WATER IMPACTS AND EXTERNALITIES OF COAL POWER

LIFE AFTER COAL
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Externalities in coal mining and coal-power generation

A negative environmental externality is a cost imposed on the environment and society due to the activities of a polluter; resulting in social, health, environmental degradation and other negative impacts. These costs are not paid for by the polluter. Rather, poor and marginal communities disproportionately carry the burden of these negative impacts. In the case of electricity supply, externalities occur when negative social and environmental impacts are not reflected in the costs of producing electricity or the price paid by electricity customers.[1]

South Africa is still predominantly reliant on coal for electricity generation. Approximately 89% of South Africa's electricity is generated by coal-fired power stations. In the year to end-March 2015 Eskom burnt 122 Mt of thermal coal. Coal-fired power and the electricity sector in general is a major source of externalities. Such externalities arise throughout the life cycle of coal, including the extraction (coal mining and transport), generation and demand stages. The main categories of negative externalities in the electricity sector relate to health, ecosystem impacts, climate change and water.

Externalities and the Integrated Resource Plan for Electricity

Water and energy are inextricably linked. As a consequence both have to be addressed together.[2] Energy planning typically fails to consider both current and future water constraints. On the one hand, water scarcity may impact on the long-term viability of particular energy projects. On the other hand, energy processes impact on water resources and water quality, and constrain the water available for other uses.[3] Particular water-energy nexus challenges in South Africa include water scarcity alongside a strict water allocation regime; the fact that most of our water has been allocated; a predominant reliance on coal-power generation and climate change uncertainties. Thus, understanding the interrelationship between water and energy is imperative in developing sustainable energy systems.

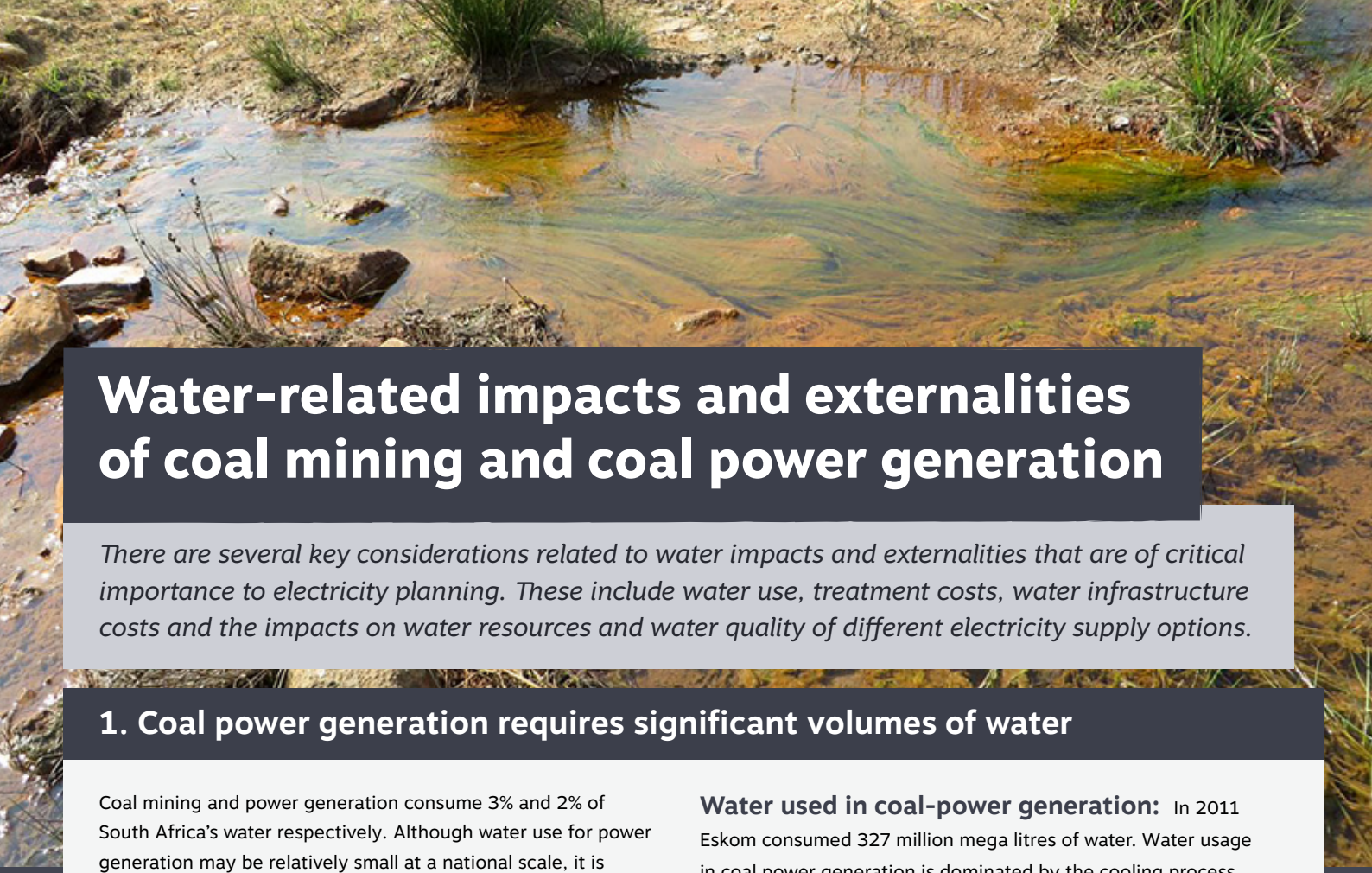
The Draft Integrated Resource Plan for Electricity (Draft IRP), 2016[4] provides cost estimates for different energy supply options. However, it does not consider and evaluate a range of externalities in general and water-related externalities and impacts in particular. This results in a misrepresentation of the total costs of coal-fired power generation.

