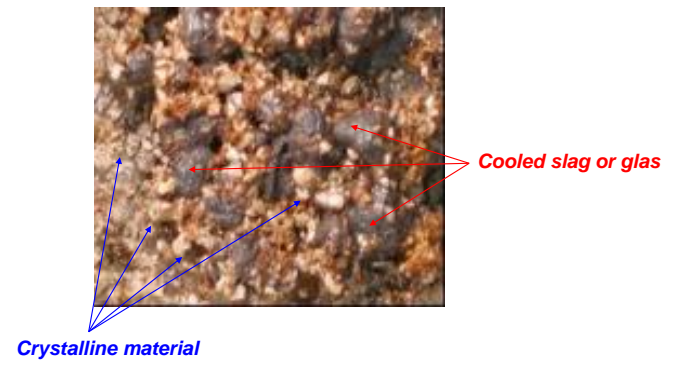
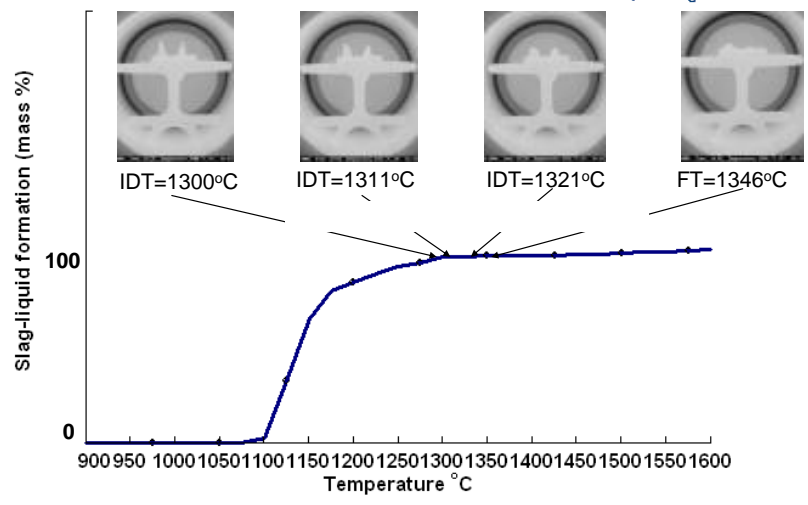


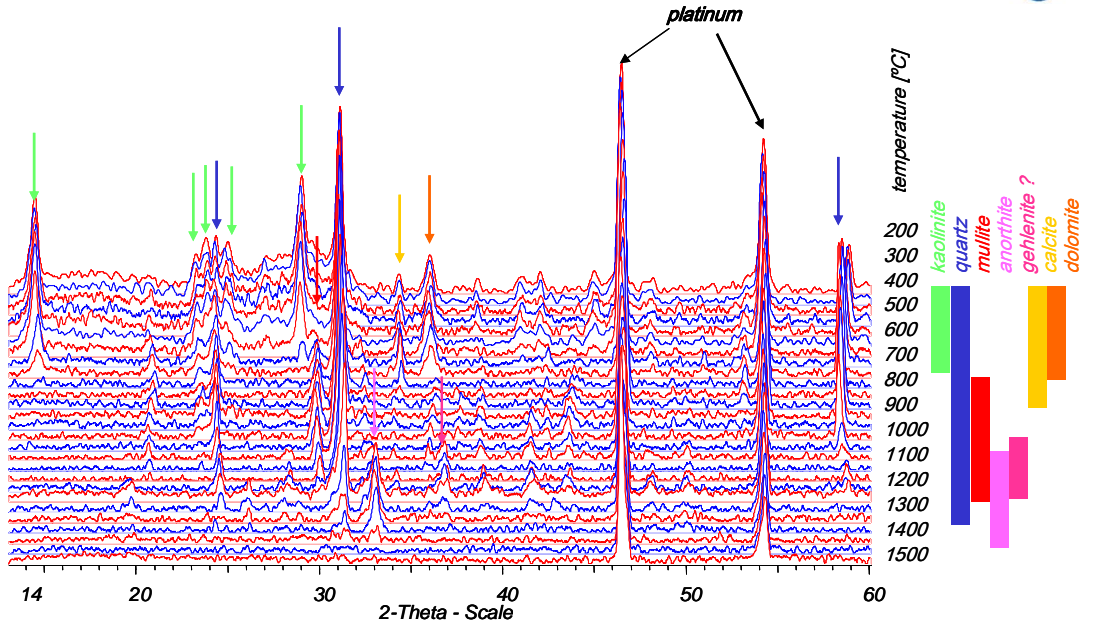
Advanced Ash Lock & Coal Lock Valve Designs

