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What Future for Coal in South Africa?

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This is a guest article by Jeremy Wakeford. Jeremy is an economist specializing in energy and sustainable development and is Research Director of ASPO South Africa.

South Africa has been in the news a lot recently because of its electricity supply problems throughout 2008. Most South African electricity comes from coal-fired power stations. Jeremy discusses the role of coal in South Africa's energy mix, long-term trends in production and consumption, and how underground coal gasification might help solve South Africa's energy problems.

Can and should our dependence continue?

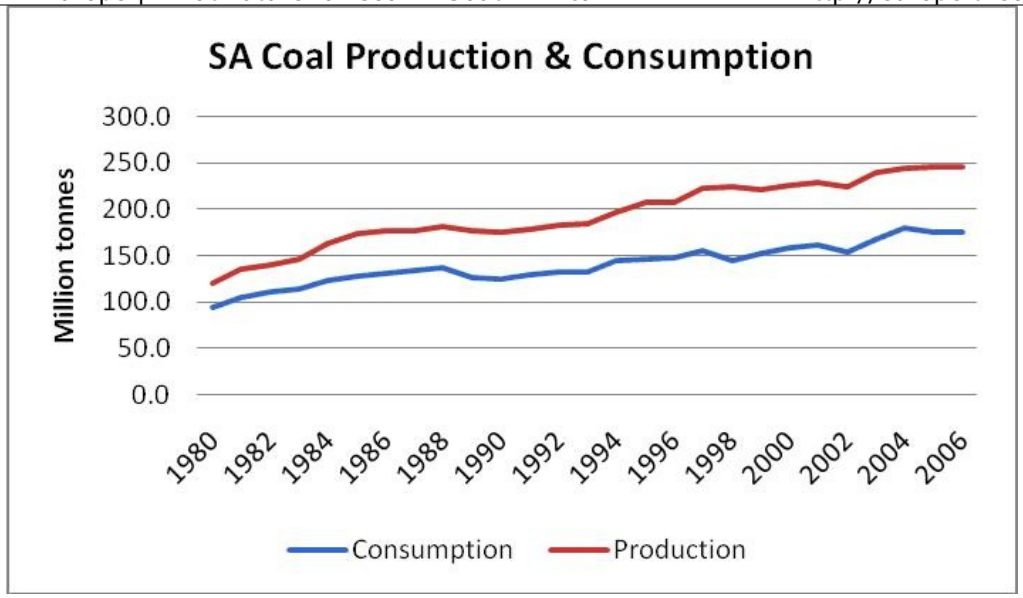
South Africa's energy economy is overwhelmingly dependent on coal. The fossil fuel provides nearly three quarters of total primary energy, supports almost 90 per cent of electricity generation, and provides feedstock for close to a third of the country's liquid fuels via Sasol's coal-to-liquids process. Coal is also used directly as a fuel by certain industries (e.g. steel production), and indirectly as feedstock for Sasol's petrochemical products. In addition, roughly a third of the nation's annual coal output is exported, generating an important source of foreign exchange earnings.

There are two major risks inherent in this heavy dependence on coal: one is the finite nature of its supply, and the other is its contribution to global warming. This article takes a broad look at some of the key issues concerning the outlook for coal in South Africa, including demand, supply, prices and environmental concerns. It concludes with a brief discussion of a promising development called underground coal gasification, which could potentially address both of these risks to some extent.

Demand for coal is growing

Production and consumption of coal in South Africa have grown reasonably steadily over the past two and a half decades, at average annual rates of 2.9% and 2.5%, respectively (see Figure 1). Consumption in 2006 is estimated by the US Energy Information Administration at 177 million metric tonnes (mt). The largest share of this, about 64%, was burned by Eskom in its power stations, with Sasol consuming another 24% and industry and small consumers accounting for the remainder. Eskom's consumption of coal grew to 125 million tonnes in 2007.

Figure 1: Production and consumption of coal in South Africa



Source: US Energy Information Administration

This growth in coal use – especially by Eskom and Sasol – is expected to continue or even accelerate over the next few years. Eskom is in the process of returning to service three coal-fired power stations (Camden, Grootvlei and Komati) with a combined capacity of 3800 megawatts (MW). It has also begun construction of the new 4800 MW Medupi power station, whose first unit is due to begin generation in 2012, while a second plant called Project Bravo (5400 MW, scheduled to start generating power in 2013) was recently given the go-ahead. The combined consumption of these five power plants could raise Eskom's coal use by over 50 mt (assuming they use the average amount of coal burned by existing power stations in 2007).

