Water hungry coal

Burning South Africa's water to produce electricity

"Among the many things that I learnt as president was the centrality of water in the social, political and economic affairs of the country, the continent and the world." *Nelson Mandela, World Summit on Sustainable Development, Johannesburg, 2002*

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Executive Summary

Safe, affordable and accessible water is regarded as one of our planet's scarcest natural resources.[1] This is particularly true on the African continent, where water insecurity is often an everyday reality. At the same time, equitable access to water is fundamental to life and human health and well-being.

South Africa already struggles with water scarcity, and it is predicted that the country will face a significant water crisis in the coming decade.[2] Thus water scarcity could well become a fundamental development constraint in the future.[3] Within this context, a range of choices are being made. Choices with major implications for water availability, poverty alleviation, job creation, electricity generation and energy access. One of these choices relates to the energy future of this country, which has economy-wide implications.

The South African government and Eskom are making a clear energy choice at the moment: in favour of coal expansion, at the expense of access to scarce water resources, people's health and affordable electricity. The coal mining and electricity industry contribute substantially to water pollution and scarcity, jeopardising the country's ability to deal with an impending water crisis. Tragically, competition for this scarce resource may well culminate in conflicts over water. This means that the linkages between coal-fired electricity generation and water can no longer be ignored.[4]

However, the country continues to try to solve the *symptoms* of these crises instead of addressing the causes. Eskom and the South African government continue to deal with the electricity crisis by building new coal-fired power stations, pushing the price of electricity upwards due to rising coal costs,[5] generating substantial environmental and health impacts, worsening climate change, and thereby accelerating impacts on water scarcity. And the moves to label coal 'a strategic resource'[6] puts South Africa's water resources at severe risk. It is very likely that building more coal-fired power stations like Medupi and Kusile, and increasing coal mining to supply them will essentially send South Africa into a water deficit, given that the country's total available water resources may well have already been allocated to the maximum.[7][8]

Coal-fired electricity generation currently contributes to over 90% of South Africa's electricity,[9] with Eskom accounting for a staggering 62.3%[10] of South Africa's emissions in 2011.[11] Burning coal to produce electricity is an incredibly water intensive process,[12] with a number of serious implications for both water quantity and quality.[13] Coal-fired power stations use significantly more water compared to the water needed for most almost 'water-free' renewable energy technologies.[14]

Eskom itself admits that in the process of generating electricity, the utility is a significant user of the country's fresh water.[15] In one second, Eskom uses the same amount of water as a single person would use within one year, based on access to the minimum 25 litres of water per day. And in seven seconds, the utility uses nearly the same amount of water as a household would use in an entire year, based on the free basic water allocation.[i] Within this context, in 2012 there are still nearly a million households without access to the minimum 25 litres of water[16] per person per day.[17]

According to the National Water Act (Act no. 36 of 1998) the government, as trustee of the nation's water resources, must allocate water equitably, and in the public interest.[18] These allocation decisions are becoming ever more crucial against the backdrop of an impending water crisis, which

i During 2011, Eskom used 327 billion litres of fresh water, amounting to a staggering 10 000 litres of water **per second**, compared to a single person using the minimum of 25 litres of water per day, which would amount to 9 125 litres of water **per year** or a household using the minimum 6 000 litres of water per month, which would amount to 72 000 litres of water **per year**.

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makes transparency and accountability in the water sector even more important. However, there is a serious lack of transparency regarding water management plans and water licences in South Africa. Most of this information remains confidential, and inaccessible to the public.

Of the 22 mines that supply Eskom with coal, half were operating without a valid water licence in 2010,[19] which creates clear threats to the accountability of users and the protection of this country's water resources.[20] And there are still more questions than answers. A recent inquiry by Greenpeace Africa shows that in 2012 the Department of Water Affairs has issued 83 water licences for coal mining, while the Department of Mineral Resources lists 119 operational coal mines.[21] The Department of Water Affairs did not provide an answer clarifying this gap in licensing by the time of publication of this report.

South Africans have a right to know how water is being allocated, managed and polluted. Confidentiality in the water sector essentially disempowers the people of this country, effectively removing their ability to hold industry accountable for its water use. This is particularly true given the fact that no part of the country's water resources are regarded as 'private property',[22] and the National Water Act (Act no.36 of 1998) clearly states in its preamble that "water is a natural resource that belongs to all people".[23] The current allocation of water to the coal mining industry and to Eskom for coal-fired electricity is not a transparent, accountable or sustainable decision. And it is definitely not in the public interest, given that **there are very effective alternatives to coal, but there are no alternatives to water**.

The vast majority of renewable technologies use substantially lower amounts of water than coal-fired electricity generation.[24] [25] Wind and solar photovoltaics (PV) are virtually 'water-free' technologies.[26] Not considering these alternatives is economically irresponsible, given the high opportunity costs. In fact, investing in another new coal-fired power station (Kusile) equates to a hidden cost of an estimated R42 billion per year that it would operate - and this is only taking into account the water use of the power station.[27] At the high end, the estimated total social damage cost (or externality cost) of Kusile is economically very significant, and could amount to R60.6 billion per year that it operates.[28]

The real solution to South Africa's water and electricity crisis is not incremental improvements in coal technology, it is an Energy [R]evolution: a shift away from coal and nuclear energy, and towards renewable energy and energy efficiency. This report finds that implementing an Energy [R]evolution in South Africa would not only deliver sustainable electricity to all citizens, but would drastically decrease the amount of water required for electricity production in the country: to half of what would be required for coal mining and coal power combined, and to a level even lower than a 2007 baseline.[ii] By shifting away from coal and nuclear energy and towards renewable energy systems, substantial amounts of scarce water could be saved, and diverted to other sectors where it is urgently needed, avoiding water insecurity and potential conflict.[29]

Eskom is the only recognised 'strategic water user' of national importance in South Africa.[30] But the utility's unnecessary water-use for its coal-fired power stations will push this country closer to a water crisis. The utility consistently makes seemingly convincing public statements about how it takes concerns about its water use and environmental sustainability 'seriously'.[31] However, Eskom simply continues to prioritise coal to the exclusion of all other options. And the 'solutions' the utility proposes are not solutions at all, they are simply expensive technology-fixes designed to maintain the status quo.

In light of global water scarcity and catastrophic climate change, incremental improvements in the technology used to burn coal to create electricity are simply not good enough. In reality, Eskom has failed to recognise that the way it currently generates, transmits and distributes electricity is flawed and unsustainable, with substantial, unavoidable and long-lasting impacts. The connection that is not being made is that reducing the country's coal addiction may actually help to cultivate economic growth and create sustainable jobs through renewable energy.[32]

It is often argued that South Africa's significant coal dependency results in a number of serious 'environmental' impacts.[33] However, it is easy to dismiss these impacts as 'environmental' in nature. Although the right to have access to an environment that is not harmful to people's health or well-being is enshrined in the country's constitution,[34] 'environmental impacts' are often viewed as a necessary evil to allow for development, job creation and a stronger economy. The reality, however, is that it is impossible to survive without water, and all South Africans have an inalienable right of access to sufficient, clean, safe drinking water.[35] The country's coal dependency is a clear illustration of how decisions made today can have long-term unintended consequences.

A significant water crisis is looming in South Africa,[36] and investing in new coal-fired power stations instead of renewable energy and energy efficiency puts all South Africans at risk. Water is not just an environmental issue. It is a fundamental issue at the very heart of justice, development, economics and human rights.

ii These calculations are based on a comparison of water usage for two scenarios in 2030 (compared to a 2007 baseline): The Reference Scenario (modelled on the IRP2010 scenario) and Greenpeace's Advanced Energy [R]evolution scenario, see p. 25 of this report.

1. Background

There are few issues that are so deeply inter-related and important for development as the issues of energy and water.[37] Water plays a critical role in poverty alleviation and development.[38] But at the moment, we are essentially burning our rivers to produce electricity.[39] Fundamental changes are needed in South Africa's water and energy sector in order to meet the challenges posed by water scarcity, and to ensure universal, equitable access to water in this country.[40] Making the connection between water and coal in South Africa is clearly a very important step - indeed, the linkages between energy, electricity generation and water can no longer be ignored.[41] This report substantiates these underlying linkages, and the impacts of short-sighted coal-based energy and electricity generation choices on South Africa's water.

