



South Africa's planned coal infrastructure expansion: drivers, dynamics and impacts on greenhouse gas emissions

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Key points

- South Africa is planning to expand coal –related infrastructure, including electricity generation , mine and rail infrastructure.
- Drivers of investment in new coal fields include security of coal supply for Eskom
- and also include political support for enhanced Black Economic Empowerment
- Rail infrastructure expansion and changes in global coal demand could impact the domestic coal industry significantly.
- The inconsistencies between new coal investments and South Africa's climate mitigation objectives are unpacked and the emissions compared.
- If coal infrastructure plans are implemented, it is likely that South Africa will exceed its implicit carbon budget
- The impact of lower cost coal supply will have market impacts domestically and in export end markets.
- Further work is needed on indirect emissions, which are currently not accounted for by decision-makers

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1. Introduction

Despite both international commitments to reduce its emissions and a national climate change mitigation policy, South Africa is also planning substantial growth in new fossil fuel infrastructure. Planned investments include the development of new coalmines to sustain current electricity generating plant and meet demand from planned new power generation projects, as well as railway and port expansions to enable increased exports of coal, mainly to the East.¹

The planned export infrastructure investment is potentially incompatible with required global reductions in the combustion of fossil fuels, and comes in the context of a growing number of international analyses that foresee a decline in rates of growth of the global seaborne coal trade. Several large investment banks (Goldman Sachs (2013), Deutsche Bank (2013), Bernstein (2013)), ratings agencies (S&P), and the International Energy Agency (2013), amongst others, have projected low thermal coal prices going forward, the peaking of import demand in China (and thus a peak in the seaborne trade), and decreasing support for coal investment.

In some cases, this is due to increased environmental pressures (for example banning low-grade imports to improve air quality in China or climate change mitigation targets); in others, market fundamentals are contributing to softer prices. In China, rail issues have largely been resolved, mitigating the need for growing imports. And, notably, the global industry is in a situation of oversupply, leading to much lower prices than were expected even a few years ago (McCloskey, 2014; SACRM 2013; FFF, 2014), while Australian take-or-pay rail contracts mean there is no appetite to cut production in some major exporting countries.

Lower global demand growth is a risk for South Africa, which is embarking on large state-driven rail infrastructure expansion plans based on an anticipation that demand for exports (likely lower quality product) will remain strong or rise and domestic demand will remain steady or increase, at least in the medium term. If expected global demand does not materialise, this could potentially lead to investment in a number of stranded mine and rail assets – or increased pressure from industry to utilise the coal intended for exports in the domestic market, and pressure on Eskom to support the industry – with potentially significant ramifications on the price Eskom pays for coal and on South African emissions.

On the other hand, if medium- and long-term demand remains high (especially into India), this will continue to drive shifts in the structure of the South African coal market and affect domestic pricing. Future export prices, and the economic and political drivers of the opening up of new coalfields (the Waterberg basin) are thus key to understanding the trade-offs, potential opportunities and possible risks of planned infrastructure expansion.

There is also the potential for conflict between South Africa's continued domestic use of fossil fuels and its national climate change mitigation policy (as well as the international commitments the country has made to reduce emissions).² Further investment in coal-fired plant and upstream investments runs the risk of either becoming stranded assets in the medium-to-long term, or keeping the country locked into a high-carbon emissions trajectory that prevents South Africa from meeting its own mitigation imperatives, outlined in the Copenhagen Accord and South Africa's National Climate Change Response White Paper (DEA, 2011).

There is one further element to the debate around planned infrastructure expansion. Given the historical cross-subsidisation of the domestic market from the export market, changes in the dynamics of the export market will have substantial cost impacts on the South African energy system. Most national discussion around the development of new infrastructure thus centres on

¹ Besides coal-related infrastructure expansions, there is also much discussion of the potential for hydraulic fracturing in the Karoo; a Gas Utilisation Master Plan is under development, investment in LPG import infrastructure is under way, and the initial phases of offshore exploration by large oil multinationals has recently begun.

² Most analyses assume carbon capture and sequestration is required to meet mitigation targets, though the commercial viability of the technology is unknown (DoE, 2013b; SACRM, 2013; SBT, 2007; Winkler, 2007).

the implications for South African energy security and growth, rather than the impacts of exported carbon. But growth in rail and other export infrastructure will provide an opportunity for low-cost South African exports to impact global supply and demand dynamics, as per the analysis of the US coal sector in Power & Power (2013). As South Africa invests in expanding its export rail infrastructure, so relatively low-cost South African coal will have the potential to displace more expensive producers in key export markets, notably India. As low-cost coal drives down prices, so too is there potential for fuel substitution in end markets, with concomitant indirect impacts on the demand for and consumption of coal.

This paper combines three approaches to understanding the emissions implications of new fossil fuel-related infrastructure. Firstly, we assess the current dynamics of the South African coal industry and political economy drivers of investment decisions – with a view to understanding what factors might be driving lock-in of a high-carbon emissions trajectory in South Africa. Section 2 thus introduces the South African industry, reviews current issues impacting the sector and planned investments in rail and energy infrastructure, and finally posits some drivers of the planned investments. Section 3 unpacks South Africa’s climate change mitigation policy, its carbon budget to 2035 and current emissions profile, and recent climate mitigation policy changes and how these compare to likely future emissions. Section 4 provides an overview of the scenarios in the South African Coal Roadmap, discussing the emission implications of different possible futures for the South African coal industry. After briefly examining three possible ‘coal futures’ we will outline the extraction-based emissions associated with different coal production scenarios; and finally we will apply a methodology for assessing the emissions implications of incremental infrastructure investment on global supply and demand dynamics.

2. The South African coal industry and current drivers of infrastructure expansion

Coal has dominated the energy economy of South Africa since the early 1970s, when Eskom (the state-owned utility), massively expanded electricity generating capacity through the construction of several large coal-fired power plants, growing installed capacity from less than 6500MW in 1969 to over 25 000MW in 1990 (Steyn, 2001; Marquard, 2006). From the early 1980s, when Sasol’s coal-to-liquids plant at Secunda was commissioned, coal has also become key to the supply of liquid fuels. The energy system is highly dependent on the coal sector: it currently provides 75% of total primary energy supply, accounts for 85% of installed electricity generating capacity, the production of 92% of electricity, and around 30% of liquid fuels (through Sasol) (IEA, 2014)

2.1 The domestic industry

In 2012, South Africa’s total coal production was 258Mt, of which 76Mt was exported, Eskom utilised 125Mt and Sasol 44Mt, while the remainder was used directly in local industry (pulp and paper, cement and domestic iron and steel production, amongst others); most production is thermal coal (Chamber of Mines, 2013). The production of coal is dominated by eight mega mines (Eberhard, 2011) and ownership is concentrated in five major producers who account for about 85% of total production: Anglo American, Exxaro, Glencore, BHP-Billiton, and Sasol. Besides Sasol, who mine predominantly for their own use through Sasol Mining (or contract Anglo American), the five so-called ‘majors’ also dominate supply to Eskom (90%) and exports (75%) (Macquarie, 2014: 10).³

A small (by tonnage) junior mining sector makes up the remainder of production, including companies which have grown out of large Black Economic Empowerment deals, such as African Rainbow Minerals, or Shanduka Coal; internationally-listed juniors, and small-scale local mining companies.

³ Marquard (2006) and Eberhard (2011) review the history and development of the industry and its structure, and the post-apartheid evolution of firms as they internationalised and diversified their assets.

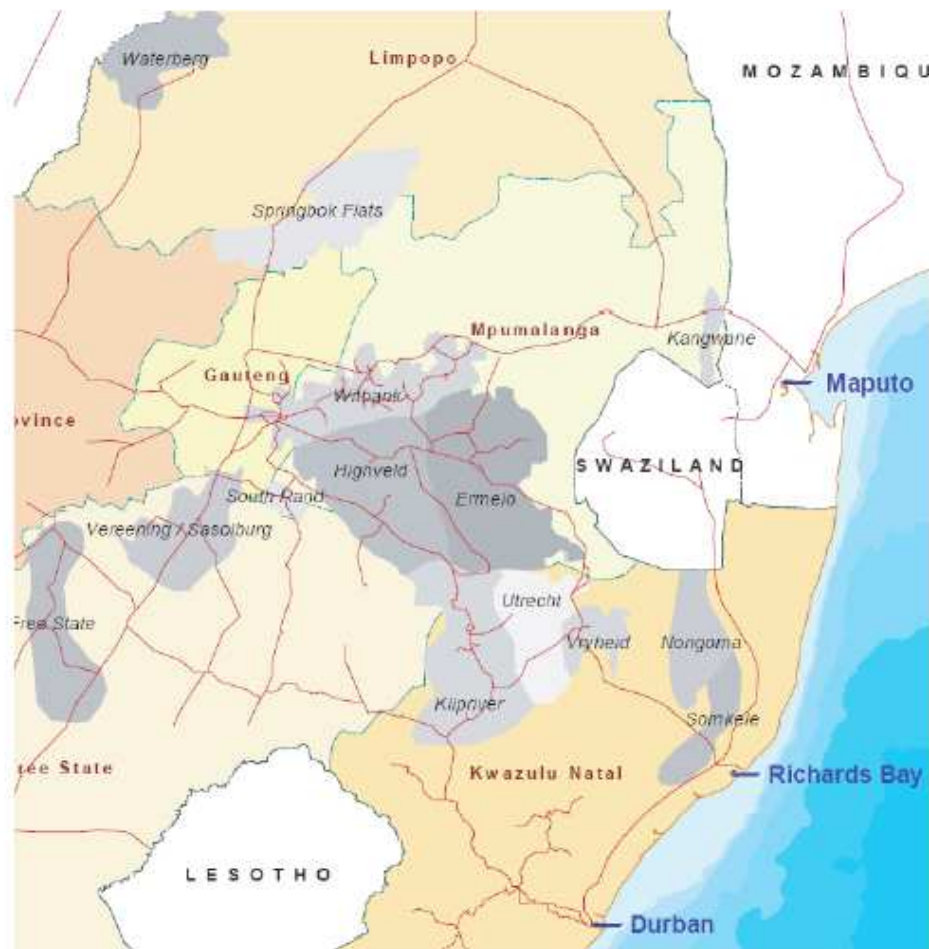


Figure 1: South Africa's coalfields, rail infrastructure and ports
(Eberhard, 2011)

Production is concentrated in the Central Basin – the Witbank, Highveld and Ermelo coal fields located primarily to the east of Johannesburg, where most electricity-generating infrastructure is located (Eberhard, 2011) (see Figure 1). While South Africa has significant coal resources, the Central Basin reserves, where most mining has happened historically and which forms the heart of the energy supply system, are declining in quantity and quality. Eskom sees the Waterberg coalfield as the solution to availability and cost issues arising from geological and market factors in the Central Basin, while the industry supports expansion for obvious reasons. The Waterberg coal field (top right in Figure 1) is located 1050km from the export terminal at Richard's Bay and about 500km from the Central Basin. The field has fairly complex geology (and the coal produced can differ significantly from Central Basin coals, meaning it is not directly substitutable without retrofitting power stations) and faces water and rail constraints. Only one mine is currently operational in the area (Exxaro's Grootgeluk mine, which produces semi-soft coking coal and thermal coal for Eskom's Matimba power plant, the only operational power plant currently located in the Waterberg). The Waterberg is linked to the Central Basin through one 5Mtpa rail line, which currently transports both iron ore and coal (metallurgical and export grade).