Effect of mineral matter on slag formation

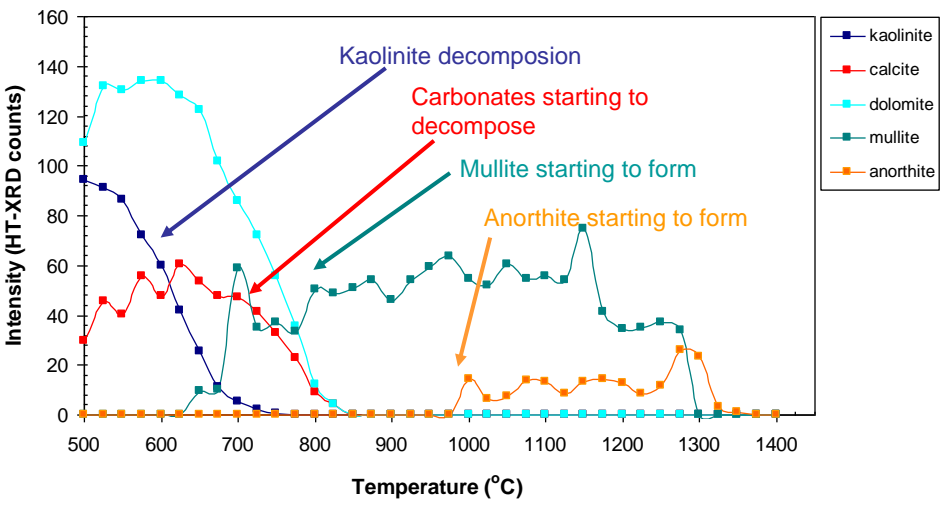


SLAG FORMATION VERSUS AFT ANALYSIS
c:\FactSage\USERDATA\Models\Equi0.res JC van Dyk