1.1. Water scarcity

Throughout its history, the provision of an adequate supply of water has been one of the key limiting factors in the economic development of this country,[42] and key issues around equity and access to water remain. This is addressed in the preamble of the National Water Act (Act no. 36 of 1998): "Recognising that while water is a natural resource that belongs to all people, the discriminatory laws and practices of the past have prevented equal access to water, and use of water resources".[43]

South Africa has insufficient and unreliable rainfall,[44] which means that it is a net importer of water.[45] [46] The country has a mean annual precipitation of 497mm/year, which is almost 50% less than the global average of 860mm/year.[47] In fact, all three of the most economically developed countries in the Southern African Development Community (SADC) - Botswana, South Africa and Namibia - are water scarce.[48] This means that "water scarcity is a fundamental development constraint", not only for this country, but for the entire SADC region.[49]

South Africa has a history of trying to solve water scarcity problems by engineering dams and 'importing' water through inter-basin transfer schemes, but this is not a long-term solution to water scarcity. In fact, this kind of technical response often comes with dramatic consequences, including the loss of ecological integrity in aquatic systems and increased levels of pollution from mining.[50] In the preamble of the National Water Act (Act no. 36 of 1998) it is recognised that "water is a scarce and unevenly distributed national resource".[51] Water has to be transported over large distances to supply urban areas,[52] and this means that millions of South Africans already drink water that was captured in reservoirs in excess of 400km away.[53]

That water scarcity is a significant challenge for South Africa, is something even the Department of Water Affairs acknowledges. The Department itself has projected that water demand will exceed supply by 2025, even by its most conservative scenario, unless considerable attention is paid to managing water demand.[54] [55] Although substantial steps forward have been taken, the delivery of water continues to be difficult. Despite the fact that Section 27 of South Africa's constitution enshrines the basic human right of access to sufficient, safe, reliable water,[56] in 2012 there are still nearly a million households without access to the minimum 25 litres of water per person per day.[57] [58] [59]

The Water Services Act (Act no. 108 of 1997) enacted this right to access water, by stating that no water authority may refuse to give people within its jurisdiction access to water services.[60] The current Basic Free Water Policy makes provision for 6000 litres of water per month for each household, free of charge.[61] [62] But equity around water also includes the quality of access to water: in 2010

the Department of Water Affairs estimated that there are a further two million people who have access to a water supply that does not meet the basic services standard.[63] South Africa is facing a serious water supply crisis:[64] it is estimated that the country's population will grow to nearly 53 million people by 2025,[65] and this is likely to amplify the already-existing competition between the needs of different water users.[66] Combined, these factors are likely to create a significant and increasing strain on the country's water supply.

However, it is not only the availability of water that is a constraint, but also its allocation.[67] The National Water Act (Act no. 36 of 1998) affirms that water is a common good and that the State is the custodian of this scarce natural resource.[68] Thus, ownership of South Africa's water is replaced by the right to its use.[69] The Act makes it clear that water must be allocated taking into account the three key principles of equity, beneficial use and sustainability.[70] According to the Act, the government, as trustee of the nation's water resources, must act in the public interest to ensure that water is used, protected, developed, conserved, managed and controlled in a sustainable and equitable way for the benefit of all South Africans.[71] But these allocation decisions are becoming ever more complex against the backdrop of an impending water crisis, and even the Department of Water Affairs acknowledges that "water allocation challenges are a reality".[72] This makes transparency and accountability in the water sector of critical importance.

1.2 Looming conflicts over water

In semi-arid countries such as South Africa, water scarcity is a critical stressor, which can determine livelihood vulnerability, and the impacts of water insecurity can produce serious stress at all levels.[iii][73] In the future, the competition for water is only likely to increase among water-intensive sectors such as agriculture, power generation and the residential sector.[74] Possibly creating unparalleled conditions for conflicts over water rights, and access to this scarce resource.

The second draft National Water Resource Strategy recognises that increased water scarcity is likely to increase competition between business and local communities (particularly poor and historically marginalised communities) in the future. And this potential competition could well result in conflict over water,[75] with the poorest at a clear disadvantage over well resourced big businesses. At the same time, many people living in informal rural and urban parts of the country still lack access to safe and adequate drinking water. This means that water scarcity and insecurity, and unsatisfactory delivery of services combined with factors such as poverty, inequality, unemployment and poor quality of life are resulting in increased service delivery protests - often linked to limited access to water, homes and electricity.[76] In fact, according to the Water Research Commission, water scarcity may already be driving service delivery protests in South Africa,[77] and the Minister of Water Affairs has acknowledged that there is a "growing and disturbing trend of service delivery protests and water tends to be a common denominator for most of these".[78]

In the words of a member of the Muyexe village in Limpopo: "How can a person survive without water? It is an essential source of life. Even if people want to develop their land, due to water scarcity it cannot happen…"[79] However, inequitable access to water is a daily reality for millions of South Africans - for the residents of Pelhindaba, there are 10 communal taps to serve a population of more than 600 people, but only two of these taps were actually in working order in 2012.[80] It is therefore unsurprising that the government is blamed for failing to deliver services to communities around the country.[81]

A river basin divided

The Steelpoort River Basin flows into the Olifants River. In this basin, water users already perceive there to be a number of problems related to the quality and quantity of water, which can lead to tension and conflict. The people living in the river basin also lack the information related to the water consumption of other water users, which reduces transparency and accountability, and can easily lead to increased tensions during periods of scarcity. In this region, farmers and communities already come into conflict with mines due to over-use and pollution of the water resources. If there are water-related conflicts, the users go to court (if they are able to afford this), but this obviously puts marginalised communities at a disadvantage.

At the moment, the Department of Water Affairs authorises the trade of water rights from farms to mines in the area on a small-scale basis. However, the government will soon need to make decisions about whether mines should be given priority access to water, or whether some farming activities must be retained. In a province that is rapidly becoming industrialised, this is going to prove to be a very difficult political choice,[82] with potentially significant impacts on people's livelihoods and food security. And this type of choice is echoed across the country.

South Africa has already allocated approximately 98% of the national water resource.[83] [84] This is an enormously high allocation figure, which means that the country has no remaining buffer or dilution capacity for times of drought, or future economic growth,[85] or even to deal with future water conflicts. The decision to invest in new coal-fired power stations

iii Village, local municipality, district municipality and nationally.

instead of relatively 'water-free' technologies such as wind and solar photovoltaics (PV) has substantial implications for South Africa's water security, and threatens the availability and quality of the scarce resource. This decision is clearly not in the public interest. As the country's only 'strategic water user', the Department of Water Affairs guarantees Eskom's water supply, come 'hell or high water'[86] - potentially at the expense of other users in times of drought. But there is a lack of transparency around how this allocation of water is made, what the costs are of prioritising Eskom's water-intensive coal-fired power stations, and why Eskom is not being pressured to shift towards renewable energy.

1.3. Climate Change

Global climate change has very specific implications for South Africa, and is likely to reduce Southern Africa's water resources even further.[87] [88] The government's Water for Growth and Development Framework accepts that climate change is a threat to the sustainability of water supplies, and that it has the potential to significantly affect the availability of water in South Africa.[89] Climate change is predicted to result in more extreme and variable weather events (droughts and floods) in many parts of the country, which will significantly impact on river flows and water availability.[90] [91] The region is likely to experience substantial reductions in maize production and it is estimated that by 2020, yields from rain-fed agriculture in the region could fall by up to 50%.[92] It is also likely that temperature impacts will increase crop water requirements.[93]

1.4. Making the coal-water connection

South Africa is a significant producer, user and exporter of coal, and the country's economy is hugely dependent on coal.[94] An estimated 93% of the country's electricity comes from coal,[95] and the carbon-intensive nature of Eskom's electricity production is reflected by the fact that in 2011, Eskom contributed 62.3% of South Africa's total emissions.[96] In fact, Eskom emitted more carbon dioxide (CO_2) in 2011[97] than Sweden, Norway, Finland, Switzerland and Denmark[iv] combined.[98]

Eskom claims that building new coal-fired power stations is necessary to meet 'rising electricity demand in South Africa'.[99] In reality, investments in coal have failed to deliver a secure supply of electricity to more than 12 million South Africans,[100] and it is estimated that the electrification of the country's low-income households would actually "only increase electricity consumption by 0.11% in 2020".[101] This means that Medupi and Kusile are not being built to achieve electricity access for the poor,[v] they are being built to meet the demands of energy-intensive industry. Clearly, achieving universal electricity access for all South Africans "does not justify the building of large coal-fired power stations".[102]

It is undeniable that significant contributions are made to the South African economy through the mining and primary minerals industries. However, the development pathway South Africa has chosen does not come without a price: the country is a significant emitter of greenhouse gases, it has an energy intensity that is significantly higher than average,[103] and Eskom uses slightly more than a staggering 10 000 litres of water per second.[104] In addition, while the South African government might argue that the country is still developing and needs to cultivate rapid economic growth to create employment and overcome poverty, the reality that the country's carbon emissions per capita are way above the global average, and will need to fall significantly, still needs to be confronted.[105]