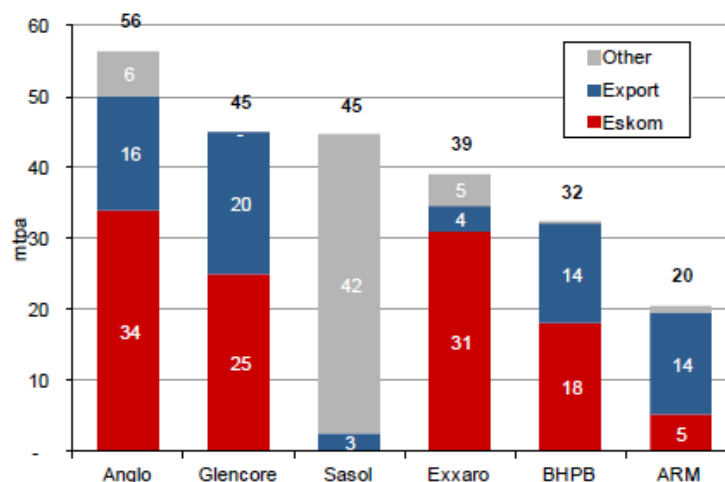


Figure 2: production, exports, Eskom supply by producer (by tonnage)
(Macquarie 2014)

Any possible expansion of mining in the Waterberg will likely depend, given the economics of mining the field, on either new power plants being built there (which in the future will require new water and transmission infrastructure), or a large increase in rail capacity to transport coal for export or to Eskom power plants in the Central Basin.⁴ The optimal economics of the field point to multi-product mines, i.e. mines that produce Eskom-grade product (be it for combustion in the Waterberg or the Central Basin) as well as export-grade product (SACRM, 2013; Macquarie, 2014). The viability of export-only mines is not known (SACRM, 2013). The expansion of the 5Mtpa line to a planned 26Mtpa line over the next five years, and the potential development of a new heavy haul line, is therefore key to maintaining both domestic consumption and expanding export levels.

2.2 The export industry

South Africa is the seventh-largest producer of coal globally and the sixth-largest exporter, accounting for around 9% of the global seaborne trade in 2013. Despite its relatively small absolute contribution (and stagnating exports), it is an important ‘swing producer’, able to export to both the Atlantic and Pacific markets. Since 2007, exports have shifted dramatically to the Asian-Pacific market (Eberhard 2011; McCloskey 2014). Although it is a low-cost producer (Wood Mackenzie 2013; Eberhard, 2011), South African coal typically has not traded competitively against other Pacific producers (Indonesia and Australia), partly as result of increased distances to market (Macquarie, 2014).

⁴ Although not yet operational, the two companies most actively developing mines in the Waterberg both plan to supply Eskom and also export (Resource Generation and the Waterberg Coal Company). Large miners also have interests in the area, notably Anglo American, Exxaro, BHP-Billiton and Sasol.

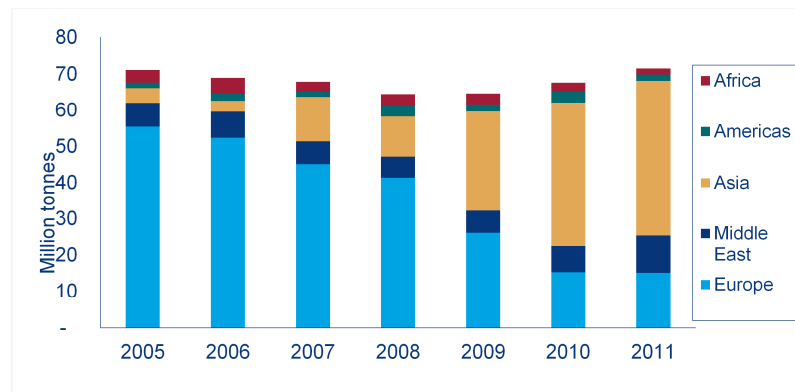


Figure 3: Shift from 2005 to 2011 in South African export tonnages by destination
(Eskom 2013)

Export product was historically of a much higher quality, and thus value, than local thermal coal, with a net calorific value of around 27MJ/kg (and other specifications, such as low ash). The swing to the East has been accompanied by a fundamental shift from RB1 and RB2 spec coal to lower quality (and price) RB3 spec coal (Sylvester, 2013).⁵ Exports are transported via a 580km-long dedicated coal line from the Central Basin coalfields to Richard's Bay Coal Terminal (RCBT) north of Durban. The line is run by state-owned Transnet Freight Rail (TFR) and has a nominal capacity of 73 Mtpa, though this is seldom fully used. The RCBT, built in 1976 and expanded several times since (total capacity grew from 12Mtpa in 1976 to 91Mtpa in 2014), is privately owned by the major coal companies. Its export capacity of the coal terminal exceeds the nominal rail capacity by around 18 Mtpa, and exceeds the functional rail capacity by even more, depending on the performance of the line in any given year.

Transnet and the RCBT have historically had an acrimonious relationship because of the mismatch between rail and port capacity and underperformance of the rail line. Rail performance was viewed as a particular hindrance to growth during the commodities boom in the 2000s, which the mining houses claim to have 'missed out on'.⁶ This is a refrain that the state has taken up, including the former Minister of Public Enterprises (which oversees state-owned companies such as Eskom and Transnet) (DPE, 2012). Given South Africa's declining manufacturing industry, problematic labour relations and low levels of growth over the past few years, any potential reduction in exports is viewed by parts of the state as highly problematic. Eberhard (2011) has attributed most of the rail issues to inefficiencies in planning and a lack of investment by Transnet; he argues that the rail part of Transnet's business is effectively subsidised by the ports and pipelines.⁷

Export allocations at RCBT are based on shareholding.⁸ At 72Mtpa capacity, 4Mtpa are allocated to junior/Black Economic Empowerment companies through the Quattro scheme, administered by the Department of Mineral Resources as an empowerment measure; at 91Mtpa capacity, this allocation increases through three BEE schemes: South Dunes Coal Terminal (6Mtpa), Quattro (4Mtpa) and 9Mtpa put out via tender. Eskom too has access to export capacity through the South Dunes Terminal, which is used to promote empowerment by providing access to the export capacity for miners who are not major shareholders in the

⁵ 'RB' denotes Richard's Bay. South African coal exports were typically RB1 and RB2 specification: 6000kcal/kg or above (~25MJ), low ash, varying volatiles; RB3 has a minimum calorific value of 5500kcal (23MJ), higher ash, and higher moisture (Bergh, Falcon & Falcon, 2013).

⁶ TFR's performance was at its worst in 2006-8 (Macquarie, 2014), with exports in 2008 of only 61Mt. The contribution of the mining sector to GDP declined by 10% pa during the commodities boom, according to Roger Baxter of the Chamber of Mines (presentation at McCloskey Coal conference, January, 2014)

⁷ While the freight rail business accounts for a substantial portion of Transnet's total revenues, it is less profitable than either pipelines or ports.

⁸ Major shareholders include Anglo American (24%), Glencore (25%), and BHP-Billiton (21%).

terminal. But rail infrastructure is insufficient to match the capacity of the port, and allocations are thus smaller than shareholding would indicate, and access for BEE miners limited.⁹

Although improved efficiencies at TFR have quelled the (public) conflict somewhat, there is on-going tension between TFR and the terminal on the RBCT's allocation for junior/BEE miners; the TFR's inability to rail the full capacity of the terminal is seen by the miners as the major hindrance to enhanced BEE exports. TFR in turn has argued that there needs to be higher levels of competition in terminals, seeing enhanced terminal capacity as potential leverage over the RBCT and its approach to the allocation of capacity for junior miners. Transnet General Manager Divyesh Kalan has stated explicitly that there is a politically strategic move for enhanced terminal capacity:

I think there *are many factors other than just commercial discussions*. It would be useful to have an alternative terminal, whether it's a Transnet terminal or any other terminal, to stimulate competition. We will make a commercial decision on that and will also make a decision based on what Transnet's influence is on a channel. We do not want to be dictated to. (FM, 2014a emphasis added).

RBCT is widely understood to be the cheapest option for exporting coal (McCloskey/Coaltrans),¹⁰ and a new terminal would have significantly higher costs than a brownfield expansion (SACRM, 2013). The South African Coal Roadmap (SACRM), an industry-funded and -driven process that drew together key stakeholders including miners, Eskom and the state, developed a set of scenarios to examine the future of the coal industry in South Africa and the policy interventions required to maintain the sector. The scenarios found that, given there is space for exports out of other terminals in the country, even under the most optimistic scenarios the rail would remain the primary constraint – RBCT at a capacity of 110Mtpa (which the terminal can easily be expanded to, should rail capacity be able to meet the demand) is more than sufficient to meet export demand. The primary constraint is not terminal capacity, but rather rail capacity. The discussed Transnet terminal and the expansion of the Richard's Bay Grindrod Terminal from 3Mtpa to 20Mtpa are both likely unnecessary and less economic than RBCT, though there may be political pressure to invest nonetheless.¹¹ RBCT policy also limits the grades of coal to be stockpiled at the terminal, potentially impacting juniors export products and raising costs (by only accepting higher grade RB1 spec coal).