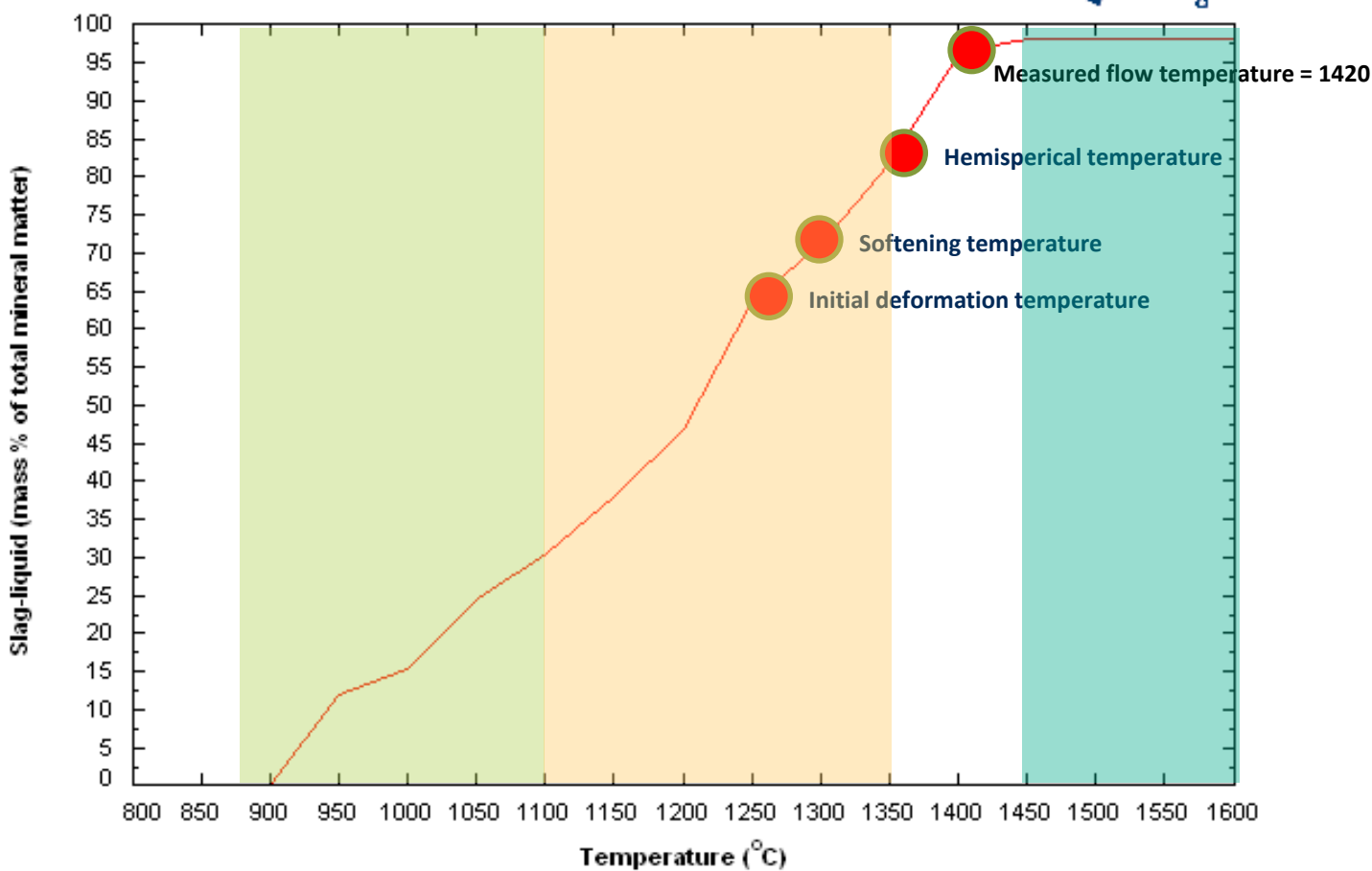
- Patterns recorded using a Philips X'pert MPD diffractometer equipped with Raytech 12° position sensitive detector and an Anton Paar HTK2000 heating stage
- Radiation used was Co-K α 2
- Sample placed on Pt-strip
- Recorded X-ray spectra with crystalline phase...50°C and 100°C intervals.



What is AFT telling us (OR NOT)?



SLAG-LIQUID FORMATION: 100% COAL
c:\FactSage\Results\Equi0.res 14Feb12 - JC van Dyk





Minerals Engineering

Volume 19, Issue 10, August 2006, Pages 1126–1135

Selected papers from Computational Modelling '05, Cape Town, South Africa



Mineral matter transformation during Sasol-Lurgi fixed bed dry bottom gasification – utilization of HT-XRD and FactSage modelling

J.C. van Dyk^a, S. Melzer, A. Sobiecki

Sasol Technology, R&D Division, Syngas and Coal Technologies, P.O. Box 1, Sasolburg 1947,

Received 24 January 2006. Accepted 15 March 2006. Available online 8 May 2006.

<http://dx.doi.org/10.1016/j.mineng.2006.03.008>, How to Cite or Link Using DOI

[Permissions & Reprints](#)

[View full text](#)



Fuel

Volume 88, Issue 1, January 2009, Pages 67–74



Viscosity predictions of the slag composition of gasified coal, utilizing FactSage equilibrium modelling

J.C. van Dyk^a, F.B. Waanders^{b,1}, S.A. Benson^{c,2}, M.L. Laumb^{c,2}, K. Hack^{d,3}