Greenpeace Africa study

A comprehensive study commissioned by Greenpeace Africa [5] titled '*The External Cost of Coal-Fired Power Generation: The Case of Kusile*' finds that that externalities of Kusile with respect to water resources range between R0.95- R1.86 per kWh produced (ZAR 2011). Based on the study, Greenpeace Africa recommended that Kusile should be cancelled, there should be no further investments in coal-fired power stations, and Eskom should shift investments towards renewable energy.

Summary of estimated annual externality costs relating to water resources for Kusile

	Low estimate for Kusile (R million)	R/kWh (low)	High estimate for Kusile (R million)	R/kWh (high)
Climate change (generation)	3,148	0.097	5,334	0.165
Climate change (mining)	479	0.015	776	0.024
Water use (generation)	21,305	0.66	42,357	1.311
Water use (mining)	5,964	0.18	11,862	0.37
Water pollution (mining)	6.1	0.0002	7.7	0.0002
Total	**30,902**	**0.95**	**60,337**	**1.86**



Water-related impacts and externalities of coal mining and coal power generation

There are several key considerations related to water impacts and externalities that are of critical importance to electricity planning. These include water use, treatment costs, water infrastructure costs and the impacts on water resources and water quality of different electricity supply options.

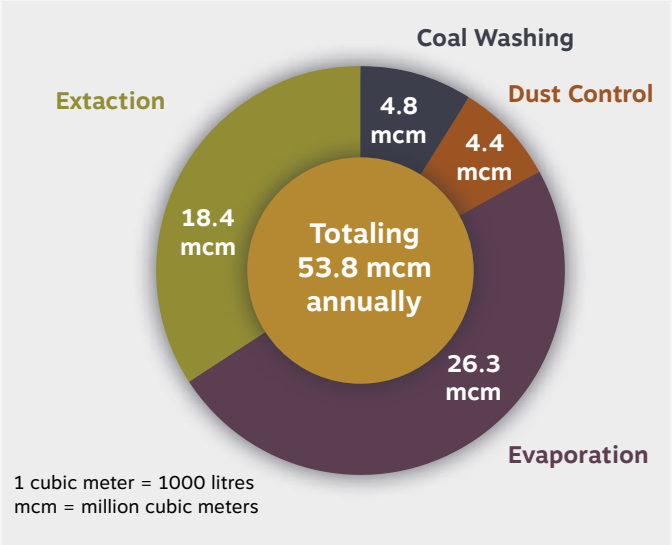
1. Coal power generation requires significant volumes of water

Coal mining and power generation consume 3% and 2% of South Africa's water respectively. Although water use for power generation may be relatively small at a national scale, it is far more significant on a regional level. For instance, power generation accounts for 37% of water use in the Upper Olifants, an area that already confronts considerable water-related challenges.