Transnet has embarked on efficiency improvements on the rail link, which have brought exports up from a low of 61Mt in 2008 up to annualised levels of about 70Mt (with further tonnages being exported via Durban, Grindrod, and Mozambique). The major solution to the conflict lies in TFR's new investments and planned rail link expansions. This includes the development of the 'Swazi link' to take freight off the coal line, expanding the Overvaal tunnel, and investment in new locomotives and rolling stock. In total, Transnet's coal export business will invest R35.7bn between 2013 and 2020, slightly more than 10% of total Transnet investment under their Market Demand Strategy. Expansion of the coal export line to 81Mtpa by 2015 and then 97.5Mt by 2019 will account for R32.4bn of the total (Transnet, 2013).¹² The SACRM assumed

⁹ Black Economic Empowerment (BEE) has formed a key component of the post-apartheid state's attempts at redistribution. BEE policy guides procurement, access to government contracts, employment policy and ownership in key sectors, including mining and liquid fuels (where 26% of company ownership must be in the hands of 'historically disadvantaged' individuals/firms). It is viewed as a primary means of allowing broader access to economic wealth (beyond the white minority), though it has also become a vehicle for political patronage.

¹⁰ Handling costs at RBCT are between R25/t to R44/t, versus \$11/t (about R118/t) at the Matola terminal in Maputo and between R80/t and R120/t for other export facilities in South Africa (FM, 2014a).

¹¹ Transnet finally announced in October 2014 that it would not go ahead with its terminal construction plans, after it came to an agreement with RBCT and the majors to increase BEE access at the terminal and new take-or-pay rail contracts were signed after a decade long hiatus. Quattro tonnages have now been increased to 8Mtpa (Business Day, 2014b). As Brian Molefe said of the terminal expansion plans: 'We kissed and made up with BHP Billiton so we're not building another terminal' (Bloomberg, 2014).

¹² Expansion to 97.5Mtpa requires signing new long-term take-or-pay contracts with miners, which Transnet CEO Brian Molefe has announced will happen by the end of November 2014. Under these agreements, 4% of contracted tonnages will be allocated to BEE miners for transformational objectives, translating to 4Mtpa extra

a somewhat lower level of rail capacity (Transnet's previous plans were to reach 81Mtpa by 2019), and unless the Waterberg line is also expanded, exports would be lower than TFR is now planning on that rail line.

The SACRM was an industry-funded process to 'explore the short, medium and long-term activities and interventions needed to support the coal industry in South Africa between now and 2040 to maximize its contribution to South Africa in the face of an uncertain future' (SACRM, 2013: 2). The modelling used local and global responses to climate change as the defining drivers for the coal industry in the future. Four scenarios were developed (see section 4.1 below for further detail): 'More of the Same' and 'Lags Behind' are 'high coal' futures; 'At the Forefront' which is a business as usual path; and 'Low Carbon World', a lower coal scenario. Under 'Lags Behind', exports peak at 92Mtpa, before declining to 78Mt by 2040; exports under 'At the Forefront', peak at 77Mtpa before declining to 55Mtpa, and in 'Low Carbon World', exports peak at 80Mtpa before declining to 50Mtpa. Transnet's current plans thus depend both on an expansion at the RBCT and on optimistic export assumptions; if these do not materialise, the rail capacity is likely to be stranded. Furthermore, expansion of the RBCT rail line will impact domestic supply security, and will enable export expansion out of the Central Basin, and potentially the Waterberg. The rail constraint has functioned up until now as a de facto export limit on the mining houses, meaning that even when export prices were much higher, there was no alternative market to Eskom supply, which had the effect of artificially suppressing domestic prices.

Eskom has pushed strongly for the 'securitisation' of coal through legislative amendments to the Mineral and Petroleum Resources Development Act (2002; amendments of 2012), the key piece of legislation that governs the mining sector and mineral rights. The legislation would empower the Department of Mineral Resources to declare coal a 'strategic mineral' and would enable the regulation of exports (through an export quota or tax, according to former Minister of Mineral Resources, Susan Shabangu) and domestic pricing. The legislation, passed by Parliament in March 2014, has yet to be signed into law by the President, despite lobbying by the mining industry to have the legislation finalised. There is a discrepancy in strategy within the DPE; although both Eskom and Transnet fall under the Ministry of Public Enterprises, Transnet's expansion of the export line directly contradicts Eskom's lobbying for the securitisation of coal to protect domestic prices. Sylvester (2013) has pointed out that in the context of expanded rail capacity, legislation to limit exports would actively strand the investments being made by Transnet.¹³

2.3 Domestic pricing

Eskom, which produces 95% of South Africa's electricity, historically contracted with coal companies to build mine-mouth plants to utilise low-grade (otherwise unsaleable on the export market) coal. The development of washing technology allowed firms to export a portion of their production while supplying Eskom with a 'middlings fraction'. Middlings are an intermediate coal product that falls between higher grade washed coal and discard or reject coal. Although some of the older Eskom plant does utilise relatively 'high' CV coal, in the 22-24 MJ/kg range (SACRM, 2014), the average CV of Eskom coal is <20MJ/kg (Eskom 2013).

allocation at RBCT. BHP-Billiton's October 2014 signing of a new take-or-pay contract was the first time medium/long term contracts have been signed since the others expired in 2005. Without the take-or-pay contracts, TFR was not willing to invest further in the line (Business Day, 2014c)

¹³ Since a Cabinet reshuffle in early 2014 changed the Minister of Mineral Resources, there has been much less industry concern with the securitisation measures, at least publically, and the industry has been actively pushing for the legislation to be signed into law by the President. The Presidency and the DMR have sat on the amendments while the nascent oil and gas industry lobbies for better terms for the structure of state and BEE-involvement in oil and gas ventures.

Table 1: Eskom plant by calorific value of coal required
(Sylvester, 2013)

<i>Eskom station</i>	<i>Expected CV, MJ/kj (air dried)</i>
Camden	24.2
Arnot	23.8
Kriel (units 1-3)	23.1
Tutuka	22.5
Hendrina	22.2
Duvha	21.9
Grootvlei	21.4
Majuba	21.4
Komati	21
Kriel (4-6)	20.6
Matla	20.5
Matimba	20.4
Medupi	20.4
Kendal	19.2
Kusile	18.8
Lethabo	16

Coupled with very low transport costs (coal moved short distances from mine to mine-mouth stations, primarily by conveyor), this resulted in Eskom paying very low prices for its coal. Figure 4 above highlights the disparity between export and domestic tonnages and prices for 2012; while export volumes have typically been between 20 and 30% of total production by tonnage since the 1990s, the value of export grade product has been substantially higher, fluctuating at around 50 percent by total value (Marquard, 2006).¹⁴

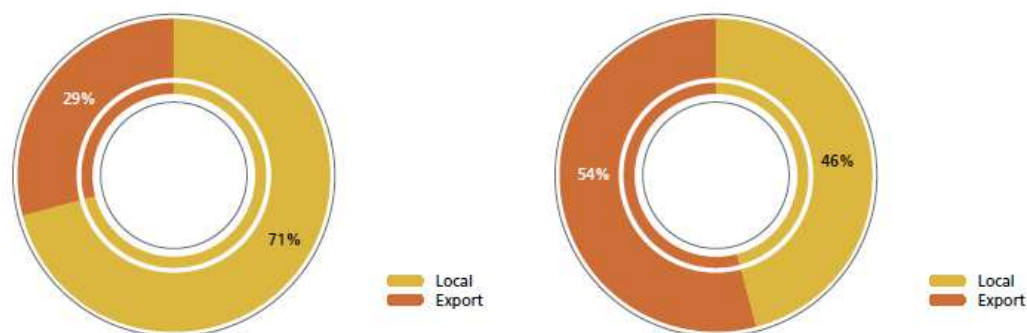


Figure 4: Domestic vs. export tonnages: coal sales by volume (left) and sales by value (right)
(CoM, 2013)

Domestic contracts were typically long-term, on either a cost-plus basis (Eskom-only mines) or fixed price (with escalation) contracts with multi product mines that sold their middlings fractions to Eskom while exporting beneficiated coal (i.e. coal that has been washed, and is thus

¹⁴ Thus for example, in 2012, 261Mt of coal was sold at an average price of R367/t; this can be further broken down into local sales of R43.9bn (185Mt at R236/t), versus exports of R52.xbn (76Mt at R687/t) (Chamber of Mines, 2013). For comparison, Eberhard quotes an average price for domestic coal in 2009 of R170/t.

of a higher grade) at much higher prices (Eberhard, 2011).¹⁵ The swing of the export market to the East and the increase in demand for lower quality product from India and China, has exposed several vulnerabilities in the South African coal market, not least that the higher prices fetched by exports functioned historically to keep Eskom prices lower.¹⁶

In the first place, this was by way of the creation of a product that would not otherwise have had an export market value, either because Eskom uses screened coal of a low quality, or due to washing. Beneficiation of coal to an export grade of ~27MJ results in a secondary fraction which can be supplied to Eskom. Although it is dependent on the coal mined, Sylvester (2013) estimates the secondary fraction at around 21MJ. Secondly, the returns on investment (in new coal mines and beneficiation infrastructure in the 1970s) required by firms were covered by the considerably more profitable export industry.¹⁷ Third, export permits in the 1970s were also dependent on agreements to supply Eskom with cheap coal, with this state intervention in the sector continuing until 1991 (Marquard, 2006).

Eskom consider themselves 'responsible for the development of South Africa's coal production industry', and the 'symbiotic' relationship of tied mines to Eskom plant as the coal industry's 'raison d'être'. The system of allowing higher grade exports benefitted producers 'without cannibalising Eskom's security of supply' (Maharaj, 2012). The external shift of demand for lower grade exports in markets in Asia is now fundamentally undermining this system.

At the same time as a market for low grade thermal coal has developed, Central Basin reserves are depleting, and declining reserve qualities are rendering the system of higher grade washed exports and Eskom middling coal uneconomical in some cases. Indeed, Bergh, Falcon & Falcon have stated that the remaining reserves 'reflect a poorer in situ quality compared to that mined historically. Due to this lower quality, the exploitation of the reserves for the traditional high-quality export market is now limited, and not economically and practically viable' (2013:823).