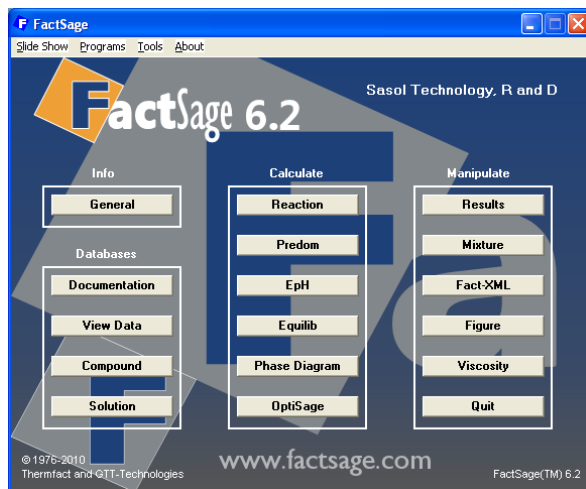
^a Sasol Technology, R&D Division, Syngas and Coal Technologies, P.O. Box 1, Sasolburg 1947, South Africa

^b School of Chemical and Minerals Engineering, North West-University, Potchefstroom 2520, South Africa

^c Microbeam Technologies, Inc., P.O. Box 14758, Grand Forks, ND 58208-4758, USA

^d GTT-Technologies, Kaiserstrass 100, 52134 Herzogenrath, Germany

Received 1 April 2008. Revised 24 July 2008. Accepted 28 July 2008. Available online 27 August 2008.





Tar production during low pressure gasification:

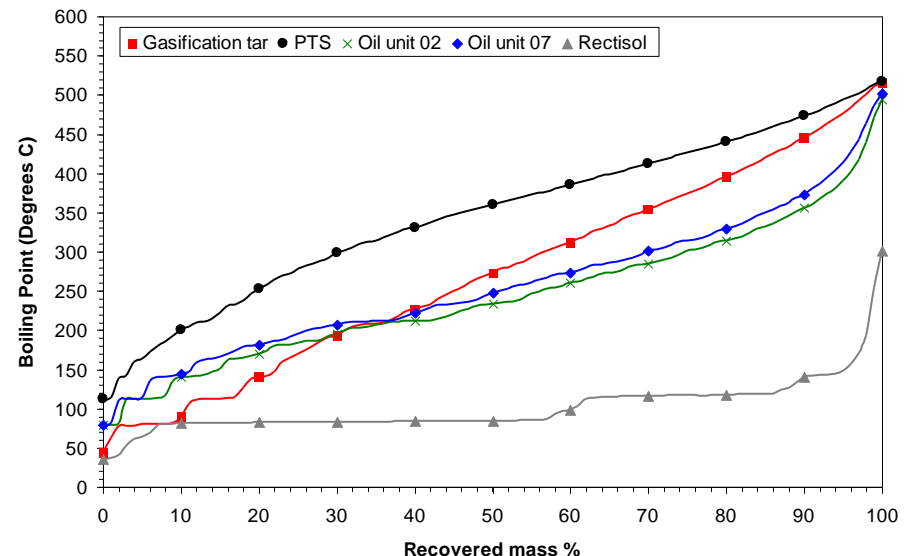
- Liquids evolved from the gasifier downstream are tar, oil, gas liquor and naphtha
- Tars and oils are distilled in the tar refinery into various boiling point cuts (light and heavy)
- Heavy cut (pitch) is used as a feed for coal-tar coke production
- Light cuts are hydrogenated for the fuel pool

Importance of tar:

- Light cuts are hydrogenated for the fuel pool
- Direct conversion of coal to liquids
- Downstream products
 - Distillation for fuel
 - Pitch to coke
 - Crude tar acids