Water used in coal mining: Significant volumes of water are used during coal mining; for coal washing, extraction, dust control and evaporation. Approximately 431 litres of water is used per ton of coal produced. The Greenpeace study multiplies this figure by the coal requiements of Kusile (17 million tons), yielding an annual water requirement of **7.4 million cubic meters.** This results in an overall opportunity cost of water used during coal mining for Kusile of between **R6-12 billion each year.**

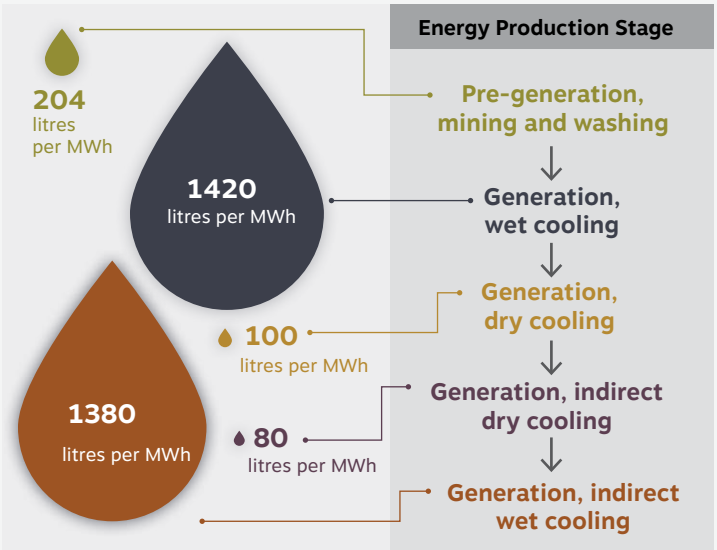
Water used in coal-power generation: In 2011 Eskom consumed 327 million mega litres of water. Water usage in coal power generation is dominated by the cooling process. Coal-fired power, with or without Flue Gas Desulfurisation (FGD), consumes far more water than wind, solar photovoltaics and concentrated solar. The Greenpeace study estimates the net marginal revenue and hence opportunity cost for Kusile in relation to other technology options. It finds that using dry cooled coal-fired generation with FGD, instead of concentrated solar power, results in forgone revenue due to water consumption of R0.83 for every kWh of electricity sent out (ZAR 2011). This translates to annual foregone revenue of R26.7 billion due to water use of Kusile compared to concentrated solar power.

Estimated water use in coal mining (in 2016)



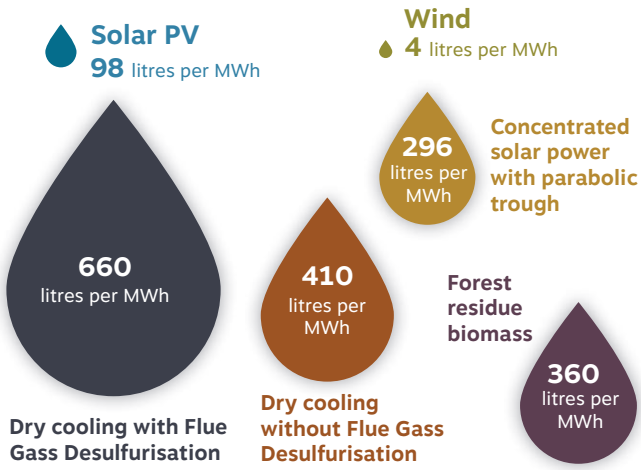
1 cubic meter = 1000 litres
mcm = million cubic meters

Estimated water use in coal-power generation



(Madhlopa, et al., 2013)

Comparison of water consumption for various energy technologies



(Business Enterprises, University of Pretoria. 2011)

2. Water for power generation in South Africa is under-valued

In 2010 the electricity sector paid far less for water (approximately R3.40 per cubic meter) than the average household (approximately R8 per cubic meter). Such under-valuing of water for power generation results in over-use and creates no incentive to prioritise water-efficient supply options.[6] For instance, between 2006 and 2016 Eskom's water consumption per unit of energy has increased from 1.3 litres per kWh to 1.44 litres per kWh. In contrast, valuing water would justify a rapid transition away from coal-based energy to water-efficient renewable energy. This would mean that water currently used for coal-power generation could be better allocated, to other more sustainable uses.