The demand for lower=grade exports, while it may increase overall yields, results in a direct loss to the market of some Eskom grade product, which would have to compete directly with exports for coal for its older stations. There is also indirect competition for those stations that are optimised for middlings fractions of coal. For example, if an exporting colliery switched from RB1 to RB3 specification coal (CV 23.5MJ), 'then it would yield middlings with a minimum CV of less than 18.5 MJ/kg as well as being 40% of the volume of the middlings yielded when washing to an RB1 specification' (Sylvester 2013). Most of Eskom's plant requires above 18MJ/kg coal (see Table 1), except Lethabo, which is located in the Free State and is supplied by the tied Anglo New Vaal mine, and there will be efficiency losses if coal of a lower CV is used.

Furthermore, contracted supply from cost-plus mines has not been able to meet Eskom quality needs or quantity demand (Eskom, 2013), resulting in further price increases as short- or medium-term contracts are sought to fill in gaps due to geological and mine performance factors. Figure 5 shows how the volumes of coal purchased on cost-plus contracts have declined; from 56% of tonnages purchased by Eskom in 2007 to around 46% in 2012.

¹⁵ Matla, Kriel, New Denmark, New Vaal are examples of the former; Duvha and Optimum of the latter (Eskom 2013). Cost-plus contracts were based on Eskom and the miners contributing the initial capital to the mine; Eskom pays for the costs of mining plus a set return on capital invested. The fixed price contracts are for set quantities of coal at a predetermined price (Eberhard, 2011).

¹⁶ Marquard (2006) has noted that historically, the South African energy economy is notable in is disconnect from global energy prices and trends – a function of the low cost coal available for electricity and liquid fuels, sanctions, and the apartheid's state desire (or need) for self-sufficiency. It is interesting that while coal prices have been disconnected from international oil and coal prices up until now, the low prices still depended on the international system for suppressing domestic costs.

¹⁷ One member of the mining industry put it thus: 'Eskom covers your bread and the exports cover the butter'.

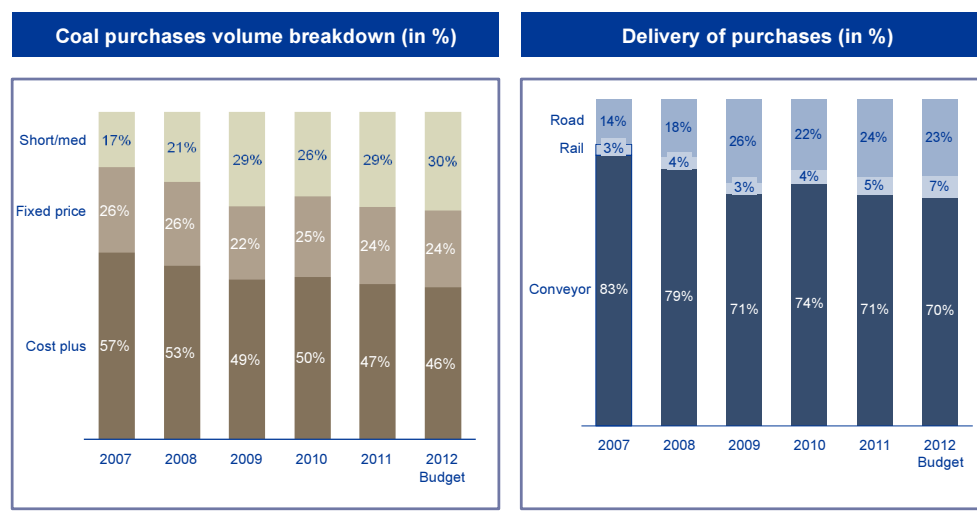


Figure 5: Proportion of short/medium and fixed/cost-plus contracts (left). Proportion of coal transported by road, rail and conveyor (right) 2007-2012
(Eskom, 2013)

As the portion of shorter-term contracts has climbed and road haulage has been used to transport the coal in place of conveyors (and to supply return to service stations without tied collieries), so logistics costs have increased. In one case, the costs of coal delivered are as high as R100/t (Eskom, 2014b). This should be compared to costs of R4-5/t of coal delivered by conveyor. The logistics costs associated with moving coal around Mpumalanga are thus very large. Even as Eskom has worked on migrating from road to rail, the costs of riling coal around Mpumalanga is higher than mine-mouth costs. Should coal be railed from other coalfields, the costs of moving it around the Central Basin will remain high. Furthermore, there is a question around the cost of riling coal from the Waterberg and the impact of that on the price Eskom pays.

Geology, logistics and market structure have thus fundamentally altered the operating environment for Eskom, which is now facing significant challenges in maintaining electricity supply (due to lack of capacity and construction overruns at the new-build projects) but which will also face primary energy supply security challenges from 2018 onwards. The primary energy supply challenges come both in terms of actual supply (coal quality and availability in the Central Basin) and in terms of pricing (domestic rise to export parity prices, the costs of poorer geology, and increasing logistics costs to fill in supply gaps and promote junior miners that are not located close to destination plant). It should be noted that the SACRM found that there was sufficient coal in the Central Basin to supply both Eskom and other domestic users until at least 2040 (depending on the assumptions about export levels and the Waterberg's ability to contribute to exports), but the roadmap questioned the security implications of lack of investment in new mines, coal availability to Eskom from new mines (or competition for exports) (SACRM, 2013).

2.3.1 Eskom's coal supply cliff

Figure 6 shows what Eskom is referring to as its 'coal supply cliff', i.e. the quantity of coal required by Eskom to 2050 that has not yet been contracted, or is facing a 'threat' from low grade exports (thought to be 300-800Mt over the period). Eskom's response to the forthcoming threats to security of supply has been to implement its Coal Supply strategy, comprised of the following elements (Eskom, 2013):

- Progress coal supply from the Waterberg: Eskom is in an 'advanced stage of securing coal from mines in the Waterberg for its Mpumalanga power stations'.
- Driving policy changes in the coal supply sector with government departments.
- Progress implementation of new coal technologies (fines briquetting, for example)
- Advancing of black ownership in coal mining

- Partnering with other state owned companies ‘in developing emerging miners’ (Eskom, 2014).

Of the above pillars in the coal supply strategy, the opening up of the Waterberg, policy changes and the development of emerging miners and enhancing black ownership have the most clear political ramifications for locking South Africa in to a high carbon emissions trajectory, and are discussed below.

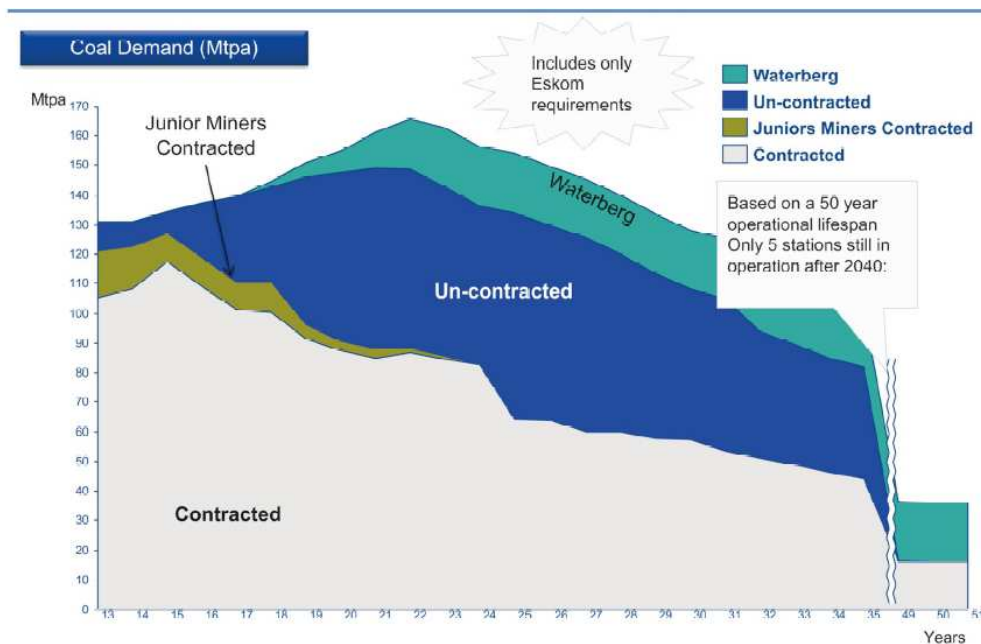


Figure 6: Eskom's coal supply cliff: contracted, committed and uncontracted coal requirements to 2050

(Kannan Lakmeharan, Eskom, 2014)

2.3.1.1 Coal supply from the Waterberg

To ensure security of its coal supply, Eskom is looking to expand its supply base beyond the Central Basin. This would depend on Transnet's expansion of the rail line to the Waterberg, and on the one hand could provide the opportunity for new miners to supply Eskom and also access export markets. But it runs the risk (once the Richard's Bay line has increased capacity) of forcing Eskom to compete with exports once again (though the argument for promoting multi-product mines has been made strongly by the industry). And the supply from the Waterberg will come with an increase in costs beyond the R350/t Eskom foresees paying into the future, as outlined in the Integrated Resource Plan (IRP) 2010 update (DoE, 2013a).¹⁸ The case for opening up of the Waterberg has been made strongly by the mining industry: Anglo American, Sasol, Exxaro, Waterberg Coal Company and Resgen, amongst others, all have prospecting rights in the area. The Department of Mineral Resources has called the Waterberg 'SA's future',

¹⁸ The Integrated Resource Plan 2010 (DoE, 2011) is the Department of Energy's official new generation capacity build plan for the country. An earlier, and superficial IRP 1 was promulgated in 2009, but the IRP 2010 represents the first instance of electricity planning including proper public consultation (previously, Eskom undertook its own internal planning). An initial Base Case scenario was adjusted after a period of public comment and participation, with the resulting Policy-Adjusted Scenario becoming the official build plan. Based on capacity included in the IRP, the Minister of Energy is empowered by the New Generation Regulations (2011) to make 'determinations' of which plant is to be built and by whom. Thus for example, the Minister has made four rounds of determinations that the private sector will build new renewable energy capacity to 2020, under the Renewable energy Independent Power Producers Procurement Programme (REIPPPP). The 2010 version remains the official plan, although a 2013 update extended the 2010 plan to 2050 and updated the demand forecast and costs. This 2010 update has not yet been officially adopted by the Department of Energy.

the development of which needs to be accelerated ‘in order to ensure the long term sustainable supply of coal’ (DMR 2009).