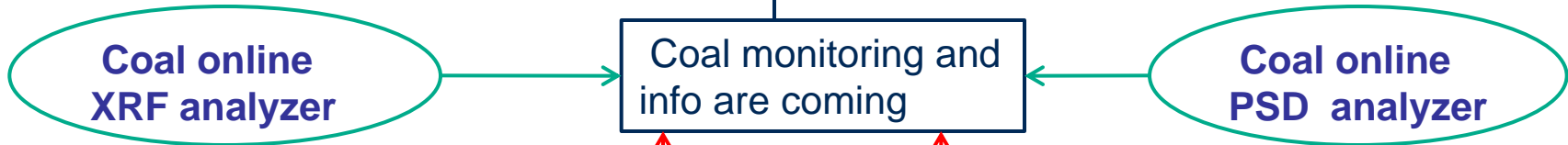
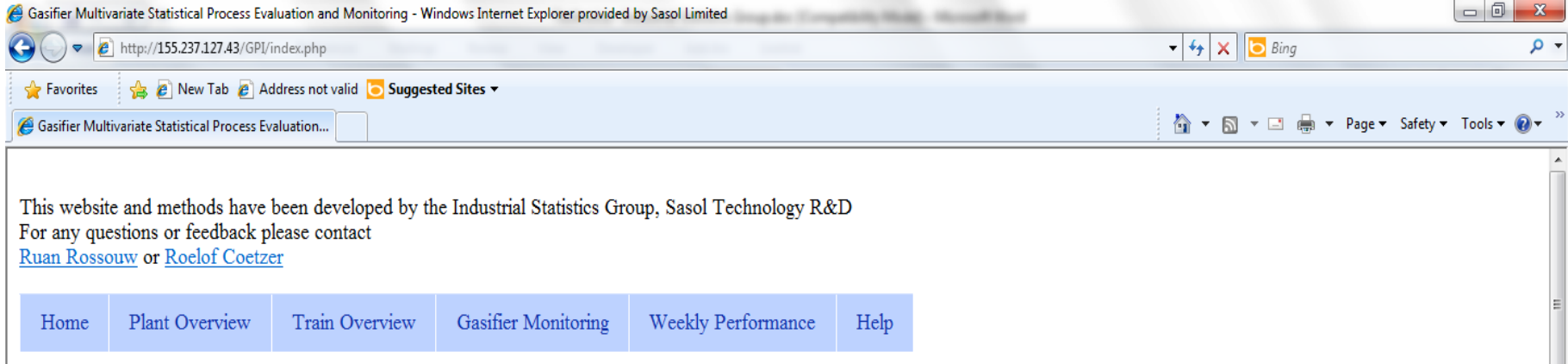
Current questions:

- Problematic heteroatoms and phenolics
- Can tar quality and quantity be influenced?
- Can Quantity and Quality be predicted for different coal types?



Web application: Multivariate Statistical Process Evaluation and Monitoring (MSPEM) – Online measurements

sasol
reaching new frontiers



The road ahead in the next 5 minutes.....



2. SASOL

**3. Sasol Technology
C&GPT**

**4. C&GPT Technical
focus areas**

5. Coal has a future....

1. South-Africa



Coal has a future....!



Sasol R&D has the expertise and capability to support Sasol's existing and new business ventures

Cheap source of energy

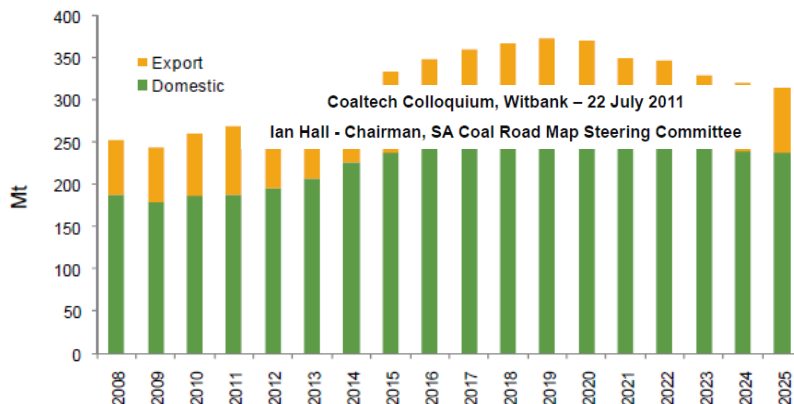
Widely distributed

Coal also provides a stable source of energy and there is an abundance of supply both in South-Africa and around the world.

