SUB AND SUPERCRITICAL EXPERIENCE ON ESKOM COAL-FLEET

Centre for Science and Environment Conference

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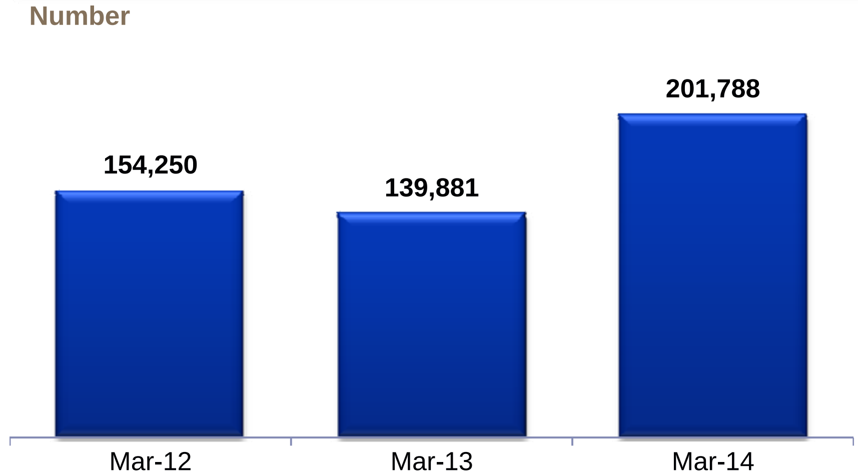
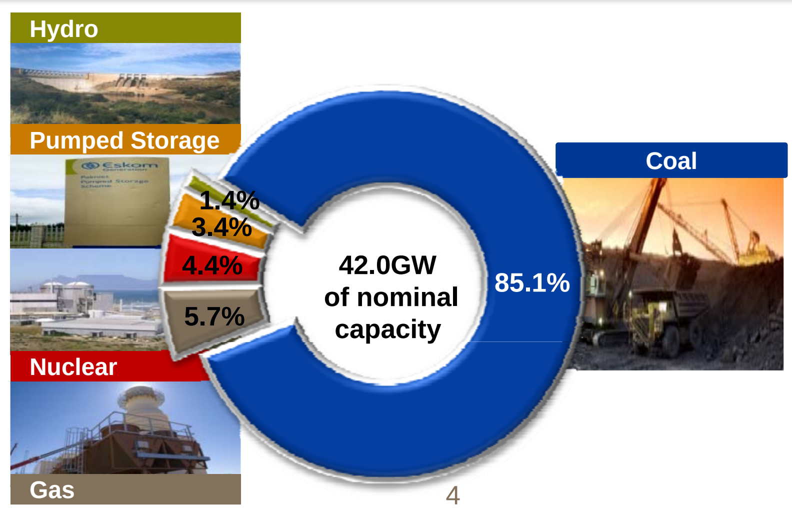
ESKOM AT A GLANCE

- Strategic 100% state-owned electricity utility, strongly supported by the government
- Supplies approximately 95% of South Africa's electricity
- Performed 201 788 household electrification connections during the year, the highest in a single year since 2002
- As at 31 March 2014:
  - 5.2 million customers (2013: 5.0 million)
  - Net maximum generating capacity of 42.0GW (2013: 41.9GW)
  - 17.4GW of new generation capacity being built, of which 6.1GW already commissioned
  - Approximately 359 337km of cables and power lines
  - 46 919 employees, inclusive of fixed-term contractors, in the group (2013: 47 295)
- Moody's and S&P stand-alone credit ratings: b1 and b- respectively with a negative outlook