The other option is for new coal-fired power to be built in the Waterberg. Currently, a baseload independent power producer’s procurement process is under discussion, though as of October 2014, no tenders had been released. It is likely that under the so-called BLIPP, smaller-scale fluidised bed combustion (FBC) plants would be built. This is partly to increase private participation in the industry, and would also have the benefit of cheaper coal supply (FBC coal costs are estimated at R150/t in the IRP 2010 update, though if discard coal is burnt the costs may be lower) (DoE, 2013a). Several of the players who are expected to tender have completed or are completing environmental impact assessments for plants in the Waterberg.

The SACRM was explicit that under the three scenarios discussed above, the Central Basin reserves are sufficient to meet demand in Mpumalanga (provided mines are opened on time – which is a serious risk – and coal is sold to Eskom, although supply risks increase from 2025 onwards). With export line expansions, the potential risk for Eskom supply will increase, and thus Transnet must also ensure that it invests in rail capacity to the Waterberg, otherwise the RBCT line will either be underutilised (if Eskom pays export parity prices) or Eskom will not be able to contract the requisite tonnages. Even to ensure medium-term security of supply, the SACRM found that the Waterberg line is necessary only from the early 2020s (except under ‘Low Carbon World’, where it is never needed) (SACRM 2013: 69). Although the Waterberg expansion has not been officially included in Transnet capex plans up until now, Transnet announced in October 2014 that they would be investing R1billion in the line for incremental upgrades, with the intention of expanding capacity to 26Mtpa by 2019. This is out of line with what is required in the Central Basin under all of the Roadmap scenarios. The CEO of Transnet announced also that the heavy haul line capex would be included in Transnet’s 2015 capital plans, and that Transnet was looking at a rail line expansion of between 40-80Mtpa from 2021 onwards (Mining Weekly, 2014).

The Industrial Development Corporation, which reports to the Economic Development Department, has also indicated that it will be involved in coal mining in the Waterberg region, since its coal exposure is ‘underweighted’ and it ‘needs to support the development of coal projects such as those in the Waterberg region’ in response to declining reserves in the Central Basin. It has thus planned involvement in two (as yet unnamed) projects from 2015 onwards (IDC, 2014).

2.3.1.2 Policy changes

Policy changes refer to the Mineral and Petroleum Resources Development Act amendments and the attempt to prevent exports that threaten the security of Eskom supply. When the legislation will be enacted is not yet known, and whether the new Minister of Mineral Resources will have any appetite to use the provisions on strategic minerals and developmental pricing remains to be seen.

Eskom has recognised the risk of the changing international market on domestic pricing dynamics, and the risk of new entrants in the industry. They were especially concerned at the 2012 merger of Glencore and Xstrata. Kiren Maharaj, head of the primary energy division, told the Competition Commission that there would be a number of ‘detrimental’ impacts on Eskom in the context of low-grade exports and changes of ownership structure of the coal industry. These impacts included

[3.3] a likely increase in the exporting of coal with the concomitant consequences for domestic prices of coal to Eskom (in order to prevent increased coal exports, Eskom would be required to match the economic return gained from exporting the relevant quality of coal by subjecting itself to export parity pricing.) (Maharaj, 2012: para 3).

The statement above was made at a Competition Commission tribunal hearing and refers specifically to the change in the ownership structure industry that was brought about by the ‘merger’ of Xstrata and Glencore. The merger resulted in a large increase in Glencore’s export capacity at RBCT, and Eskom was quick to point out that Glencore’s approach to pricing was

market-driven, rather than cost-driven (as Xstrata's historically had been). Eskom's involvement in the Commission hearings followed on from an attempt by Glencore (when they bought Optimum Coal), to renegotiate the long-term coal contracts for the supply of coal to Hendrina power station. This was on the grounds that Glencore calculated they were losing R1.8bn (NPV) by supplying coal to Eskom rather than exporting it (Optimum, 2012). The implications of these levels of rent accruing to Eskom, and in turn to electricity intensive industry, are profound.

Given the rise in demand for lower grade exports, Eskom's supply cliff will likely require Eskom to pay significantly higher prices to ensure a continued supply of coal in the Central Basin (or to reflect the higher transport costs of coal from the Waterberg). Eskom has estimated that the export parity prices they will need to compete at (in the Central Basin) are as given in Table 2.

Table 2: Export parity prices for Eskom grade product at different export prices
(Eskom, 2013)

<i>Export price (US\$)</i>	<i>Export price (R/t)</i>	<i>Eskom EPP price (R/t)</i>
87	816	476
105	985	596
121	1135	704

Compared to the historically low prices Eskom has paid for coal (roughly one-third the price of export-grade coal) (IEA, 2014: 10), these export parity prices indicate a fundamental break with the structure of the industry in the past. Although 2014 export prices are substantially lower than the figures quoted here (hovering around \$70/t), and are forecast to remain soft in the short term, the medium-to-longer-term prices will have to rise to reflect rising cost bases in many producing countries. Rather than competing with exports, Eskom has argued that pricing should be cost-driven plus a 'fair' return (Maharaj, 2012). What constitutes efficient costs and a fair return is now a subject of debate between miners and Eskom. New coal supply contracts will depend on high enough returns for international mining houses, as well as risk allocation mechanisms that mining houses deem fair (Ephron, 2012).

Eskom estimate that the effect on electricity prices of such an increase in primary costs will be significant. If the delivered cost of the short/medium term contracted coal (30Mtpa) is R600/t, then this would add 5% to the 2013 average operating cost of 56.4c/kWh (Eskom 2013) (in a context of real electricity prices that are double the 50 year average, and are likely to increase further according to the tariffs granted by the National Energy Regulator of South Africa). The political pressure on Eskom to prevent further electricity price increases is enormous, yet the utility is facing a funding shortfall of R225bn to 2018. Expectations of a state bailout of the utility under the Medium Term Budget have not materialised, with Eskom to receive only R20 billion.¹⁹

The SACRM identified the differences in cost between developing new resources in the Central Basin or the Waterberg. The SACRM found that despite the differences in geology and the beneficiation required in the Waterberg, average coal production costs are substantially lower at R56/t run of mine coal than in the Central Basin (R205/t).²⁰ Given the much lower yields and

¹⁹ According to IEA (2014), the cost of coal in 2012 was 27% of Eskom's total operating costs. Under the Multi-year Price Determination (MYPD) tariff application, NERSA granted primary energy cost increases of 8%pa up until 2018; unit costs of coal have increased far beyond that, however, with a 14% increase between 2012 and 2013.

²⁰ It should be noted that the figure for the Waterberg is likely based on the production costs at Exxaro's Grootgeluk mine, which is the only currently operating mine in the area. The economics of Grootgeluk are interesting, since the apartheid state-owned iron and steel company, Iscor, set up the mine to supply coking coal for the domestic steel industry. The economic rationality of the mine was less important than access to strategic metallurgical coal, and one coal analyst has argued that the area is not a viable mining investment except for very large-scale mines with the beneficiation complexity of Grootgeluk (which produces semi-soft coking coal and Eskom grade thermal coal) (Xavier Prevost at McCloskey 2014; FM, 2014c).

requirements for beneficiation in the Waterberg, the price per saleable ton would likely be 2-3 times higher than the ROM cost quoted in the SACRM.

Even once very high transport costs are included, estimated delivered costs of coal from the Waterberg appear to be more expensive even than the increased prices in the Central Basin in the future; Macquarie have estimated that coal from the Waterberg will price in at R410/t. While higher than the assumed average future price of coal in the IRP update (DoE, 2013) of R350/t (which is based on Eskom calculations) this is still lower than the R500/t used for the sensitivity analysis under the IRP 2010 Update. On the other hand, export parity prices at some mines could greatly exceed these costs.

The MPRDA amendments were intended to lower the risk to Eskom of increasing competition. However, the economics of multiproduct mines are such that limiting exports could have the unintended consequence of raising coal prices for Eskom given the need for higher returns from mining houses. Limiting exports under the MPRDA would also result in stranding port capacity (which already exceeds rail capacity), and especially new investment in the export and Waterberg lines.

2.3.1.3 Transformation objectives and new emerging miners

Problems with supply and pricing are exacerbated by government pressure on Eskom to use their purchasing power to increase BEE ownership in the sector. This comes with explicit economic costs (higher production costs than mega-mines, logistics costs, reduced cross subsidy between exports and Eskom product, and direct financial costs of empowerment deals on the economics of projects) and political effects in terms of both alienating major mining houses and strengthening links between new miners and the political elite.²¹

The political cost of empowerment comes in the form of the loss of good relations with the major mining houses. For example, the Kusile power plant (initially due online at the end of 2014; now due end 2015) remains without a signed long-term coal contract. Although Anglo American Inyosi Coal's New Largo resource is 'secured' (according to Eskom),²² Eskom and Anglo are involved in on-going disputes over the coal contract. This is to do with pricing and a 'fair return', but also due to the former Minister of the Department of Public Enterprises, Malusi Gigaba's insistence that Anglo increase its BEE shareholding to meet Eskom's required BEE procurement level of a 50% plus 1 black-owned company (FM, 2014b). The pressure from the Department of Public Enterprises (the Ministry under which Eskom falls), through Eskom, is for 64% of Eskom's coal supply to come from 'emerging miners' (*Business Day*, 2013). Since the majors currently provide 80% of Eskom's supply, this is a significant policy shift (although Exxaro is a BEE mining company, they are not 'emerging').

This directive is not in accordance with the Mining Charter, which governs the BEE requirements for the sector underneath the Minerals and Petroleum Resources Development Act (MPRDA 2002), and sets ownership at 26% by historically disadvantaged individuals. The DPE directive furthermore does not appear to be applied uniformly to other miners with which Eskom has contracted or is in contractual negotiations with.

For example, one of the planned suppliers to fill in the 5Mtpa gap in Kusile's supply (caused by New Largo's lack of timely development because of the contracting dispute), Universal Coal, only recently increased its BEE shareholding to 50% for one of its (three) coal mining Special Purpose Vehicles; the remainder are less than 30% BEE owned (www.universalcoal.com), and the option for Universal to buy out their BEE partners back down to the 26% ownership remains.²³ Similarly, in the Waterberg, neither Resgen nor the Waterberg Coal Company (the

²¹ BEE deals in the mining sector as a whole have totalled R340bn since 1997 (Jeffery, 2014).

²² Statement by Ayanda Ntshanga, Eskom Primary Energy Division at Fossil Fuel Foundation Junior Miners conference, 2014. See also *Business Day* (2014a).