For its part, Sasol has announced that it is conducting feasibility studies for an expansion of its existing synfuels plant at Secunda by 20 per cent (or 30,000 barrels per day) and for the construction of a new plant (called Mafutha) with a capacity of 80,000 barrels per day. If both of these projects come on stream, they could raise the demand for coal by approximately 25 million tons a year (again extrapolating from past consumption patterns).

Thus the domestic demand for coal could rise by 75 million tonnes or over 40% over the next decade. Only from about 2025 when the decommissioning of older coal-fired power plants begins could one expect consumption of coal to start falling (provided no further coal-fired plants are built). This raises an important question: for how long might South Africa's coal reserves be able to sustain current and projected rates of consumption?

Can reserves sustain this growth?

The electricity crisis has already thrown a spotlight, so to speak, on the status of the country's coal reserves: Eskom attributed a part of its electricity supply problems at the start of this year to difficulties it experienced in sourcing sufficient quantities of suitable grade coal. This prompted the Minister of Public Enterprises, Alec Erwin, to say that the government would if necessary intervene to ensure Eskom's coal needs were met. Could this be an indication of moves towards resource nationalism, as are increasingly being observed across the globe in relation both to energy (especially oil) resources as well as food production? There is probably little immediate chance of this happening, for two reasons. First, Eskom uses low-grade coal while export-quality coal is high-grade and unsuitable for burning in existing power stations. Second, coal mining companies have long-term supply contracts to fulfil. Outright nationalisation of the coal industry would seem a remote possibility given the need for financial capital, management expertise, etc. possessed by the mining companies. However, it is still possible that growing domestic demand

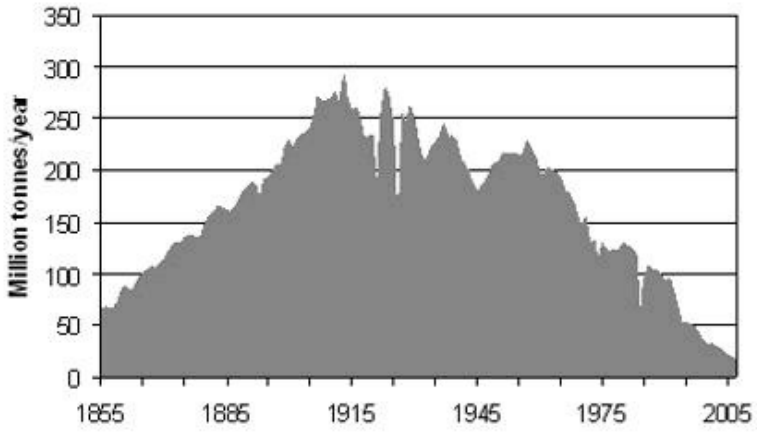
could at some point in the future come into conflict with exports.

According to BP's *Statistical Review of World Energy 2007*, South Africa's proved reserves of coal stood at 48,750 million tonnes at the end of 2006, representing 5.4% of the world total (the sixth largest national share). BP estimates a reserve to production ratio (i.e. the number of years production could be sustained at current rates) of 190 years. The Statistical Review defines proved reserves as "those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known deposits under existing economic and operating conditions." This figure seems to be based on the 1987 Bredell report. However, the official government figure for reserves has been revised downward sharply to only 28.6 billion tonnes (South Africa Yearbook 2006/7), giving an R/P ratio of about 115 years.

David Rutledge, a Professor at the California Institute of Technology, has used the 'Hubbert linearization' method to estimate that there could be as little as 10 billion tonnes (Gt) of recoverable coal reserves remaining in Africa (most of which is in South Africa). If true, current production could be sustained for only about 40 years.

The R/P ratio is however of limited usefulness, for a couple of reasons. First, as mentioned already, the annual rate of consumption is expected to grow in the medium term, not remain constant. More fundamentally, production cannot maintain any particular rate indefinitely and then suddenly collapse to zero. Because coal is a finite resource, its production will of necessity reach a peak at some point and then decline gradually toward zero. This production profile, initially identified by the geophysicist M. King Hubbert in the case of US oil production, is clearly evident in the history of British coal output (see Figure 2).