Building new coal-fired power plants will increase the country's emissions, accelerate climate change and worsen already existing water insecurity. This in itself will create fundamental future development constraints, with impacts on food security, industrial development, water access and water rights. Clearly, the deeper causes of water scarcity and the electricity crisis need to be addressed. However, the connection that reducing the country's coal addiction may actually help to cultivate economic growth and create sustainable jobs through renewable energy is not yet being made.[106]

At the moment, there are 13 operational coal-fired power stations in the country,[107] and these stations use conventional pulverised coal technology. The quality of coal used is poor, with a high ash content,[108] and low calorific values, which translates into high levels of pollution.[109] Three retired coal-fired power stations have been brought back online (Camden, Grootvlei and Komati) to help meet rising demand. In addition, Eskom is currently constructing two new coal fired power stations: the 4 764MW Medupi plant in the Waterberg (to be supplied with coal by Exxaro), and the 4 800MW Kusile plant in Witbank (to be supplied mainly by Anglo Coal's New Largo colliery).[110]

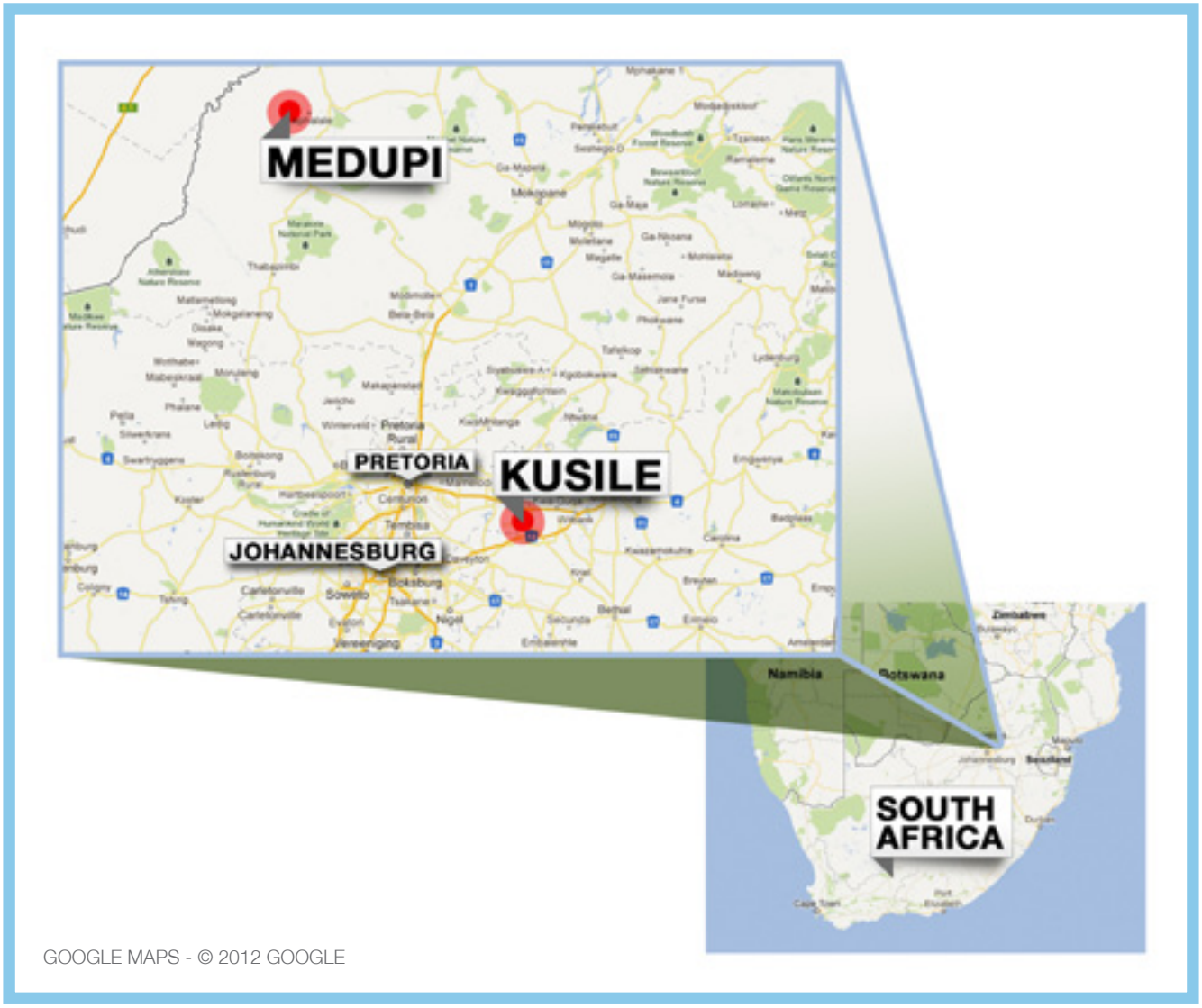
These new power stations, which will use supercritical technology, will be the third and fourth largest coal-fired power stations in the world,[111] and Kusile will require a massive 17 million tons of coal per year.[112] Medupi, situated in the remote Waterberg coalfields, will not initially use Flue Gas Desulphurisation (FGD) technology to reduce sulphur emissions.[113] In theory this means that Medupi will be retrofitted with the technology. However, whether this in fact materialises is another question - retrofitting rarely works in practice as it is often difficult to implement and enforce retroactively, and usually has major cost implications.[114]

On the other hand, Kusile, located in Mpumalanga, will use FGD technology as soon as it is fully operational. Both power stations will be 'carbon capture ready', which means that they could potentially be retrofitted with Carbon Capture and Storage (CCS) technology at a later stage.[115] But the

iv Eskom emitted a total of 230Mt of carbon dioxide (CO_2) in 2011. CO_2 emissions in Mt of CO_2 by Denmark (46.78), Finland (55.01), Norway (37.31), Switzerland (42.42) and Sweden (41.71) come to a total of 223.23Mt of CO_2.

v In fact, the "projected demand from all poor households in 2020 is expected to account for just 4% of the total electricity from the Medupi power station". (Tait and Winkler. 2012).

Map: the location of the Medupi and Kusile coal power plants currently under construction in South Africa.



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reality is that CCS technology is largely unproven, it would use substantially more precious resources such as fresh water,[116] would be hugely energy intensive and expensive, and would not be ready in time to save the climate.[117]

South Africa is a water scarce country, but every step in the chain of using coal to produce electricity pollutes and consumes vast amounts of water.[118] [119] Together with coal mining, burning coal for electricity generation has a number of serious implications for both water quantity and quality,[120] and it is undeniable that coal-fired electricity generation is highly water intensive compared to renewable energy technologies such as wind and solar PV.[121] South Africa is powered almost completely by coal-fired electricity and according to current plans, the majority of the country's electricity will be generated from coal-fired power for the foreseeable future, despite incremental increases in renewable energy.[122] In fact, the Minister of Public Enterprises has publicly stated that South Africa might actually be looking to increase its coal expansion beyond Kusile by investing in a 'Coal 3' power station.[123]

The limits to coal expansion are very real. Further large-scale development of South Africa's coalfields is incredibly risky, particularly in the central basin, and could result in permanent and expensive environmental damage. Indeed, unlimited coal expansion could put the quality of scarce and essential water resources in this productive economic region at risk.[124] In the Waterberg area - where Medupi is under construction, and possibly where a third mega-coal fired power station may be built - there is an already severe shortage of water.[125]

Therefore, the increasing number of new mega coal-fired power stations will deal South Africa a triple blow: a significantly larger contribution to climate change, greater pressure on already-stressed water resources[126] and increased health risks due to coal expansion.[127] And if climate change continues as projected, coal-fired power stations in drought-prone regions will increasingly become even more of an unacceptable liability, locking the country into a dirty future that we can ill afford.

This means that the continued investment in new coal-fired power stations fails to take into account the severity of the water crisis facing South Africa or the size of coal's water footprint, while also totally disregarding the impacts on people's health. Instead, the investments in Medupi and Kusile are creating a situation where, in addition to significant greenhouse gas emissions, their water requirements will weigh even more heavily on already stressed water resources. This will lead to increased levels of competition for scarce water with other key sectors such as industry, agriculture and domestic use.[128] And while the government plans increased contributions from renewable energy,[129] this increase is not ambitious enough to tackle the impending twin crises of water scarcity and unaffordable, inaccessible electricity.

1.5. Water: the foundation of life

The Department of Water Affairs allocates significant amounts of water to the highly polluting electricity sector.[130] Somehow, the linkages between how the intensive water-use for coal-fired electricity exacerbates water scarcity and water poverty, while also contributing to catastrophic climate change (which in turn will increase water insecurity), are not being made. Electricity is viewed as a "high-value economic use of water", which means that the allocation of water to Eskom's power stations is considered to be of strategic importance, and is prioritised.