3. Mining and burning coal impacts on our scarce water resources

Our scarce water resources are impacted throughout the coal life-cycle including direct impacts on water quality during coal mining; impacts of air pollutants on water resources and coal ash contamination of groundwater. However, acid-mine drainage has the most severe impact, polluting our surface and groundwater with acid, salts and metals. This creates considerable negative impacts related to human health, livestock, crop production, and aquatic ecosystems. The Greenpeace study estimates the damage costs of coal mining on our water quality, focusing on sulphate pollution as an indicator of acid mine drainage. It estimates the damage cost imposed on other water users by Kusile from sulphate pollution to be between **R4.5 million and R7.7 million each year.** This figure would be signficantly more if it considered other pollutants and downstream impacts. Research by Pretorius (2009) suggests that the cost of acid mine drainage could be as high as **0.38/kWh (ZAR 2009).** Notably, South Africa's water security is put under considerable threat when coal mining coincides with our Strategic Water Source Areas. There is a considerable overlap between coal mining and Strategic Water Source Areas in Mpumalanga and Limpopo. For instance, about 45% of the Enkangala Drakensberg water source area overlaps with coal fields in Ermelo, Vryheid, Highveld and Utrecht.

4. Historical impacts of coal mining require treatment and associated costs for decades to come

The cost of treating mine water increases depending on the water quality sought. It is estimated that the capital cost to treat mine water effluent in the Upper Vaal to potable quality would be R528.5 million with a running cost of R55.7 million per year (ZAR 2011), whereas treating to lower irrigation quality would require a capital cost of R68.223 million and running costs of R11.93 million per year. With such costly treatment requirements, it does not make economic sense to continue mining and polluting water resources. It is far more cost-effective to prevent pollution in the first place. Importantly, South Africa has around 5 906 derelict and ownerless (D&O) mines captured on a database – there are likely significantly more. These create considerable health and safety risks and pollute water resources and agricultural land. It is estimated that the closure of D&0 mines, including long-term treatment of acid-mine drainage, would cost up to R60 billion. In the past decade, the Department of Water Affairs and Forestry has invested only about R120 million to investigate and deal with historical water pollution caused by D&0 mines. The Department of Mineral Resources has spent only around R42 million on rehabilitating five D&O mines. This is a fraction of the amount required.

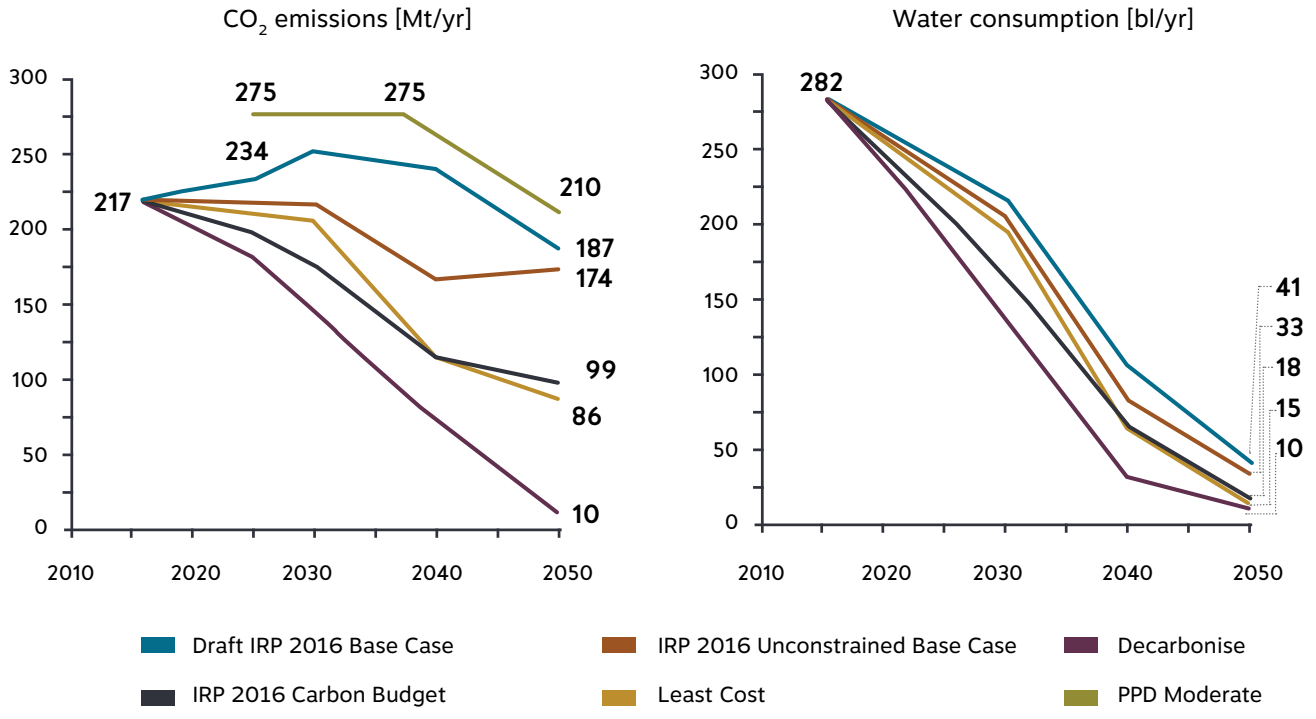
5. A decarbonised future uses far less water, costs less and creates more jobs