Figure 2: British coal production



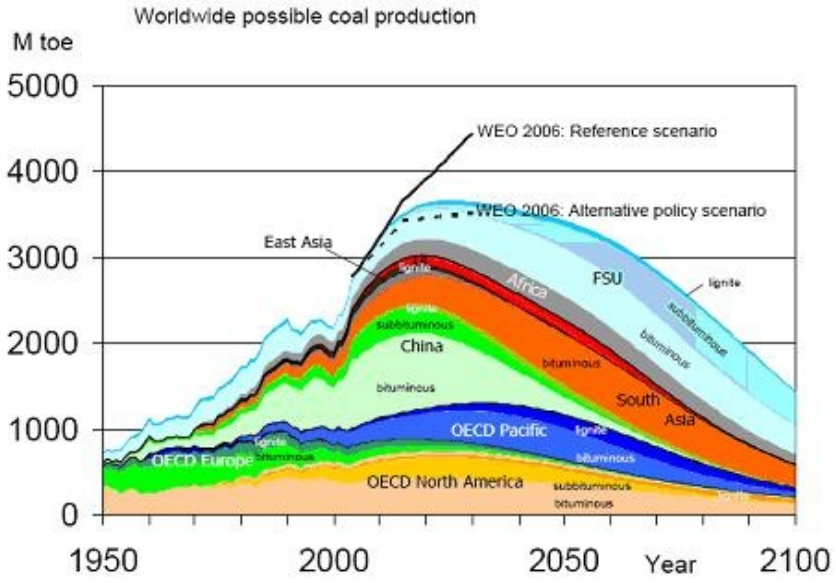
Source: Prof. Dave Rutledge: http://rutledge.caltech.edu/

The 'Hubbert peak' for South African coal production may still be a few decades away, depending on which estimate of ultimately recoverable reserves turns out to be most accurate. If Rutledge's conservative reserve estimate is used as a base, and the rule of thumb applied that peak production occurs when roughly half the recoverable resource has been mined, then the peak could come by 2020 if production grows at historical averages (2.5%) until then.

Whatever the case, the economics of mining dictates that the most accessible reserves are mined first, so that the net energy return from the coal mining declines while the production costs rise over time (although the latter may be counteracted to an extent by technological improvements). To a degree this process is already in evidence, as costs are rising and the quality of mined coal is declining, according to statements made by Eskom officials.

The global picture is similar. Several studies of global coal reserves published last year indicated that world reserves are likely to be much lower than has been commonly believed. One of these studies, by the German Energy Watch Group, forecasts that global coal production might reach its peak as early as 2025 (see Figure 3). Meanwhile, demand is growing rapidly in many developing countries, mostly notably in China (which has recorded growth of 12 percent per annum since 2001) and India.

Figure 3: Global coal production: history and forecast

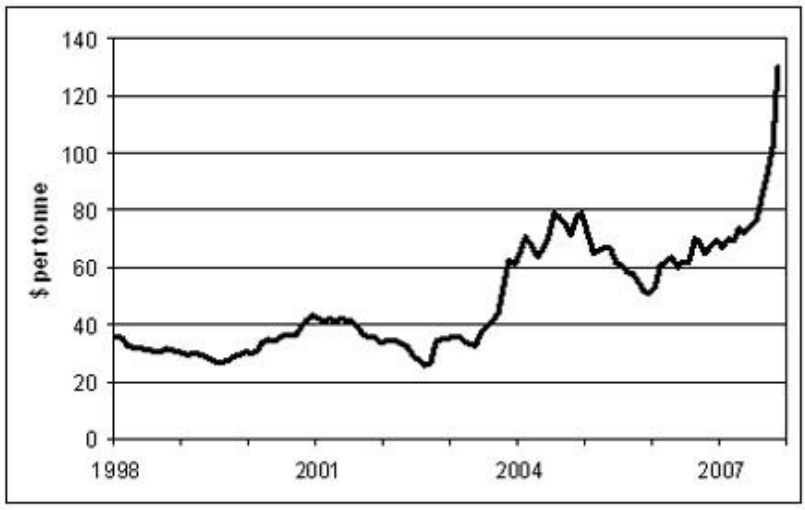


Source: Energy Watch Group (2007)

Spiralling prices

The surging demand in the face of short-term supply constraints has resulted in a dramatic rise in coal prices over the past few years (see Figure 4). The spot price of coal on the international market has risen from $100 to $300 per ton within the last year. A major reason is that China, by a large margin the world's top producer and consumer of coal, recently became a net coal importer.

Figure 4: Northwest Europe steam coal marker price



Source: McCloskey Group

All this has been good news for South Africa's coal exports. South Africa was the world's fourth largest coal exporter in 2005, selling 65 million tonnes of high-grade coal to buyers in Western Europe (approximately a quarter of their coal imports) and East Asia. It was recently reported that India may source low-grade coal from South Africa to fuel new power stations.