DEPARTMENT OF MINERALS AND ENERGY

PRIMARY SUPPLY	TRANSFORMATION	TRANSPORT	END USE
Oil	Oil Refineries	Rail Road Pipeline	Liquid Fuels
Natural Gas	Mossgas	Pipeline	Gas
Coal	Sasol	Pipeline	Export Coal
	"Washery"	Road/Rail	
	Eskom and Others	Transmission Wires	Electricity
Hydro			
Nuclear	Koeberg		
Biomass		Person/Road	Mainly Wood

RSA forecast production for domestic & export markets



Name of company	sales tons	Name of company	sales tons
Anglo Operations Ltd		Kuyasa	
Goedehoop	6 706 980	Delmas	1 592 828
Isibonelo	5 061 810	Optimum Coal	
Kriel	11 161 696	Optimum	9 485 774
New Denmark	3 728 928	Sasol Coal	
New Vaal	17 553 712	Sasol Mining	44 470 000
SA Coal Estates	12 036 849	Siyanda Coal	
BHP Billiton		Koorfontein (Gloria)	3 643 692
BHP Billiton	30 985 000	Total Coal SA	
Exxaro (Eyesiswe)		Dorstfontein	532 545
Arnot	5 212 731	Forzando North	962 743
North Block Complex	3 116 928	Forzando South	798 432
Matla	11 264 453	Tweewaters Fuel	
New Clydesdale	703 952	Springlake	401 205
Exxaro (Kumba Resources)		Umcebo Mining	
Grootegeeluk	18 377 751	Umcebo - Xantium	6 658 258
Leeuwpan	2 590 744	Xstrata Coal	
Tshikondeni	268 416	Xstrata Coal	20 066 489
Kangra			
Savmore	2 736 532	TOTAL	220 118 448

Source: Chamber of Mines

Coal has a future....!

sasol
reaching new frontiers



Coal is nothing more than ancient wood which has been under pressure for millions of years. It is not sinister as you may have been led to believe.

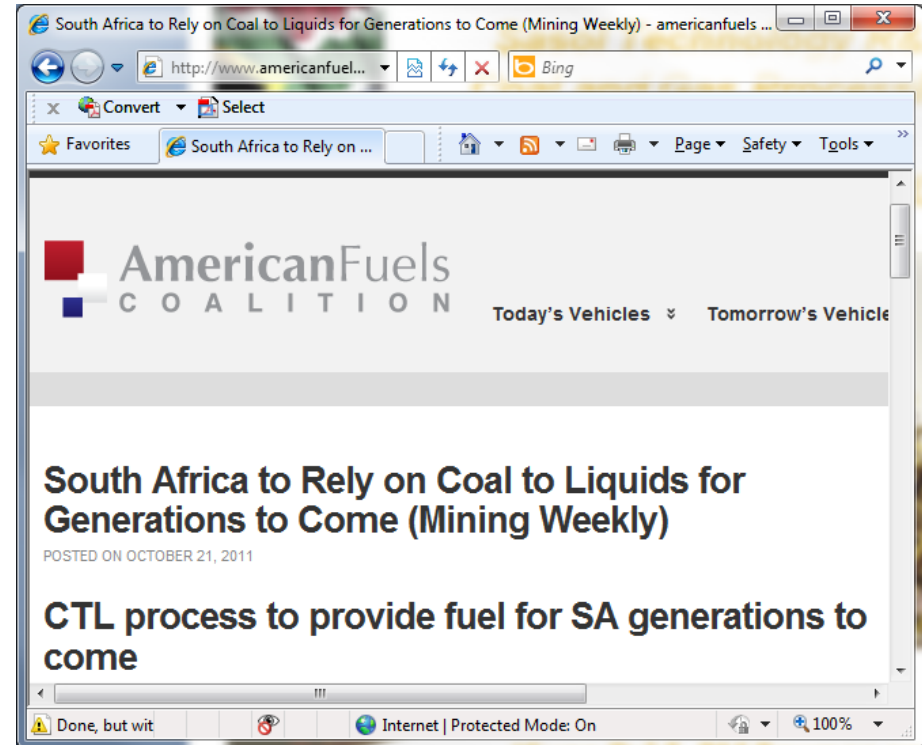
Accelerating technology advancements through focussed R&D ensures continued relevance

Number of employees

Gold	160 102
PGMs	183 914
Iron ore	13 722
Chrome	10 893
Manganese	4 988
Diamonds	12 046
Coal	70 703
Aggregate & sand	6 689
Other mines & quarries	28 865
Total:	491 922

Source: DMR

Coal is South-African made. We do not have to import this product into this country.



Coal is (still) the solution....

sasol
reaching new frontiers