In light of growing water scarcity, the Department of Water Affairs has recommended dry-cooling technology at new coal-fired power stations 'where feasible'.[131] Unfortunately, this is an efficiency solution, which alone is ultimately short-sighted and useless; given the vital role water already plays both during coal mining and coal-fired electricity generation. The Department has fallen far short of demanding a transition to relatively 'water free' renewable energy technologies, which would be a much more valuable long-term solution, with a much larger impact on preventing water insecurity in South Africa.[132] If the Department were serious about ensuring water availability through water conservation and demand management,[133] there is no better way to manage the demand of the electricity sector than through a transition away from coal and towards renewable energy.

The National Water Resource Strategy creates the implementation framework for the National Water Act (Act no. 36 of 1998) and Eskom is the only recognised strategic water user of national importance in this strategy.[134] This means that water transfers to supply Eskom are supported by the Department of Water Affairs, and there is a commitment to create a secure supply for the electricity sector. In theory, higher water use priorities are accorded to the water reserve, international agreements and obligations and the water requirements for social needs,[135] but there are clear trade-offs through prioritising water supply to Eskom. The utility requires substantial amounts of high quality water at the highest levels of assurance for its coal fired power stations: to provide steam for the turbines, to cool and clean machinery and to scrub pollutants. During 2011, the utility used a staggering 327 billion litres of fresh water.[136] However, the water use of the coal mining sector that serves Eskom is not included in this calculation. The coal mining sector is not specifically included as a water user of strategic importance in the National Water Resource Strategy[137] either. But Eskom relies entirely on the coal mines to supply their power stations, which indirectly includes the mines as strategic (and therefore prioritised) water users.[138]


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1.6. Coal versus water as a strategic resource

Effective alternatives to coal-fired electricity exist, but there are simply no alternatives for water.[139] Efforts to declare coal a 'strategic resource',[140] and thus further protect and expand coal in South Africa are counter-intuitive, implying that coal will remain at the centre of the country's economy for the foreseeable future, despite the fact that the country's coal reserves may well have been overestimated: South Africa may well have less coal than was once thought.[141] Betting on coal is also in contradiction to the country's move towards a 'low-carbon economy'.[142]

Deciding which resources should be declared 'strategic' is an enormous decision, that has many economy-wide, socio-political implications. One of the problems with declaring coal a strategic resource is that water and coal cannot be strategic resources at the same time. The coal mining and electricity industry contribute substantially to water pollution and scarcity, jeopardising the country's ability to deal with an impending water crisis.

Thus, the current allocation of water to these two sectors is simply not sustainable - neither in the short nor long term. Building new mega coal-fired power stations such as Medupi and Kusile, and increasing coal mining to supply them, is likely to send this country into a water deficit;[143] given that South Africa's water resources have already essentially been allocated to the maximum.[144] Labelling coal 'a strategic resource' puts the country's water resources in severe danger, and locks this country into a dirty and risky future.

The allocation of South Africa's key resources of water and coal are political decisions that will significantly determine the country's future pathway. As outlined above and acknowledged by the Department of Water Affairs and the National Planning Commission, water scarcity could well become a future fundamental development constraint. If new coal-fired power stations are built, this will reduce the availability and quality of South Africa's water, create stranded assets in the form of coal-fired power stations with limited or no water availability, while also accelerating climate change, which in turn will reduce water availability. This feedback loop has the potential to undermine electricity generation and nullify attempts to increase access to electricity.

On the other hand, South Africa has some of the best renewable resources in the world, and renewable energy technologies are able to deliver sustainable electricity, while at the same time substantially reducing the stress on South Africa's water resources.[145] Decades of investment and technological progress means that renewable energy technologies such as wind, solar photovoltaic and solar thermal collectors are becoming steadily more mainstream.[146] In fact, between 2005 and 2010 the global installed capacity of wind grew by 333%,[147] and solar photovoltaics grew by more than 700%.[148]

The question remains: why are Eskom and the government not scaling up their ambition to tackle the twin crises of water scarcity and climate change?

2. The thirsty, polluting coal process

Every step in the coal chain requires direct use of water: the extraction and preparation of coal from mines, its incineration at a coal-fired power station, the measures taken to control dust and pollution at both mines and power stations, and the disposal of the coal combustion by-products.[149] This section will briefly outline the various stages of water use in the process of extracting coal and burning it to produce electricity.

2.1. The water impacts of coal production

Water depletion and pollution

Coal mining has unavoidable impacts on local water resources, both in terms of water consumption and pollution. For both underground and surface mining, groundwater is pumped out to dry the area being mined. As a result: flows of groundwater and streams are affected, water tables are lowered, ecosystems are damaged and entire regions are put at risk. In some cases, water bodies have just disappeared.[150]

Leachate from discard dumps, subsidence and discharges of dirty mine water or Acid Mine Drainage from mining all have a direct impact on water quality.[151] Mining operations need vast volumes of water for the following processes:

Dust control measures

Large amounts of dust are created as coal is hauled along roads, and also results from stockpiles of coal and soil - dust from surface mining is much more of a significant problem than in the underground mining process. This means that substantial amounts of water must be used for both dust suppression and road wetting at the mines.[152] [153]

Coal washing

Before coal can be burnt at a coal-fired power station, it needs to be processed and cleaned. This means that the coal actually has to be washed, usually at the mines themselves.[154] This water-intensive process separates impurities from the coal through a flotation process. Due to their greater density, the impurities sink to the bottom while the coal floats freely.[155] The use of groundwater during the coal washing process leads to the further depletion of this resource.[156] Washing coal creates substantial amounts of contaminated 'sludge',[vi] [157] which must be disposed of in slurry dams, [vii] and can pollute freshwater supplies if stored incorrectly.[158]

Dirty water

Any water that comes into contact with disturbed areas on the mine is known as 'dirty water' and is either used by the beneficiation plant,[viii] used for dust control measures, pumped into slurry dams, or released into river systems. For all of these options, evaporation of water also occurs. Some mines re-use and recycle some of their water, which

vi A mixture of fine coal and water.

vii Slurry dams contain coal-combustion by-products.

viii Beneficiation is a mechanical process to improve the quality of coal prior to use.

means that different mines will have different water use figures, depending on the procedures used and the amount of water that is recycled.[159]

2.2. The water impacts of coal combustion at coal-fired power stations

Coal-fired power stations burn coal to produce either hot air or steam to turn the turbines so that they are able to generate electricity. Three fifths of the heat released from coal combustion are lost as waste heat. Removal of this waste heat through cooling consumes enormous quantities of water.[160]

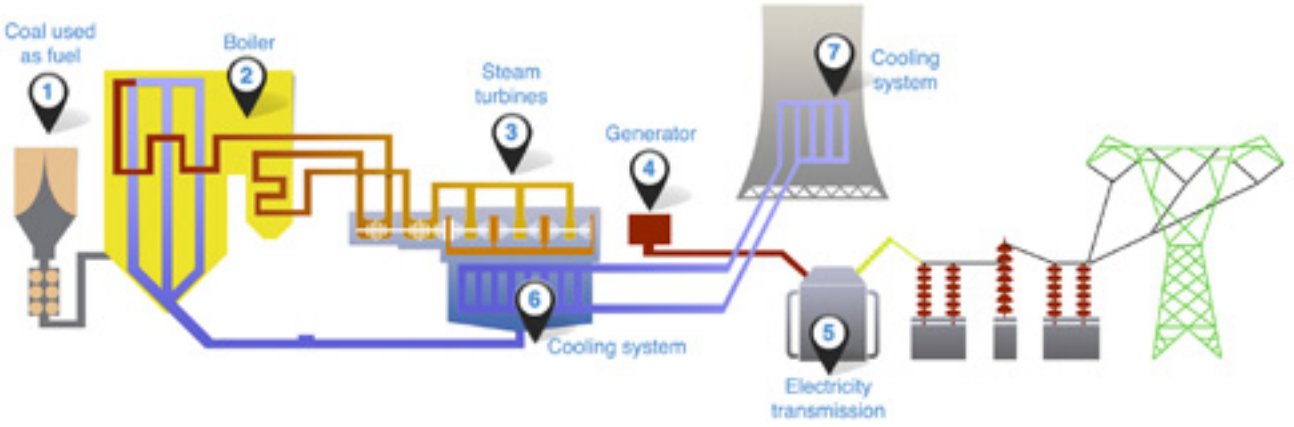
Water is used in the following processes in coal-fired power stations: water purification, the steam cycle in generating electricity, cooling, sluicing of ash, ash handling and disposal, drainage, sewage treatment and mine water recovery.[161] Water is also used in certain air pollution control measures (such as FGD), and is discharged into ash slurry dams, which contain coal ash.[162]

However, the majority of water is used in just two processes: the internal steam cycle and the cooling process.