Domestic coal prices are also on the rise. Eskom has cited a 30 per cent rise in the price of its key feedstock in the past year as one of the reasons it is seeking a 100 per cent increase in electricity tariffs over the next two years. The CEO of ArcelorMittal, the giant steel producer, recently stated that he expects the price of coking coal to rise between 150% and 200%. As long as demand remains strong, the spike in coal prices will not be a temporary anomaly.

Can our climate cope?

The scenario of demand growth – subject sooner or later to supply limitations and thereby forcing up prices – applies in a business-as-usual scenario. But from the climate change point of view, can we afford to burn all the coal that's left? In parts of the developed world at least, there is a movement away from coal. In February 2007, NASA's chief climate scientist James Hansen called for a moratorium on the construction of new coal-fired power plants unless they sequester the carbon emissions. Lester Brown, President of the Earth Policy Institute, recently noted that opposition is mounting to coal-fired electricity generation in the USA, where many State governments are placing moratoriums on the construction of new coal power plants. The European Union has embraced renewable energy and is at the forefront of efforts to reduce carbon emissions.

South Africa is a signatory to the Kyoto Protocol, but as an Annex I country currently has no obligation to reduce its greenhouse gas (GHG) emissions. However, this may change under a successor treaty to Kyoto, which is due to expire in 2012. Given the severity of climate change, a new protocol could be much more stringent, and could involve an international carbon trading system that would add a substantial premium to the price of fossil fuels. There is consequently a significant risk for South Africa that its carbon-intensity will undermine the international competitiveness of many of its exports (e.g. minerals, beneficiated metals and certain manufactured goods).

Thus far, although carbon capture and storage (CCS) has received a lot of attention, the development of economical technology could take years or even decades. Earlier this year the Bush administration cancelled federal funding for a consortium aiming to construct a demonstration coal-fired power station that sequesters its carbon dioxide emissions, on account of rising costs. Whether or not CCS will some day become technically viable in South Africa, it looks highly likely that carbon sequestration at existing plants would substantially increase the costs of coal-based electricity and/or liquid fuels.

Two birds with one stone?

More promisingly, Eskom and Sasol are currently working jointly to develop an alternative technology for extracting the energy from coal, called underground coal gasification (UCG). This is a process whereby coal is ignited in situ underground, fed through a borehole by air or oxygen and yielding a synthetic gas (syngas). The syngas can be used for electricity generation, for the production of synthetic liquid fuels or for industrial uses (e.g. manufacture of petrochemicals). In addition to this flexibililty, several other advantages are claimed for UCG. First, otherwise uneconomical resources can be utilised; Eskom estimates that an additional 45 billion tons of coal could be exploited through UCG. Second, there is no need for traditional mining and associated health and safety risks for miners. Third, indications from a pilot UCG project in Australia indicate that the process has a much lower environmental impact (in terms of groundwater contamination,

land degradation and subsidence, and greenhouse gas emissions) than conventional mining.

Eskom already has a small pilot UCG plant in operation at its Majuba power station in Mpumalanga, generating 100 kilowatts of electricity. So far, Eskom is optimistic that the costs will compare favourably with those of conventional coal mining and power generation. One must pose the question, however, as to why UCG has not been commercialised before in South Africa (and other countries such as the United States), given that the technique has been used since the 1950s in the former Soviet Union.

Conclusion: watch this space

Let us attempt a quick summary of the coal situation. In the first place, coal's future in South Africa is perhaps not as certain as was commonly believed, at least until recently. Second, the risks of continuing heavy dependence on coal are becoming clearer: including security of energy and electricity supply, as well as climate change and associated financial risks related to carbon pricing. Third, the international price of coal looks set to continue to rise in the foreseeable future – whether from resource constraints or climate protection - so that the long era of cheap coal seems likely to be over for good. Fourth, underground coal gasification may provide a partial solution to all of these challenges in South Africa by substantially extending the amount of economically recoverable coal reserves while also limiting the environmental damage. The development of UCG will no doubt garner close scrutiny over the next few years, and not just in this country.

But this prospect should not allow a renewed complacency to set in regarding coal dependence. From a long-term perspective it arguably still makes sense for the country to diversify its energy sources by investing in renewable energy technologies and industries as ultimately these will be needed, have proven environmental benefits, and are becoming increasingly cost competitive with fossil fuels.

Jeremy Wakeford

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