²³ Universal Coal is 30% owned by IchorCoal, who also own Vunene Mining, who own the rights to the Usutu colliery next to Camden power station (which faces amongst the highest logistics costs currently). Eskom owned the mining rights for Usutu until the Department of Mineral Resources reallocated them to a shell company that later became Vunene Mining. The DMR claims they were never converted under the minerals

most active developers) has a BEE shareholding of 50% plus 1; and indeed, neither company even constitutes ‘domestic capital’. Both are ASX-listed Australian juniors (although WCC at least has strong political connections, with former ANC Treasure-General Mathews Phosa heading the Board).

Eskom is also planning to set up a ‘Mine Development Fund’ which would provide capital for emerging miners. Such miners would have to be new entrants, and 50% plus 1 black-owned. To meet empowerment and transformation objectives and to ensure security of coal supply, Eskom is investing resources in expanding coal interests; Eskom will provide technical and financial support to emerging miners, and will also take on higher levels of risk in terms of contracting.

Promoting emerging miners as part of an economic policy of transformation and BEE follows on from an already interconnected mining and political elite more broadly (Jeffery, 2014). Many well-known ANC members or their family members have direct interests in the sector (Deputy President Cyril Ramaphosa’s Shanduka Coal; Mathews Phosa and the Waterberg Coal Company, Brigitte Radebe’s Mmakau Mining, Patrice Motsepe’s African Rainbow Minerals), but there is far more widespread enmeshing of coal interests. For example, Shanduka Coal, which is 49.9% owned by Glencore, has plans to merge with the Pembani group, to form a R13.5bn BEE mining house. Pembani has its own coal interests (Carolina) but also holds interests in BHP-Billiton and Exxaro. And the Chair of Pembani, Phuthuma Nhleko, also previously sat on the board of Anglo American. Glencore also owns 49% of ARM Coal, a subsidiary of Motsepe’s African Rainbow Minerals (Glencore, 2013). So the political weight behind the industry is large, and BEE deals have often been concentrated in the majors; Eskom on the other hand is more concerned with coal supply, though the transformation objectives will also carry a cost for the utility and are viewed as a lever for the state to use to promote transformation.

2.4 Summary

Eskom’s interest in new coal supply infrastructure, both mines and rail, stems primarily from energy security concerns (cost and availability) and political pressure to enhance empowerment in the coal sector. Port infrastructure expansions, though much discussed, have not yet materialised; and given the excess capacity at the RBCT, are not likely to in the short-to-medium term. The major constraint on exports has historically been underperforming rail capacity, which seems to be starting to be resolved through take-or-pay contracts being signed, more capacity being given to junior miners, and massive investments by TFR to improve efficiencies and increase capacity on the RBCT line. This is being accompanied by expansions on the Waterberg line that TFR claims will reach 26Mtpa by 2020, enabling cheaper coal to be burnt in the Waterberg, be railed to Mpumalanga, or be exported.

In the context of climate mitigation policy, that requires a careful balancing of short- and medium-term security of coal supply and longer-term avoidance of carbon lock-in, the significant infrastructure investments being made in rail, and the potential political lock-in of coal through Eskom’s development of the Waterberg and junior miners contradicts the mitigation policy and possible global pressures South Africa will face in the future.

3. South Africa’s climate change mitigation policy

South African emissions totalled 563Mt CO₂-eq in 2010 including land-based emissions (there is high uncertainty about the land-based sink; excluding land-based emissions – sources minus sinks – increases total emissions in 2010 to 582 Mt CO₂-eq). Of this total, energy accounts for 495 Mt CO₂-eq, or 88% of South Africa’s emissions excluding land-based sinks (DEA, 2014).

legislation and thus Eskom lost its right; Eskom is now forced to negotiate for the coal it used to own the rights for (*Mail & Guardian*, 2011).

Table 3: South African emissions by sector, 2000-2010
(DEA, 2014)

	Energy	IPPU	AFOLU (excl. Land)	AFOLU (incl. Land)	Waste	Total (excl. Land)	Total (incl. Land)
	(Gg CO ₂ eq.)						
2000	381 790	29 961	39 565	9 037	12 434	463 750	433 221
2001	383 620	28 652	39 725	12 772	13 122	465 118	438 166
2002	392 107	30 368	38 916	16 060	13 789	475 180	452 324
2003	421 121	30 987	36 995	10 310	14 477	503 581	476 895
2004	439 835	32 548	37 049	19 545	15 179	524 611	507 107
2005	433 719	33 400	37 235	29 667	15 907	520 262	512 693
2006	453 536	34 190	37 148	23 869	16 649	541 523	528 244
2007	479 058	33 871	36 522	23 435	17 409	566 860	553 773
2008	475 817	30 229	37 580	25 280	18 170	561 797	549 497
2009	476 346	27 456	36 658	21 688	18 989	559 450	544 480
2010	495 432	29 634	37 577	18 248	19 806	582 449	563 120

3.1 Domestic policy

South Africa's climate change mitigation policy, outlined in the 2011 National Climate Change Response White Paper (NCCRWP) (DEA 2011) defined a national GHG emissions trajectory range. The NCCRWP specifies key points in a 'peak, plateau and decline' (PPD) trajectory from the present to 2050. The PPD trajectory²⁴ sets the performance 'benchmark against which the efficacy of mitigation actions will be measured' (DEA, 2011). The PPD trajectory was referenced by President Zuma during the Copenhagen climate summit, when he announced that South Africa would reduce emissions by 34% and 42% below a business as usual trajectory by 2020 and 2025 respectively. This peak in emissions would be followed by a decade long 'plateau', before an absolute decline from 2035 onwards. This commitment has been formally submitted to the United Nations Framework Convention on Climate Change, indicating that the extent to which South Africa could achieve a PPD trajectory depends on support for finance, technology and capacity building from the international community.

Figure 7 shows how the PPD emissions range has been quantified: emissions peak at a lower limit of 398Mt CO₂-eq in 2020 and an upper limit peaks at 583 Mt CO₂-eq in 2020 and 614 Mt CO₂-eq in 2025. The trajectory plateaus until 2035 with the lower limit of 398 Mt CO₂-eq and upper of 614 Mt CO₂-eq before declining in absolute terms, in a range that corresponds to the assumed 'uncertainty' of the emissions baseline on which the reductions were based. By 2050, the range results in quite divergent emissions outcomes, with the lower PPD trajectory assuming annual emissions of 212 Mt CO₂-eq versus the higher PPD trajectory resulting in annual emissions of 428 Mt CO₂-eq. This divergence in turn translates into a significant difference in the total carbon budget allocated between the present and 2050. The latest available GHG inventory indicates that emission in 2010 were 563 Mt CO₂-eq (DEA 2014), including land-based sinks.

²⁴ 'South Africa's GHG emissions peak in the period 2020 to 2025 in a range with a lower limit of 398 Mt CO₂-eq and upper limits of 583 Mt CO₂-eq and 614 Mt CO₂-eq for 2020 and 2025 respectively. South Africa's GHG emissions will plateau for up to ten years after the peak within the range with a lower limit of 398 Mt CO₂-eq and upper limit of 614 Mt CO₂-eq. From 2036 onwards, emissions will decline in absolute terms to a range with a lower limit of 212 Mt CO₂-eq and upper limit of 428 Mt CO₂-eq by 2050.' (DEA, 2011).

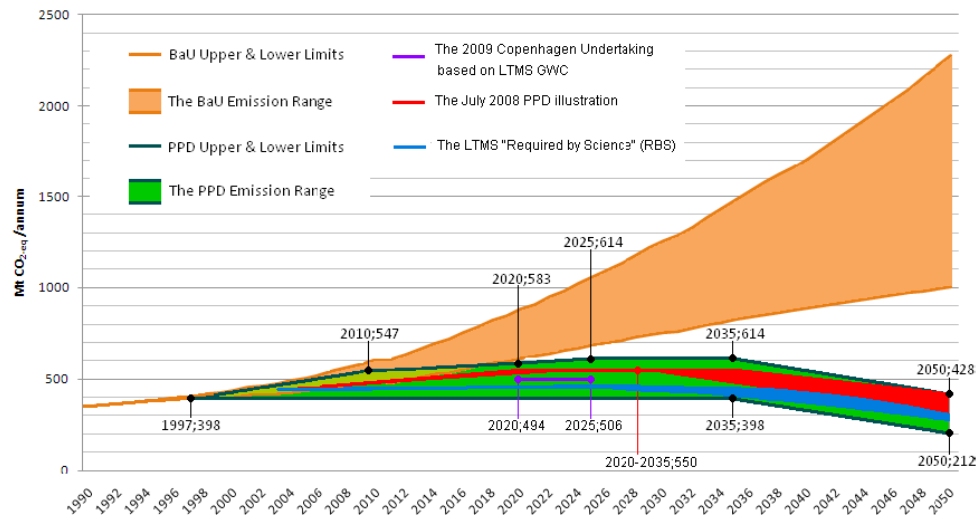


Figure 7: The peak, plateau and decline trajectory of the NCCRWP
(DEA, 2011)

The area under PPD implicitly constitutes a national carbon budget. The National Development Plan explores a carbon budget approach and elements for good design, including a ‘benchmark total carbon budget’ (NPC 2012). Winkler and Marquard calculated a national carbon budget, simply deriving it from the area under PPD for the period 2010-2050: 19 Gt CO₂-eq being the intermediate value between the budget for the lower range (15 Gt) and upper range (23 Gt). They also refer to analyses proposing much smaller national carbon budgets; both from experts from China and India based on equal cumulative per capita emissions (7 or 11 Gt) as well as some South African business leaders who suggested 10.2 Gt CO₂-eq (Winkler & Marquard 2012).

For this study, a shorter time-period of 2010 to 2035 is used, to remain consistent with the Coal Roadmap scenarios and the data available on coal export trajectories. The implicit carbon budget below the lower PPD range is 10.3 Gt CO₂-eq and 15.3 Gt CO₂-eq below the upper PPD range, over the period to 2035. The mid-range (the average of the two PPD ranges) is 12.8 Gt CO₂-eq.

How precisely the benchmark emissions trajectory is to be achieved is the subject of further work, including both technical analysis and also consultation with stakeholders by the DEA. The NCCRWP includes a ‘mix of measures, including notably a carbon tax and also other instruments (e.g. standards and regulations). Work is underway during 2014 and 2015 to define Desired Emissions Reduction Outcomes (DEROs) for sectors and sub-sectors, and company-level carbon budgets. Carbon budgets in this sense are limits, for which companies would be held accountable. Since DEROs are for sectors, and those are not legal persons, strong accountability is not possible, but they are still expected to provide guidance on emissions pathways at a sub-national level. This would allow for planning and implementation within sectors. Three timeframes are being considered: long-term (2050), medium-term (2030) and short-term (2016-2020). The short-term timeframe is the same for DEROs, company-level carbon budgets and the carbon tax. Beyond that, alignment between DEROs and the carbon tax remains a policy question.