The internal steam cycle

Figure 1 illustrates how water is used during the combustion of coal to produce electricity. The process occurs as follows: "demineralised water is piped above a boiler (2) where the coal is burnt, and the heat turns the water to steam. The steam then turns a turbine (3) to generate electricity (4). As the steam passes through the turbine it is fed into a condenser (6), which transforms the steam back into water".[163]

Figure 1: Water use during the coal combustion process at a power station



The cooling process

All coal-fired power stations need a cooling process for power generation machinery as components can be damaged by extreme heat.[164] Water is used to condense and cool steam[165] - the cooling is necessary to condense the steam after it has passed through the turbine, and to eject the excess heat into the environment. Cooling can be achieved using water, air or a combination of the two.[166] So-called 'direct dry cooling' technology keeps the cooling water in a separate closed circuit, which means that cooling happens through heat transfer rather than evaporation.[167] Ironically, dry cooling does reduce water use, but is a less energy-efficient solution, and is also more expensive. Four coal-fired power stations currently use dry-cooling technology in South Africa[168] and both Medupi and Kusile will use this technology.[169]

Air pollution control measures

Because burning coal to produce electricity is one of the most polluting practices on the planet, pollution control measures are required. Substantial amounts of water are needed for these processes: to handle and control the ash (a by-product of combustion), scrub out the sulphur released in the flue gas, and also for CCS - should this technology ever become available.

2.3. Water contamination by Acid Mine Drainage

The issue of Acid Mine Drainage (AMD) is particularly alarming in South Africa's semi-arid environment.[170] The contamination of this country's water through AMD is possibly one of the most serious and complex immediate water quality/mining related problems.[171] [172] [173] In fact, the government's Water for Growth and Development Framework identifies Acid Mine Drainage as an immediate crisis, which is a serious threat to water quality, and an obstacle to securing sufficient water for growth and development.[174] Indeed, Acid Mine Drainage presents a serious threat to both groundwater and surface water resources in the Witwatersrand. If this threat is not properly managed, it is estimated that per day, nearly 200 million litres of AMD may pollute the area's water resources, placing severe risks on the security of the water supply from the Vaal River System.[175]

Coal, copper and gold mining are all linked to the formation of Acid Mine Drainage.[176] This report focuses primarily on the contribution of coal mining, which can have substantial water impacts depending on whether the mines are working or abandoned, which mining methods are being used and the geological conditions.[177] Acid Mine Drainage can originate from both operating and abandoned mine pits, but the AMD outflow into surface and groundwater resources can continue for decades after a mine has been abandoned.

According to the Department of Mineral Resources, there are 1647 active mines in 2012, with 119 operational coal mines.[178] However, in 2008, a total of 5 906 mines (across all mining sectors) were considered abandoned, becoming the full responsibility of the government.[179] The government continues to be publicly criticised for not adequately tackling the issue of mine rehabilitation.[180] Nonetheless, Mineral Resources Minister Susan Shabangu has stated that no mine rehabilitation had been carried out from 2010 to 2012, and that, shockingly, none was planned.[181] These abandoned mines pose a major and specific threat to water quality. They are creating a marked deterioration of groundwater quality as the workings become flooded and start to decant, producing highly contaminated AMD outflow with unacceptably high levels of heavy metals.[182] [183] And the lack of urgent action to clean up these mines may well be "leading to an ecological and environmental disaster".[184]

How Acid Mine Drainage is formed

Acid Mine Drainage creates three interrelated problems: it creates water with a low pH, this acid water mobilises heavy metals from the environment, and treating the contaminated water with calcium to raise the pH creates saline water, which needs to be treated through reverse osmosis or other comparable processes.[185]

It is very difficult to avoid the contamination of water through Acid Mine Drainage during the mining process.[186] AMD is produced when sulphide bearing rocks are exposed to oxygen.[187] The mining process itself breaks up the rock mass, bringing the iron-sulphide bearing rock into contact with water and oxygen. When these iron and sulphide-rich minerals come into contact with oxygen and water they oxidise through a number of possible chemical pathways to form sulphates, and thereby forms sulphuric acid as well as iron oxides.[188] [189]

The acidic water is then able to dissolve other minerals in the rock, releasing aluminium and other toxic metals.[190] Both the presence of elevated concentrations of these metals and the high acidity (low pH) of the drainage water itself, have negative consequences for aquatic ecosystems and "decreases the fitness of local water resources for use by other users".[191] The drainage water can also seep into groundwater resources, as well as into streams and rivers a significant distance downstream from the source, with the potential to acidify and contaminate soil, sediments and water resources.[192] In addition, depending on the nature of the mining activity and of the catchment, subsequent precipitation of iron-rich deposits (oxides and hydroxides), and of suspended sediments carried by the drainage waters, can lead to siltation[193] and physical impacts on aquatic species.[194]

Within the context of natural weathering conditions, similar processes are produced, but at much slower rates, and the acid that is produced is easily neutralised by the alkaline materials found in the rock. Mining fast-tracks this process by comprehensively fragmenting the rock, quickly increasing the overall surface area for oxidation and acid dissolution processes.[195] During opencast mining the rock mass is deeply fragmented, which then maximises the contact between water and rock. As a result, this type of mining can be one of the most acid producing mining methods in areas in which the geology is rich in sulphides, though drainage from sub-surface mines can also be highly significant and long-term.[196] This acidic water then seeps into groundwater resources, and ultimately into streams and rivers acidifying both soil and water resources.[197]

The impacts of Acid Mine Drainage

The impacts of AMD can be severe and long-lasting, requiring substantial (and expensive) interventions to reduce the impacts. It is clear that the contamination of major river systems (such as the Vaal) by AMD threatens South Africa's water security. A number of studies have predicted that AMD may entirely decant into the central basin within the next few years, presenting a potential environmental catastrophe, but also seriously threatening the Johannesburg City Centre.[198] However, finding the correct solution is also not easy - the treatment methods currently applied to Acid Mine Drainage are also likely to create a considerable amount of waste, which will need to be minimised and managed.[199]

At risk: The Olifants River

The Olifants River supplies both Eskom and the Kruger National Park with water.[200] However, the catchment area has experienced more than 100 years of coal mining, and is now an area that is seriously degraded, with polluted, low quality water.[201] [202] Despite this, the water supply is seen to be essential for the continued operation of many coal-fired power stations and their satellite collieries. This river system is showing signs of serious water pollution, soil erosion and reduced agricultural production, and similar symptoms are starting to appear in the Vaal River Catchment.[203] Indeed, the ever-growing contaminant-loading of the Vaal River system has now reached the point where urgent steps must be taken to limit and remove the sources of contamination.[204] The extensive pollution of surface and groundwater also leads to escalating competition between key sectors for this scarce resource.[205]

Ironically, in the Olifants catchment, coal mining has polluted streams and rivers so significantly that it cannot be used in Eskom's coal-fired power stations. This means that Eskom's water must either be treated, which costs more money and uses more energy, or the water must be supplied from a different river system that has not been contaminated by mining.[206] The issue of water supply is complicated even further by the very real possibility that global climate change is likely to have an adverse effect on water availability throughout Southern Africa, in addition to the water quality concerns from pollution.[207]

Liability

Acid Mine Drainage is a long-term problem - the contaminated water may well seep into this country's water table for centuries.[208] The issue of who is to blame for this crisis, and also of who will bear the costs of fixing the problem is a contested one. In the end, whatever solution is sought for AMD, it is likely to cost South African taxpayers billions of Rand - particularly given the high number of abandoned mines, which now fall under the State's duty of care. This means that despite the existence of laws placing the responsibility for mining impacts on mine owners themselves,[209] the mining companies that created this problem may not in fact be held liable.

Although the National Water Act (Act no. 36 of 1998) supports the 'polluter pays' principle, which means that mines creating, permitting or causing pollution should be held liable for the cost of cleaning up pollution (including Acid Mine Drainage), in reality enforcement of this principle remains problematic.[210] In addition, although a pre-feasibility study on dealing with AMD is under way, the apportionment of liabilities is confidential, and may never be released into the public domain.[211]

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3. Eskom's "efficiency" efforts

Dan Marokane, Eskom's chief commercial officer, has been quoted as stating that water is just as important to the economy as coal. According to him: "*Every drop of water that we can save counts and water is one area that is receiving high priority".*[212]

As a state-owned company, Eskom's performance is also measured by the overall value that it adds to the lives of the people of South Africa. According to Eskom, the utility takes environmental sustainability 'very seriously' and claims to be working to diversify its energy mix, reduce its environmental footprint and lower carbon emissions.[213] This is an interesting interpretation of the utility's core business, which accounts for more than 60% of South Africa's emissions,[214] and has prioritised coal to the exclusion of all other options, creating huge water costs that the people of this country have to bear.