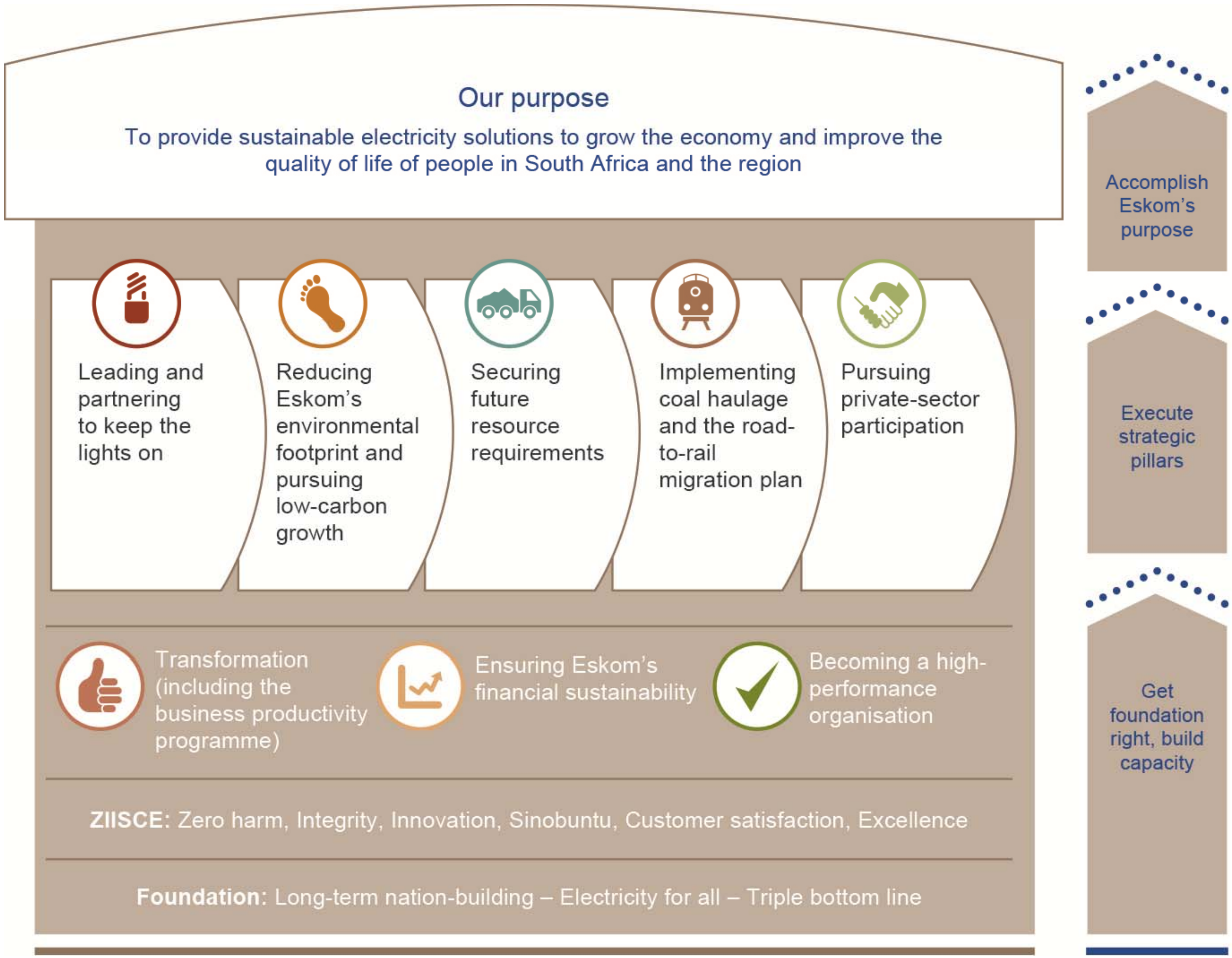
Number of electrification connections



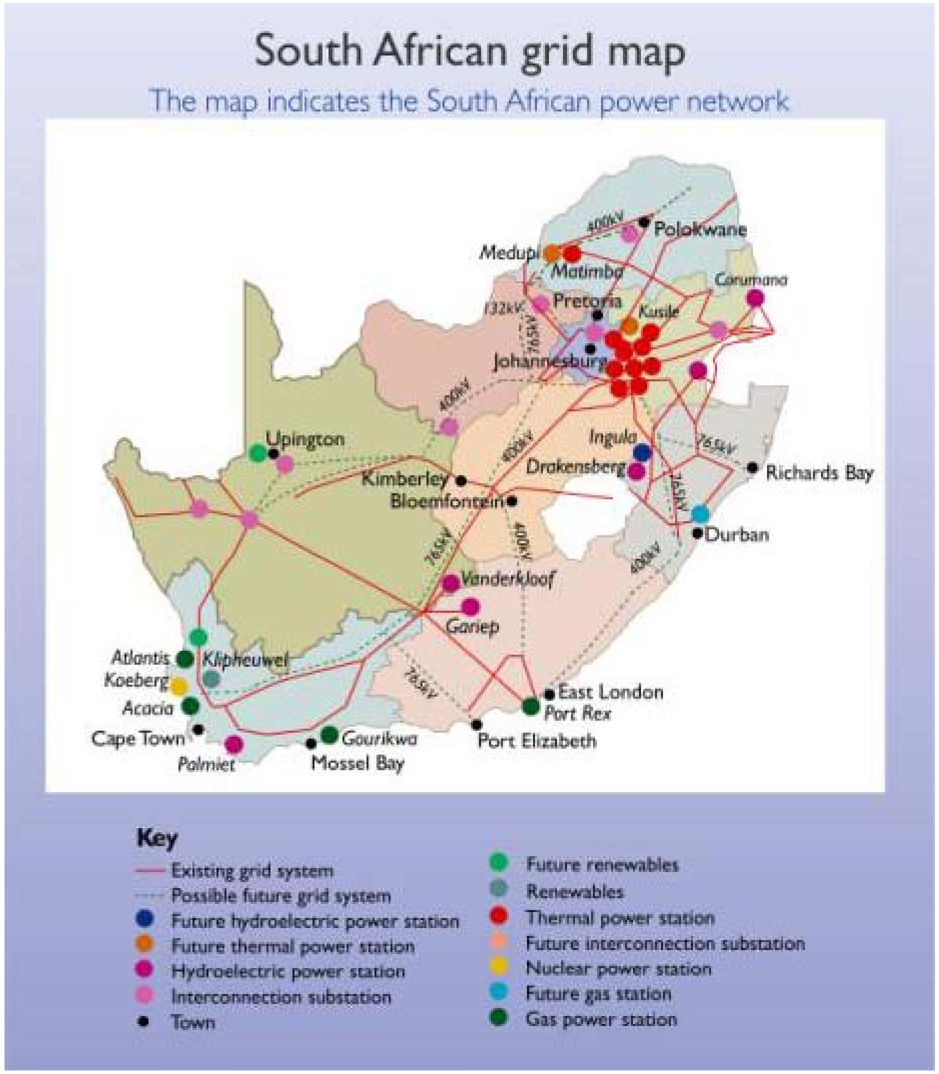
Generation capacity – 30 September 2014



ESKOM'S PURPOSE, VALUES AND STRATEGIC OBJECTIVES



POWER STATION MAP



NEW COAL BUILD

In order to accelerate progress on the Medupi Power Station Project, additional shifts were introduced, 24 hours a day, seven days week.
Unit 6 reached its full load of 794MW on 26 May 2015

ESKOM DESIGN UNIT EFFICIENCY BASED GROSS OUTPUT

POWER STATION	EFFICIENCY (%)
Arnot	37.7
Camden	33.3
Duhva	37.6
Grootvlei	32.2
Hendrina	34.5
Kendal	36.6
Komati	29.3
Kriel	36.8
Kusile*	41.9
Lethabo	38.7
Majuba	38.5
Matimba	36.4
Matla	37.6
Medupi*	41.4
Tutuka	36.4

*Based on Indicative average efficiencies across Plants / *Denotes Supercritical Plants*

TECHNOLOGY SELECTION PROCESS AND CRITERIA – SUB VS SUPERCRTICAL

The feasibility phase of the project considered both sub- and super-critical pulverized fuel technologies for implementation.

Through the technical and financial evaluation processes followed during the feasibility phase, it emerged that the **super-critical option** is the preferred technology solution.