Research by the CSIR highlights that a decarbonised energy future would require four times less water, by 2050, than a Base Case that relies heavily on coal and nuclear. [7] A decarbonised future would further cost less and create up to 331 000 jobs in the energy sector by 2050. According to the 'Chamber of Mines Facts and Figures' there were 77 506 people employed in the coal mining sector in 2016. In contrast, research by CSIR highlights that, between 2020 and 2050, wind projects alone could result in the creation of 470 000 direct and 515 000 indirect full-time equivalent jobs in construction and 185 000 direct and 198 000 indirect full-time equivalent jobs in the operation and maintenance phase.

6. Coal power disproportionately affects marginalised and poor communities

Section 27 of our Constitution provides that everyone has the basic human right of access to sufficient and safe water. Yet, it is widely accepted that negative externalities associated with coal-power generation disproportionately affect marginalised and poor communities located around coal mines and power stations. Studies on the health impacts in coal mining communities have found that community members have: 70% greater risk of developing kidney disease; 64% greater risk of developing chronic obstructive pulmonary disease (COPD), such as emphysema; and are 30% more likely to report high blood pressure (hypertension). Further, in light of South Africa's ongoing water crisis and climate change, poor communities are most vulnerable to impacts as they lack finances, skills and technologies to cope with water shortages.

CO^2 emissions and water consumption for the different energy-mix scenarios (CSIR, 2017)



Internalising water externalities in the Integrated Resource Plan

In light of the above, it is imperative that the final Integrated Resource Plan for Electricity considers a range of water-related externalities and impacts in determining and costing South Africa's future electricity supply mix. Such considerations include:

- **Impacts on critical water resources** such as our **strategic water source areas**
- **Impacts due to the deposition of air pollutants** on our water resources
- **Water-related climate change** externalities
- **The knock-on effects of degradation of our water resources** (especially acid-mine drainage) on ecosystems, crop production, health, and livelihoods of those reliant on the water
- **Environmental justice** in view of disproportionate negative affects of externalities on **marginalised communities**
- **The downstream impacts** of acid mine drainage
- **Water use, across the full life-cycle of coal,** with consideration of regional water availability
- **Water infrastructure and management costs for different supply options**
- **Appropriate valuation of water for generation** to ensure water efficiency is considered in supply options
- **Water treatment costs, including capital and operation costs,** for different supply options, with appropriate consideration of the **long-term treatment requirements for acid-mine drainage**
- **The impact** of different supply options **on water quality and our water resources**

Inadequate consideration of the above results in a misrepresentation of the total costs of coal-fired power generation. Conversely, internalising these considerations would justify a rapid transition away from coal to water-efficient renewable energy.

This is critical in light of the water crisis we confront.

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References and further reading:

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3 World Bank. 2017. *Modelling the water-energy nexus: How do water constraints affect energy planning in South Africa?* Washington D.C: World Bank Group.

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