Despite their seemingly convincing public statements, to date Eskom's response to concerns about its water use has been limited to highlighting efficiency gains by the newest coal-fired power stations (both Medupi and Kusile will be supercritical stations and they will use dry-cooling technology), and depending on inter-basin water transfer schemes for the water supply of these stations.[215] The two coal-fired power stations will be two of the largest coal-fired power stations in the world.[216] Yet Eskom argues that although Kusile and Medupi will increase the utility's total carbon footprint, the technology and design of the power stations is more efficient compared to existing coal-fired power stations, resulting "in a reduction in water usage and carbon dioxide emitted per unit of electricity generated".[217] While the design of the new coal-fired power stations will be more efficient (reducing water usage and carbon dioxide emitted per unit of electricity produced),[218] in reality these power stations will substantially increase the utility's total carbon footprint. And it is estimated that Kusile will consume a massive 26.15 million m^3 of water per year that it operates.[219]

The utility has clearly stated that it is working to minimise its water use, through using dry cooling technology in new coal-fired power stations, and reusing water in older plants.[220] But there are severe limitations to efficiency gains, and reductions in emissions and water use *per unit of electricity* are essentially meaningless when by the utility's own admission, its absolute CO_2 footprint will continue to grow.[221] In addition, Eskom's water-use for its coal-fired power stations will push this country closer to a water crisis. In light of global water scarcity and catastrophic climate change, incremental improvements in the technology used to burn coal to create electricity are simply not good enough, and are certainly not an attempt to save every drop of water possible. In reality, Eskom has failed to recognise that the way it currently generates, transmits and distributes electricity is flawed and unsustainable, with substantial, unavoidable and long-lasting impacts.

3.1. Eskom's thirst for water: incremental efficiency and pollution reduction measures

Eskom's power stations are dependent on a steady, adequate supply of high-quality water,[222] and the utility claims to recognise that competing resource needs, drought, pollution and poor water supply infrastructure all have the potential to hamper its access to affordable water.[223] However, despite these limitations, the utility shows no signs of shifting away from water-intensive coal-fired electricity generation.

There are a number of issues that contribute to higher than necessary water usage at Eskom's coal-fired power stations: the age and thermal efficiency levels of existing stations - which means that the older and less thermally efficient current stations are, the higher the water demands will be; declining coal quality - which means that more coal must be burnt to produce the same amount of electricity; and declining raw water quality supplied to stations - which means that more clean water is needed for dilution.[224] [225] [226]

Burning coal to produce electricity is one of the most destructive practices on the planet, and both Medupi and Kusile will produce significant pollutants and greenhouse gas emissions. Kusile will increase South Africa's contribution to climate change by nearly 10%,[227] but it is also likely to have significant health impacts. Coal-fired power stations are a significant contributor to atmospheric pollution levels in South Africa[228] because even when using pollution-reduction technologies, burning coal to generate electricity produces substantial pollution by-products.[ix] [229] These pollutants have been linked to bronchitis, lung cancer, asthma, leukaemia and pulmonary disease,[230] which means that coal-fired electricity and coal expansion has significant impacts on people's health - both for the people who work in coal mines/coal-fired power stations, but also for the surrounding communities. As a result, Eskom is required to

ix These include carbon dioxide, methane, carbon monoxide, oxides of nitrogen, sulphur dioxide, mercury, total mass of suspended particulate matter, and a range of carcinogenic radionuclides and heavy metals (Riekert, J. 2011).

make an effort to reduce the atmospheric emissions from new coal-fired power stations by using the latest technology to reduce emissions at both Medupi and Kusile. However, in an ironic twist of fate, in order to reduce atmospheric emissions from burning coal, Eskom will require more water. This is true for Flue Gas Desulphurisation (FGD), and also for Carbon Capture and Storage (CCS).

Carbon Capture and Storage (CCS)

CCS aims to reduce the impact of burning fossil fuels by capturing carbon dioxide (CO_2) and storing it underground. Both Medupi and Kusile will be 'carbon capture ready,'[x] which means that they will be able to install carbon capture equipment should the technology ever be ready or affordable in the future. Its future development has been widely promoted by the coal industry as a justification for the construction of new coal-fired power stations, arguing that it will magically remove the constraints around coal.[231] However, there are serious limitations to CCS:

- CCS technology is still under development and there is substantial doubt that CCS will ever be able to deliver.[232]
- If the technology ever works, it would not deliver in time to avert catastrophic climate change. It is estimated that the earliest possibility for deployment of CCS at utility scale would not be before 2030, which means that even if CCS were to work, it would deliver far too late to avoid dangerous climate change.[233]
- CCS is unaffordable in South Africa, and could lead to a doubling of plant costs and cause electricity price increases of between 21% and 91%.[234]
- Storing carbon underground is risky. The safe and permanent storage of CO_2 cannot be guaranteed.[235]
- CCS wastes energy. Ironically, in the unlikely event that CCS technology were to work, it would mean major reductions in plant efficiency, and could use a massive 10% to 40% of the energy produced by a power station, effectively reducing electricity output from coal-fired power stations such as Kusile by more than a third.[236]
- CCS carries significant liability risks if something were to go wrong.[237] It poses a threat to health, ecosystems and the climate. In fact, the industry itself does not completely trust the technology either, given its unwillingness "to fully invest in CCS without a framework that protects it from long-term liability".[238]

But the use of CCS also has massive implications for South Africa's water resources. It is estimated that coal-fired power stations using CCS technology will need a staggering 90% more water than those without, as many of the capture processes need wet cooling. This is likely to worsen water shortages, already exacerbated by climate change.[239] In addition, as long as CO_2 is stored underground, there is a risk of leakage, which means that any CO_2 release could impact on the surrounding groundwater, air or soil, with catastrophic implications. It is entirely possible that brine contaminated by the CO_2 could leak into the aquifers that supply drinking and irrigation water.[240]

Concerns about the costs, feasibility, safety, liability, inefficiencies and water implications of CCS make it a dangerous gamble, which South Africans simply cannot afford.[241]

Flue Gas Desulphurisation (FGD)

The significant amount of sulphur dioxide (SO_2) produced by the combustion of coal can be partially scrubbed out of the exhaust flue gases by various Flue Gas Desulphurisation technologies.[242] [243] Eskom's existing coal-fired power stations do not yet use advanced technology to reduce emissions.[244]

However, Kusile will have a Flue Gas Desulphurisation plant (only once it is fully operational), and Eskom plans to retrofit Medupi with this technology.[245] A number of FGD technologies exist, all of which are associated with substantial capital and operating costs. The most common technology for reducing sulphur dioxide emissions is by scrubbing the exhaust flue gas with water containing an alkaline substance such as limestone.[246]

Eskom estimates that FGD will remove an estimated 90% of sulphur emissions.[247] However, Flue Gas Desulphurisation requires water, irrespective of the technology type that is chosen, to the extent that the water requirements of a wet FGD system would significantly increase the water use of dry cooled power stations such as Medupi and Kusile.[248]

In addition, the use of FGD will generate substantial volumes of effluent from the dewatering and gypsum washing process. This wastewater will have a high nitrate, heavy metal and chloride content and will need to be disposed of.[249]

x The International Energy Agency (IEA) defines a 'capture-ready plant' as one "which can be retrofitted with CO_2 capture when the necessary regulatory or economic drivers are in place" (International Energy Agency (IEA) Greenhouse Gas R&D Programme. 2007. CO_2 capture ready plants).

4. Who really controls the water?

The overall impacts of water use during electricity production are currently underestimated, and nearly 2% of South Africa's water is allocated to a single entity: Eskom.[250] These two issues raise major concerns around transparency and accountability in terms of water allocation and management in South Africa.

4.1. Water and the electricity sector

Eskom itself admits that in the process of generating electricity, the utility is a significant user of the country's fresh water,[251] using a staggering 10 000 litres of water per second.[252] The electricity sector, dominated by Eskom, is frequently said to consume 'only' 2% of South Africa's water,'[253] which translates to 1.76% of national water supply going to coal-fired electricity generation,[254] compared to the 3% that goes to the industrial sector.[255] While it is worrying that almost 2% of South Africa's water is going to a single entity, this statistic is also misleading, because it clearly does not take into account the water used during coal extraction, processing, pollution reduction processes, and the disposal of contaminated by-products. Wassung[256] therefore estimates that the full coal power generation process actually requires approximately 4.84% of national water supply - more than double the original statistic.