In terms of sectoral plans, the electricity sector has the most clearly defined carbon constraint. The Department of Energy’s Integrated Resource Plan (IRP) included a carbon limit of 275 Mt CO₂ in its modelling, analysis and final plan for ‘IRP 2010’ (DoE 2011). A more recent update (DoE 2013) has not been officially adopted, but included the same 275 Mt, as well as ‘moderate’ and ‘advanced decline’ (of GHG emissions) scenarios. Fundamentally, however, both the IRP and its update have included carbon as a key decision-making criterion – whereas previous planning in Eskom prioritised cost, based on least-cost optimisation modelling.

The alignment between the IRP and DEROs would revolve around the desired outcomes for the electricity sector in the long, medium and short terms. In the long term, more rapid decarbonisation is possible in the electricity sector, compared to other major emitting sectors, both in South Africa and globally (IPCC 2014). In the short term, constraints are tighter, and flexibility to change such a large system is lower. This is recognised in the NCCRWP (2011: 26):

Policy decisions on new infrastructure investments must consider climate change impacts to avoid the lock-in of emissions-intensive technologies into the future. However, in the short-term, due to the stock and stage in the economic lifecycle of existing infrastructure and plant, the most promising mitigation options are primarily energy efficiency and demand side management, coupled with increasing investment in a renewable energy programme in the electricity sector.

Planned coal-fired power capacity expansions include Medupi and Kusile (under construction), a much-discussed ‘Coal 3’ plant, and the so-called base load independent power producer (IPP) programme, including 2.5GW of coal power to the private sector. The IRP scenarios include new coal, and meeting some portion of the PPD trajectory – 50% in the IRP2010, and 45% in the update, both assuming the upper range.

Many of the draft IRP scenarios assume the electricity sector will maintain its 45% contribution to the PPD higher trajectory (or even higher than the PPD trajectory); in such scenarios, active coal plants might have their lives extended (and many of the scenarios exclude the baseload IPP plants, though seemingly procurement is going to go ahead in 2015). How baseload power is to be procured remains largely unclear, though some lessons from the RE IPP procurement programme may be applied (Martin & Winkler 2014).

3.2 International climate negotiations and South Africa

As indicated above, the PPD trajectory was developed through scenario work, put forward internationally (with expectations of support) in 2009, and encoded in national policy in 2011. While developments in national climate, energy and related policies have continued (as briefly outlined above), international climate negotiations have continued.

At COP 17 in Durban, Parties agreed on a ‘regime applicable to all under the Convention’ (UNFCCC 2011). This formalised a shift that had been taking place for some time, before and after Copenhagen, to broaden participation, including non-Kyoto parties notably the US, as well as (at least some) developing countries. In framing mitigation, the negotiations did deliver broad political agreement keeping temperature increase to below 2°C above pre-industrial levels, or even strengthen it to 1.5°C. Meanwhile, the pledges put forward indicate a large gap between this goal and the efforts countries were willing to make and commit to in an agreement (UNEP 2013). Other metrics also emerged, with several observer groups and some Parties call for a goal of ‘zero carbon by 2050’ (in some cases, by 2070). Whichever way framed, there are metrics to consider whether the sum of what country mitigation commitments would add up to ‘enough’ – the question of adequacy.

At the same time, there has been a shift to determine specific commitments nationally, rather than negotiate them multi-laterally (as was done for the Kyoto Protocol). This was formalised at COP19 in Warsaw, in the phrase that countries would submit ‘intended nationally determined contributions’ (INDCs) (UNFCCC 2013). While much interpretation remains of what INDCs include, how they will be assessed and whether the contributions are for 2025 or 2030 (or maybe both), it is clear that the locus of determination – at least for this round of negotiation – is more national than before. From a South African perspective, the DERO process (including carbon budgets, and relating to the carbon tax and other measures) seems likely to inform the mitigation component of its INDC.

As outlined above, South Africa already announced in Copenhagen goals for ‘deviation below BAU’ for both 2020 and 2025. So if the timeframe were 2025, South Africa might simply reiterate its previous commitment to act. This is, however, simply a number from the PPD trajectory. South Africa may go further – both in terms of ambitious action and realised support.

It might put forward a fuller trajectory, based on the performance benchmark set in the NCCRWP, against which the collective outcome of all mitigation actions will be measured. That would indicate three phases: peaking (meaning that for some time, our emissions will continue to grow in order to achieve development and eradicate poverty and inequality) but including a slowing of the *growth* of emissions. Plateau has been identified as emissions remaining approximately flat for a decade, or stabilising. The decline phase would reduce in absolute terms, from 2035 onward. Since PPD goes up to 2050, it would firm up a long-term goal – around which a shared vision or sense of common purpose could be formed. It should be noted that emissions are very close to the PPD peak of 2025, as highlighted above.

The above is a possibility, but by no means an official South African position. Much will depend on others also taking action (e.g. US, China and India being willing to take on trajectories, specified fully over the same period). The expectation would also be, on the basis of fairness, that developed countries would take on numerical trajectories that can be considered more stringent, and a relative fair effort.

In the domestic dynamics of South Africa, actually achieving PPD will depend on what is possible in the country's political economy. The current institutional arrangements have developed to support a high-carbon development path, known as the 'minerals-energy complex' (MEC) (see Fine & Rustomjee (1996) for their seminal work on the complex, and Burton (2011) for an updated interpretation of the MEC). As outlined above, the current investments being made by Eskom, Transnet and the coal-mining industry serve only to further entrench the political interests of the coal and other minerals sectors, who have relied on historically cheap electricity for their development (Marquard, 2006).

Implementing the PPD trajectory will require a shift in institutional arrangements, and associated changes in the distribution of power. Given the current trajectories of investment in rail and coal-fired power plants, and long-lived assets, it is highly likely that South Africa will remain locked-in to a coal-based energy system for the foreseeable future. The question now is whether Eskom's commitment to Black Economic Empowerment, the relationship between political elites and the mining sector, and the solutions to forthcoming coal supply security concerns will further lock South Africa into a system where it exceeds its carbon budget. The country assumes for the most part that international mitigation objectives will not materialise, with risks associated with the investments being made should demand for coal be lower than expected in the next few decades. The next section briefly outlines the emissions implications of the future coal sector scenarios, and discusses the broader impacts of increasing the supply of fossil fuels on end-markets.

4. South Africa's coal futures

We have used the scenarios developed during the Coal Roadmap process to set parameters for understanding investment decisions and emissions implications of the upstream industry. Four scenarios were developed (see Figure 8), on which we base an analysis of emissions.

4.1 South African Coal Roadmap scenarios

The modelling included scenarios for domestic production of coal for electricity generation, exports, liquid fuels and other domestic uses. At its time of publication, the SACRM highlighted that 'At the Forefront' most adequately represented what the industry considered to be the evolving reality of the industry, while Macquarie (2014) developed further scenarios using 'Lags Behind' and 'At the Forefront' production scenarios to examine the opening up of new mining areas in the Waterberg Basin.

By comparing the implications of 'Lags Behind', 'At the Forefront' and 'Low Carbon world' (since total coal production under 'More of the Same' is similar to Lags Behind, we have elected not to include it in our analysis) we show the implications of different coal futures for South Africa, highlight the potential mismatches between coal sector expansion and emissions mitigation, and illustrate the potential pitfalls of new investments which may become stranded due to global market impacts or international climate mitigation policies. South Africa can ill

afford allocative inefficiency on the scale of billions of rand of new fossil fuel infrastructure for coal that will not find a market should a ‘Low Carbon World’ evolve. If on the other hand South Africa is ‘At the Forefront’, the implication for global climate impacts are severe, and the country will strand itself through acting to mitigate without concomitant international action. Under a ‘Lags Behind’ type scenario, South Africa will lock itself into high emissions trajectory that neither contributes to global mitigation efforts nor meets domestic climate policy.

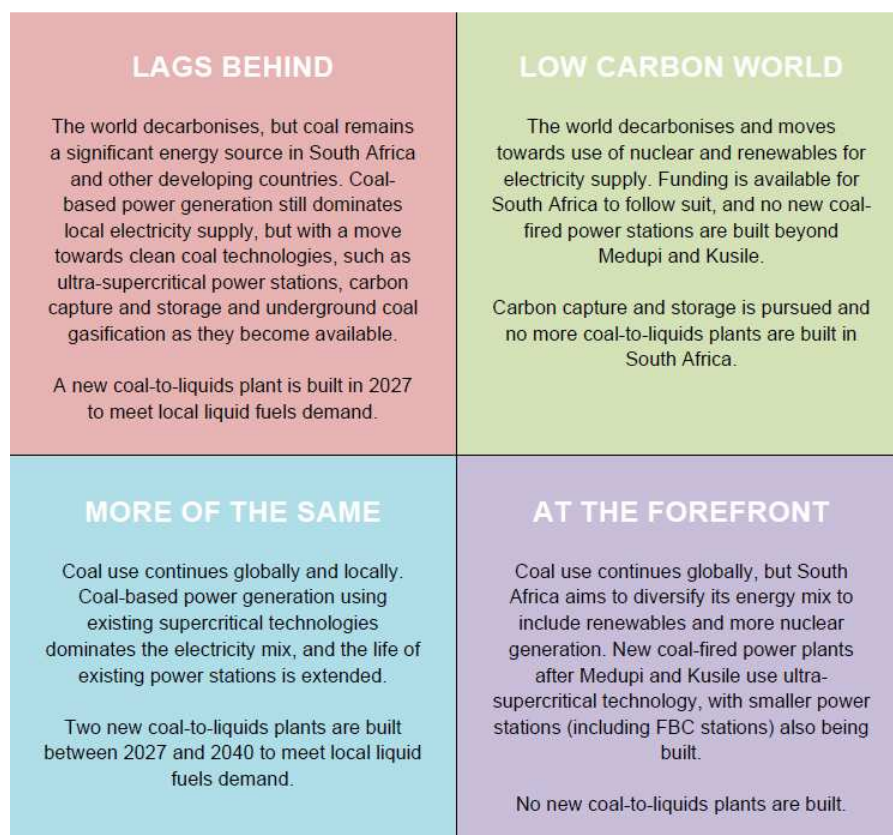


Figure 8: The South African Coal Roadmap scenarios
(SACRM, 2013)

While a ‘Low Carbon World’ may not be the most likely scenario from a domestic political economy perspective, there is significant international pressure on South Africa to move in this direction. While global action on climate change might not be as effective as required, unrestrained expansion of fossil fuels is unlikely (especially given the recently announced China-US emission reduction targets. South Africa’s recent IRP update (DoE, 2013a) has planned to extend the lives of coal plants, but state support for nuclear procurement and gas exploration mean that there will be some diversification of the domestic electricity sector. It is a question of degree how far this will go – relatively less ambitious in terms of mitigation under ‘At the Forefront’ and comparatively more ambitious under a ‘Low Carbon World’. We retain the latter to examine the possibility of significant shifts toward more effective climate policy in South Africa and globally, and explore the considerations in managing the risk of ‘unburnable carbon’ (Carbon Tracker, 2012).