The term “super-critical” refers to the critical transition point of water to steam at pressures over 22 mega Pascal (MPa). Super-critical units typically refer to main steam conditions of 24 to 30 MPa and 538 to 600 degrees Celsius (ºC), with a single reheat stage at 566 to 600ºC.

The super-critical boiler is a once through design which (with sliding pressure) means that heating, evaporating, and superheating of the incoming feed water are completed within a single pass through the evaporator tubes and therefore does not require the use of a steam drum to separate and re-circulate water during normal operation.

This technology provides improved cycle efficiency and hence improved environmental performance.

TECHNOLOGY SELECTION PROCESS AND CRITERIA – SUPERCRITICAL BENEFITS

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The benefits of super-critical technology are:

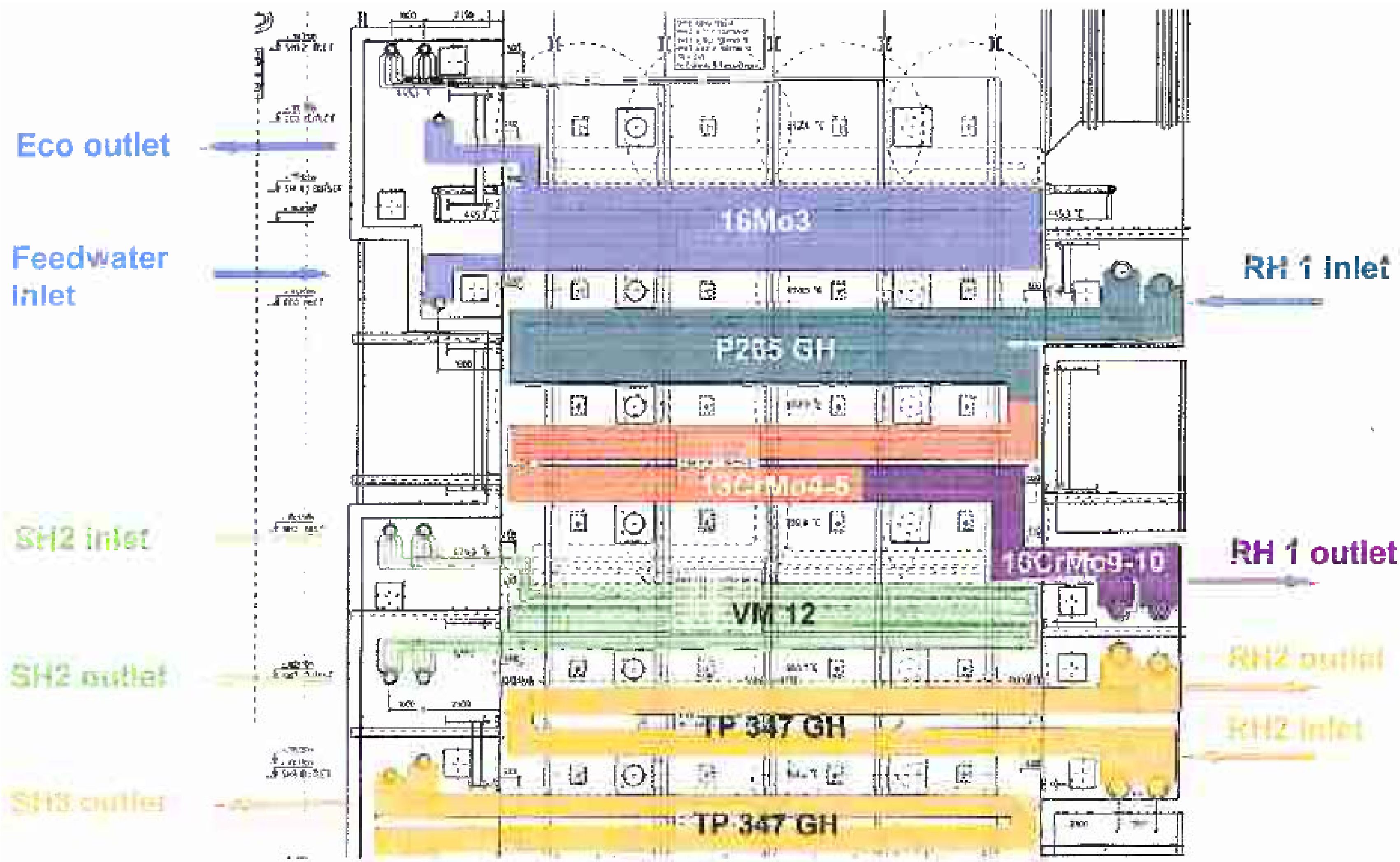
- Increased gross efficiencies. This increase in efficiency results in a reduction in coal consumption of approximately 5%.
- A reduction in emissions in the order of 5%.
- Super-critical plant performance in terms of availability indicators is comparable to that of current Eskom plant performance according to a VGB report *"Availability of Thermal Power Plants"* for the operation period from 1995-2004.