Whatever the percentage of South Africa's water that the utility uses, the requirements of coal-fired power stations can be substantial in relation to the local water resources and catchments, because the majority of South Africa's coal and coal-fired power stations occur in the drier parts of the country.[257] The fact that national water planning does not operate with statistics that feature the full cycle of water needed for the production of coal-fired electricity raises serious concerns. And if the country has already allocated water resources to the maximum, and is facing a potential deficit in the near future, this legitimately raises the question: how are Eskom's increased water needs for Kusile and Medupi being factored into water resource allocations? And if the Department of Water Affairs truly believes that water "demand must be managed and water used as efficiently as possible,"[258] why is Eskom not being pushed to invest in much more water efficient renewable energy technologies instead of coal?

4.2. Transparency and water licences: the litmus test for democracy?

The water problems associated with coal do not end at the water required to operate Eskom's coal-fired power stations, or the additional technology required to reduce emissions, or even the water depletion and pollution from coal mining.

Of the 22 mines that supply Eskom with coal, half were operating without a valid water licence in 2010.[xi] [259] In an example of severe contravention of existing legislation, the Arnot colliery in Mpumalanga had not even attempted to apply for a licence in 2010, yet it was allowed to continue operations.[260] The current state of valid licences remains

[xi] The licences were either still being processed by the Department of Water Affairs, outstanding information had to be submitted or there simply had been no application for a water licence at all.

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unclear due to issues around transparency and the kind of information that is allowed into the public domain. Eskom claims to be working closely with the Department to address the backlog of water-use licence applications for its power stations and coal suppliers.[261] But in essence, the utility has failed to ensure that all of the mines that supply it with coal have valid water licences.

Clearly, the lack of valid water licences and effective water management and licensing processes create severe limitations to the accountability of users, and threatens the protection of South Africa's scarce water resources.[262] There is a serious lack of transparency regarding water management plans and water licences in South Africa, with most of this information remaining confidential, with access restricted. How disclosure of this information could result in negative consequences for mining companies or Eskom, and the reasons for this lack of transparency around water use and water-related practices remain unclear. Instead, greater transparency supported by the enforcement of appropriate legislation by key government departments such as the Department of Water Affairs would encourage more effective and efficient water use, while also reducing operating costs. Confidentiality in the water sector disempowers the public, effectively removing our ability to hold industry accountable for its water use, particularly given that no part of South Africa's water resources are regarded as 'private property'.[263]

Furthermore, it seems impossible for transparent and effective planning and allocation of water resources to take place if water use is not fully accounted for, given that a substantial number of users seem to operate without valid water licences, and that the full amount of water needed during electricity generation is not completely factored in. Eskom's lack of transparency and accountability in its water use is potentially accelerating an impending water crisis, leaving ordinary South Africans to pay the price. This also raises the question as to whether South Africa's water resources have not only been allocated to the maximum, but may have already exceeded the maximum.

Despite water being classified as a common good by the National Water Act (Act no. 36 of 1998),[264] a great deal of information related to water use and allocation is classified as confidential, which makes it impossible to assess whether water resources may already have been over-allocated. The question remains: who actually controls the use and allocation of water in South Africa? Water insecurity is already a present reality and not a fiction of the future.

4.3. Extreme water supply options: water transfer schemes and desalination

Water transfer schemes

Neither Medupi nor Kusile will obtain the water that they need to operate from local sources, because the rivers are either too polluted from mining, or do not have enough capacity. Instead, expensive inter-basin water transfer schemes will be needed to supply the mega coal-fired power stations with the water that they need to operate.[265]

Water for Kusile will not be sourced from within the Olifants River catchment, but will be supplied from the Vaal River system instead, through the Vaal River Eastern Sub-system Augmentation Project (VRESAP).[266] The Vaal River system supplies water to approximately 60% of South Africa's economy and an estimated 45% of the country's population[267] (approximately 20 million people).[268] The VRESAP project is initiated by the Department of Water Affairs and is aimed at transferring approximately 160 million m^3 of water from the Vaal River Dam to meet the growing water requirements of Eskom and Sasol.[269]

The Department of Water Affairs has given its assurance that VRESAP would be able to supply all of Kusile's water requirements, despite the fact that the Vaal River is already showing signs of pollution.[270] Worryingly, this means that the impacts of VRESAP were not actually considered in the Kusile Environmental Impact Assessment (EIA) report, since the impacts associated with abstraction from the Vaal River system were considered as part of the VRESAP EIA.[271] This means that the EIAs for both Medupi and Kusile made assumptions that because Eskom is of strategic importance the water needed for the coal-fired power stations to operate would somehow be made available. However, this raises significant questions about whether the overall impacts of Kusile's water use are fully reflected in Kusile's EIA, or were fully considered before the coal-fired power station was given the go-ahead.

In reality, despite the fact that the Department claims that VRESAP would be able to supply all of Kusile's water requirements, Eskom claims that at their request "the Department of Water Affairs is investigating potential infrastructure bottlenecks in the Vaal River water supply system,"[272] indicating that Kusile's water supply is far from secured. The Vaal River also supplies Gauteng with its water, and this begs the question: will the Vaal River system be able to cope with additional pressure in the future? And if not, will Kusile obtain water at the expense of the people in Gauteng, as well as the farmers and local communities who depend on the river for their livelihoods - sparking possible water conflicts?

Desalination

Desalination refers to the treatment of saltwater or brackish groundwater to recover useable water (mainly for the agricultural and industrial sectors, although for use as drinking water has also been considered).[273] Desalination is often perceived to be a future source of fresh water, and the Department of Water Affairs believes that desalination will play an important role in the country's future water security.[274] However, there are serious limitations to desalination as the technology remains relatively expensive.[275]

There are various desalination techniques (including reverse osmosis, vapour compression and electrodialysis), but all of these techniques are highly energy-intensive.[276] And although desalination plants do exist, they have significantly higher costs than even effluent re-use does. According to the 2009 Water for Growth and Development Framework, the only intervention that would be more expensive than desalination is inter-basin transfers.[277]

Desalinated seawater may be a possible future solution for coastal cities if the technology becomes more cost-competitive, but it will not work for inland areas due to the prohibitive costs of transporting the desalinated water over long distances.[278] This means that desalination may alleviate some of the future strain on South Africa's water resources (for a price), but it is not a future solution to supplying new coal-fired power stations with water, as the country's coal resources occur inland.

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5. Greenwashing: Eskom's renewable energy efforts

Eskom states that it takes environmental sustainability, water use and climate change seriously and has a number of strategies and plans to back up this claim.[279] However, whether these strategies are a) accessible to the public, and b) able to significantly reduce Eskom's carbon/water footprint is another matter. Per unit of electricity produced, Kusile would use a massive 173 times more water than wind power would use, given that wind power uses virtually no water.[280] The utility continues to invest in incremental efficiency changes for its coal-fired power stations, instead of implementing a complete paradigm shift in electricity generation. Investing in renewable energy would significantly reduce emissions and water use and pollution - but Eskom shows no intention of shifting away from coal and towards renewable energy.

Eskom has installed solar panels at its Megawatt Park headquarters and also at the Kendal and Lethabo coal-fired power stations to supplement auxiliary power. This programme will likewise be rolled out across Eskom's fleet of coal-fired power stations.[281] Sadly, this appears to amount to little more than greenwashing, given that the utility is currently building Kusile and Medupi, which will result in nearly 10 000MW of new coal-fired electricity, compared with its minimal renewable energy plans - amounting to 100MW of wind, and 100MW of solar. The utility expects the construction of the 100MW Sere wind project in the Western Cape to begin during 2012,[282] but has no clear timelines or implementation plans for the 100MW solar plant. The 100MW of wind and 100MW of solar were actually incorporated as compulsory components of the utility's controversial World Bank loan for Medupi.[283] This begs the question: is Eskom interested in investing in renewable energy at all, or has the utility been pushed to invest in this minimal amount, which is a useful token decoration for its polluting coal-fired power stations?

Clearly, if we are to take Eskom's stated positions on environmental sustainability, water and climate change seriously, then the utility would be investing substantially in renewable energy systems instead of investing in slightly more efficient coal-fired power stations, and renewable energy additions to existing coal-fired power stations.[284] [285] Anything less than a complete electricity generation paradigm shift away from coal and towards renewable energy technologies is simply Business As Usual, hidden behind empty rhetoric.

The 'solutions' Eskom proposes are not the answer at all. In effect, they amount to inadequate efficiency measures, augmenting water supply through inter-basin water transfers, and short-sighted technology adjustments. These are all expensive technology-fixes that are unable to fundamentally tackle the causes of climate change and water scarcity. Technological changes can be part of the solution, if changes are made to the way electricity is currently produced. However, superficial upgrades of outdated energy generation models and efficiency measures will not be enough. Clearly, more fundamental shifts are required.