The four scenarios in the SACRM are demand-driven primarily by the electricity build plan, which was based on the IRP 2010 (DoE, 2011), the official government electricity capacity expansion plan. Though a 2013 update has been released, it has not yet been approved by Cabinet nor gazetted, and we thus rely on the Coal Roadmap scenarios.²⁵ Major differences in

²⁵ The SACRM scenarios are also internally consistent in terms of export and domestic yields from mines, which we lack the data to replicate for the IRP update.

total production arise from the assumptions made about the liquid fuels industry (whether Sasol's coal-to-liquids plant is expanded or another built) and the levels of exports South Africa is able to reach.²⁶ There are some minor differences in assumptions about other domestic uses for coal, but these are not significant. We thus use 'Lags Behind' (high coal production growth scenario), 'At the Forefront' (business as usual), and 'Low Carbon World' (low production scenario).

Table 4: South African Coal Road Map scenario assumptions and coal production tonnages (SACRM 2013)

<i>Coal Road Map Scenario</i>	<i>Lags Behind</i>	<i>At the Forefront</i>	<i>Low Carbon World</i>
Chief assumptions	Electricity build plan: IRP 2010 Base Case	Electricity build plan: IRP 2010 Policy Adjusted (official build plan)	Electricity build plan: IRP 2010 Emissions 3
	Liquid fuels: 180 000 bbl/day coal to liquids added by Sasol	Liquid fuels: no new CTL	Liquid fuels: No new CTL
	Exports: peak at 92Mtpa then decline to 82Mtpa by 2035	Exports peak at 77Mtpa then decline to 64Mtpa by 2035	Exports peak at 80Mtpa then decline to 66Mtpa by 2035
	Export prices based on IEA Energy Technology perspectives to 2035 and account for Copenhagen Accord and some climate action globally	Export prices are based on the IEA 'current policies' scenario to 2020, WoodMac FOB Atlantic price projection to 2030, and then assumed to remain flat thereafter.	Export prices are based on IEA 450 scenario to 2035, and assumes the world achieves 'extensive' climate policy.
Utility coal production (2035) (Mtpa)	207	136	94
Exports (2035) (Mtpa)	82	64	66
Total production (2035) (Mtpa)	371	262	221

As can be seen above, by 2035 the scenarios have divergent utility coal production (ranking from 94 Mtpa in 'Low Carbon World' to 207 Mtpa in 'Lags Behind'), exports (64 Mtpa – 82 Mtpa) and total production (221 Mtpa to 371 Mtpa). Although exports under LCW and ATF are relatively similar, as discussed above, current planned rail capacity expansions to 98Mtpa assumes far higher exports than either of these scenarios, and exceeds 'Lags Behind' by 16Mtpa.

4.2 Extraction-based emissions

While the authors of the SACRM assessed the emissions implications of CTL and the various electricity build plans, the report includes neither a full domestic emissions analysis nor an analysis of the implications of expanded coal exports, and we thus include here an extraction-based emissions analysis of the three scenarios.²⁷

The emissions associated with the three scenarios in the period 2010-2035 can be seen in Table 5. The emissions are significant, far exceeding South Africa's own implicit carbon budget as discussed above. Extraction emissions range from 14.7Gt to 17.2Gt for the period 2010-2035.

²⁶ Under no scenario is Sasol's CTL shut down before the end of the modelling period.

²⁷ We have based our assumptions about calorific values on the SACRM values where provided. We have used the Department of Energy's (2006) Energy Balance for further data on the CV of coal for ferroalloys and coke, and we have used the SATIM model assumptions of 20MJ/kg CV for CTL (slightly more conservative than the DoE data). Oxidation rates and carbon content are from IPCC (1996; 2006), except for domestic power generation which uses a South African specific carbon content from Trikam & Lloyd (2004).

Table 5: Estimated extraction-based emissions in Mt CO₂

<i>Coal Road Map scenario</i>	<i>Lags Behind</i>	<i>At the Forefront</i>	<i>Low Carbon World</i>
CO ₂ emissions associated with domestic demand of South African coal (2010 -2035) (Mt CO ₂)	12 154	10 653	9 964
CO ₂ emissions associated with domestic and export demand for SA coal (2010 -2035) (Mt CO ₂)	17 273	15 415	14 783

Over the period 2010-2035, domestic production and use of coal will total 12.1Gt CO₂ (Lags Behind), 10.7Gt CO₂ (At the Forefront) and 10Gt CO₂ (Low Carbon World). It should be noted that this includes only carbon dioxide, not other greenhouse gases; and accounts only for domestic coal-related emissions, excluding other major-emitting sectors such as transport. The 10.7Gt CO₂ can be compared against the mid-range of the PPD benchmark trajectory (12.8Gt CO₂-eq), where it becomes apparent that South Africa will be very close to exceeding its implicit budget to 2035.

From a global perspective, the extraction and export of coal will also have significant impacts; were those emissions allocated to South Africa (rather than the end user), the country would exceed its carbon budget in 2035 even assuming the high range of the PPD (of 15.3Gt CO₂-eq).

Not only are the total emissions associated with South Africa's extraction of coal higher than it's own mitigation objectives; since the coal out of the Waterberg is relatively cheap, there may also be indirect market impacts that are not accounted for by typical analyses of new fossil fuel investments on the supply side.

4.3 Secondary market impacts

Applying the methodology developed by Erickson and Lazarus (2014), we have examined what the potential supply impact would be should South Africa effectively expand the export rail line in the short and medium terms, as well as the Waterberg coal supply in the medium-to-long-term. Their methodology is premised on the argument that export infrastructure not only has a direct emissions impact through the combustion of the fuels taken to market, but depending on relative prices, will affect the supply curve for end markets. More specifically, the effect on consumption of adding supply to an existing market can be estimated using economic elasticities, where, for each unit of increased supply, the increase in consumption is approximately the elasticity of demand divided by the difference between the elasticities of demand and supply.

We argue that if the supply of relatively low-cost South African coal exports increases due to expanded export infrastructure, the effect would be to increase demand for coal through shifting the supply curve. We have examined exports into India since it is the major end-market for South African coal (25% of current exports), and demand is projected to grow to around 80% of exports by 2020 (Eskom, 2013). The indirect impacts on prices and the possible substitution of other fuels for coal would thus have a secondary impact on emissions. Under the three scenarios, (and assuming a mid-range elasticity of supply of 2), the effects on emissions in 2035 would equal an increase of between 2 Mt CO₂ (Low Carbon World), 5 Mt CO₂ (At the Forefront) and 21 Mt CO₂ (Lags Behind) (in addition to the direct emissions associated with the combustion of the exported coal).

The indirect emissions impact on prices, consumption and thus emissions into India can be seen in Table 6 below. We estimate the price elasticity of demand for coal in India to be -1.15 (Bohi 2013). For the elasticity of supply, we consider three possible alternatives: 1, 2, and 4, based on the elasticity of supply of the export coal cost curves of Macquarie (2013) and Wood Mackenzie (Leaton et al 2014). We use three different elasticities to highlight the impact of different assumptions about the elasticity of supply on emission impacts.

Table 6: Global CO₂ emissions increases in 2035 resulting from expanded supply of South African coal

Elasticity of supply sensitivity	Elasticity 1	Elasticity 2	Elasticity 4
Lags Behind (Mt CO ₂ in 2035)	30	21	13
At the Forefront (Mt CO ₂ in 2035)	8	5	3
Low Carbon World (Mt CO ₂ in 2035)	3	2	1

Although relatively small compared to South Africa's domestic emissions from coal, the indirect effects of increasing fossil fuels on the supply side have in the past neither been clearly articulated in the literature nor considered by policymakers in the South African context.²⁸

5. Conclusion

Despite domestic policy on climate change mitigation, South African upstream coal infrastructure expansions are going ahead, with the result that the country will likely exceed its self-allocated carbon budget in the future. Both economic and political interests in the coal sector are driving this, as well as short- and medium-term energy security concerns. Transnet capital plans, in particular, go well beyond the requirements modelled by the SACRM, indicating further lock-in to a high emissions trajectory and dependence on coal exports in the South African economy.

It is apparent that investment decisions are being made in response to both energy security concerns and economic reliance on coal for provision of energy and exports in the South African economy. Transnet's capital investments will potentially have paradoxical effects, through both opening up the Waterberg coal for Eskom use and compelling Eskom to compete with exports in the Central Basin. The Waterberg is thus entrenched as the solution to several problems in South Africa's energy economy; large and economically important mining houses also have interests in the area, and will benefit from new rail capacity linking the new mining area to established export infrastructure. Eskom is being placed under political pressure to transform the coal industry in terms of black ownership levels, which will further entrench politically connected coal interests.

We found that the emissions associated with the SACRM scenarios came close to exceeding South Africa's mid-range PPD in 2035; it is likely that once other greenhouse gases and sectors are included in the analysis that South Africa would exceed its carbon budget. Once emissions associated with exports of coal are considered, it is apparent that South Africa would undermine its mitigation objectives. The CO₂ associated with the exported coal should also consider the indirect implications of increasing fossil fuel transport infrastructure, notably the market impacts in importing countries. Thus, beyond the direct impact on South African domestic emissions, the impact of increasing comparatively low-cost South African exports will have market effects in global coal markets.

²⁸ Such analyses did, however, play a role in debates over the Keystone XL pipeline in the United States.

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