TECHNICAL SPECIFICATIONS – MEDUPI AND KUSILE

Plant type	Super critical pressure with reheat
Boiler type	Once-through sliding pressure, tower type
Fuel	Hard coal (HHV 18.7 MJ/kg)
Plant output	6 x 800 MW_e (4,800 MW_e)
Turbine type	Single reheat condensing
Steam condition	241 bar/560 °C/570 °C
Condenser	Air-cooled condenser
Condenser pressure	141 mbar at 23.7 °C ambient
Generator	GIGATOP 2 poles, power factor = 0.9, 50 Hz

M.Koko/Y.Singh, Overview of the Eskom and South African New Build Programme, VGB PowerTech 1/2 2016.

MATERIAL DESIGN CONVECTIVE PATH: MEDUPI & KUSILE



Morris Moraga, Corporate Consultant, Eskom, Publication African Fusion, 2010

Lessons Learnt

USE OF INCORRECTLY APPROVED WELDING PROCEDURES

During post-production and in some cases during installation, it was discovered that certain welding procedures where incorrectly approved.

These procedures needed to be re-approved using actual production parameters. Of the over 200 procedures requiring re-approval, 4 procedures on thick-walled components affecting X10Cr-MoVNb9-1 and 10CrMo9-10 material did not pass.

This resulted in components already installed on Medupi Unit 6 and Kusile Unit 1 requiring in-situ repairs or additional post-weld heat treatment.

Components affected included P91 circular weld on headers, separator vessels (eventually all four replaced on Medupi Unit 6) and the start-up vessel.

POST-WELD HEAT TREATMENT CHARTS FRAUDULENTLY PRODUCED

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Heat treatment charts were produced without heat treatment or incorrect heat treatment. Over 9,000 welds which were potentially affected had to be verified to establish whether post-weld heat treatment (PWHT) was performed.

This resulted in more than 400 welds with wall thickness $\leq$ 10 millimeters (mm) being cut out and replaced and more than 400 welds with wall thickness > 10 mm being heat-treated.

Areas cut and re-welded included the inlet and outlet connecting tubes of super heater 3 and re-heater 2.

DATABOOK APPROVALS

During the review of databooks for final approval, it was discovered that there were additional welding procedures not appropriately qualified thus requiring re-qualification.

Welder qualifications and re-testing documentation was missing and PWHT charts showed deviations from procedures.

A significant amount of work had to be done post-fabrication and installation to close out the databooks prior to pressure test.

SOUTH AFRICA – SUPERCRITICAL FUTURE?

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Samcheok 4 x 550 MWe Supercritical CFB Boiler

amec foster wheeler

Each Unit	English	Metric
Steam Capacity	550 MWe	1,600 MWth
Unit Steam Flow (SH/RH)	3,461 / 2,820 kpph	437 / 354 kg/s
Main Steam Pressure (SH/RH)	3,728 / 783 psi	257/53 bar (a)
Main Steam Temp.	1,117 / 1,117 °F	603 / 603 °C
Full Load Emissions	SOx < 50 mg/Nm³	
	NOx < 50 mg/Nm³	
Fuel : Coal	Moisture: 20-43%	
	Ash in dry fuel: 1.5-17.0%	
	Sulfur in dry fuel: 0.1-1.0%	
	Biomass co-firing	

Thank you

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