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6. The solution to South Africa's water and electricity crisis: An Energy [R]evolution

Renewable energy is not a future technology. It is mature and can be deployed through both large-scale and decentralised projects. Eskom appears to be in denial. What would be a game-changer and radically reduce Eskom's demand for water, together with avoiding an electricity crisis, would be to substantially diversify the energy mix away from coal and towards renewable energy.[286] Indeed, solar PV and wind-power use virtually no water during operation.[287] Coal-fired power stations (even those using the most up-to-date technology) use significantly more water compared to the water needed for most renewable energy technologies.[288] Table 1 clearly shows the significant water savings of investing in renewable technologies instead of even the most efficient, technologically advanced coal-fired power station (Kusile).

Table 1: Comparison of water use of different technology types[289]

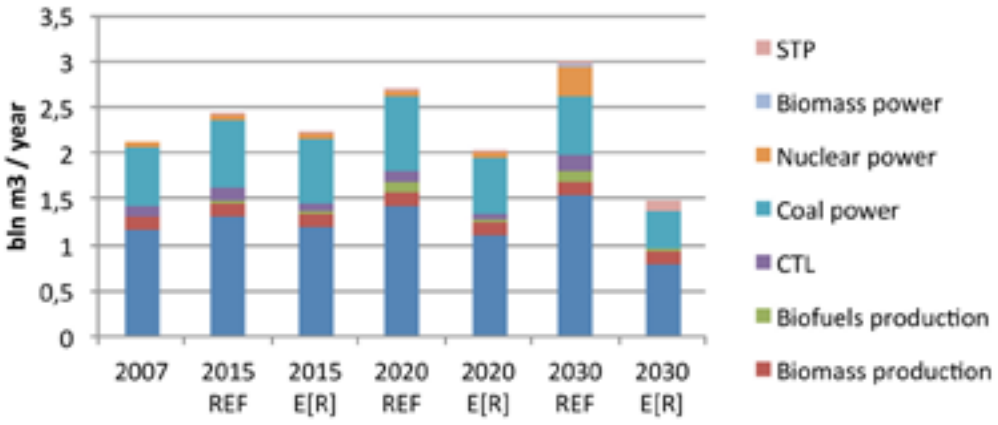
Technology type	Water use
Dry-cooling coal-fired power station (Kusile)	0.66 m^3/MWh
Concentrated solar power with parabolic trough (dry cooling)	0.296 m^3/MWh
Wind	0.0038 m^3/MWh

The vast majority of renewable forms of electricity generation use substantially lower amounts of water, and not considering these alternatives results in high opportunity costs. In fact, investing in another new coal-fired power station (Kusile) equates to a hidden cost of an estimated R42 billion per year that Kusile will operate - and this is only taking into account the water use of the power station.[290] At the high end, the estimated total social damage cost (or externality cost) of Kusile is economically very significant, and could amount to R60.6 billion a year that it operates.[291]

The real solution to South Africa's water and electricity crisis is not incremental improvements in coal technology, it is in fact an Energy [R]evolution: a shift away from coal and nuclear energy, and towards renewable energy and comprehensive energy efficiency measures. In this scenario, neither Kusile, nor the six new nuclear reactors proposed by the government need to be built to meet the growing demand for electricity. The Advanced Energy [R]evolution scenario demonstrates that transforming how we use energy is achievable, and provides a wealth of opportunities to stimulate economic growth, ensure affordable access to electricity for all, and create green, sustainable jobs. If this scenario were implemented with enough urgency and ambition, nearly 50% of South Africa's electricity could be supplied by renewable energy by 2050, and as renewable energy is scaled up, we can start phasing out coal.[292]

Rather than simply comparing the water footprint of renewable energy technologies to that of coal, Greenpeace has mapped the impacts of two different pathways, to assess which would be the better choice for the country, in the specific context of water use. The graph below compares water usage for two scenarios in 2030 (compared to a 2007 baseline): The Reference Scenario (modelled on the IRP2010 scenario) and Greenpeace's Advanced Energy [R]evolution scenario.[293]

Graph 1: Water use for energy in South Africa[i]



i The water footprint of thermal power generation and fuel production is estimated by taking the production levels in each scenario and multiplying by technology-specific water consumption factors.

The graph clearly shows that Greenpeace's Energy [R]evolution scenario maps a pathway to a low-carbon, low-risk energy system with minimal disturbance to water supplies. This scenario is able to minimise both the direct impacts of energy systems on water and the risk of catastrophic impacts on water supplies through climate change. Substantial amounts of water are required for both coal mining and coal power in the Reference scenario, pushing water use for energy production up to nearly three billion m^3/year by 2030. On the other hand, electricity technologies with low to no water requirements (energy efficiency, wind and solar PV) are substituted for coal power generation with high water impacts in the Energy [R]evolution scenario. **The graph illustrates that implementing an Energy [R]evolution would not only stimulate the country's economy, but would drastically decrease the amount of water required for electricity production in the country: to half of what would be required for coal mining and coal power combined, and to a level even lower than the 2007 baseline.**

A complete transition to renewable energy and energy efficiency is technically possible, and would help solve both the electricity and water crises facing South Africa;[294] all that is missing is the political will to make this shift happen. By shifting away from coal and nuclear energy and towards renewable energy systems, substantial amounts of scarce water could be saved and diverted to other sectors where it is urgently needed, avoiding water insecurity and potential conflict,[295] while also creating green jobs and a sustainable, clean future.

7. Conclusion

South Africa has limited coal and water resources, and the country is reaching a point of no return. We are nearly at the limits of our water resources, and are likely to face an even more significant water crisis by as early as 2025.[296] The energy decisions that are made today will influence the structure and stability of South Africa's economy for decades to come. The choice to continue investing in coal-fired electricity means that Eskom is a substantial water user, effectively putting South Africa's water resources at risk.

It is clear that water scarcity and the energy crisis are inextricably linked, and that the allocation of water must take the principles of equity, efficiency (or beneficial use) and sustainability, as prescribed by the National Water Act (Act no. 36 of 1998),[297] into account. It is still possible to pull back from the brink of a water crisis that could potentially throw South Africa into chaos, but only if water demand is significantly reduced, and the resource is managed and allocated effectively and transparently.[298]

According to the National Water Act (Act no. 36 of 1998),[299] the government has the responsibility to allocate water equitably and in the public interest. The first steps towards efficient and effective water use are transparency and accountability, which would then lead to the sustainable allocation of resources.[300] Clearly, the current allocation of water to the coal mining industry and to Eskom for coal-fired electricity is not a transparent, accountable or sustainable decision. **Neither is it in the public interest, given that there are very effective substitutes for coal, but there are no alternatives to water.** Both in the short term and the long term, these industries contribute to water scarcity, and substantial environmental and health impacts. It is very likely that building more coal-fired power stations and increasing coal mining to supply them will actually send South Africa into a water deficit, given that all of the water available in this country has essentially already been allocated.[301] [302]

South Africa is therefore facing huge political decisions related to where the country's water should be allocated in the future. It is also a country that faces potential conflicts over access to water and water rights due to increasing water scarcity.

Increasing the number of coal-fired power stations in the country will unfortunately solve nothing. There are clear and very real benefits to shifting away from coal and towards renewable energy, which would create jobs, stimulate the economy, reduce the country's contribution to catastrophic climate change, and would be the best socioeconomic use of the country's dwindling water resources. However, this shift must be made urgently, and ambitiously.

Unfortunately, we are already suffering from the unintended consequences of past choices, as the problems we face have become more complex over time.[303] A water crisis is looming in South Africa,[304] and investing in new coal-fired power stations instead of renewable energy and energy efficiency puts all South Africans at risk.

Fortunately, we are still in a position where we are able to make choices, but they need to be the right ones, and they need to be made now. **It is time to end the era of coal in South Africa through a just transition away from coal towards renewable energy.** Our ability to deal with a changing climate and future water insecurity depends on it.

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8. Greenpeace recommendations

Water is a critical resource, which is under threat. Therefore, South Africa's exceptionally high levels of water insecurity combined with further coal expansion could push this country closer to the brink of a series of water crises and water conflicts:

- **The South African government should immediately prioritise renewable energy over water intensive coal-fired electricity.**

- **As part of a just transition away from coal, Kusile should be cancelled, there should be no further investments in coal-fired power stations and Eskom should shift these investments towards renewable energy instead.**

Government Departments

South Africans have **a right to know how scarce water resources are being allocated, managed and polluted**. Confidentiality in the water sector disempowers the public, effectively removing our ability to hold industry accountable for its water use, particularly given that no part of South Africa's water resources are regarded as 'private property'.[305] In the interests of transparency and accountability, the **Department of Water Affairs** should ensure that all of the information around water management plans, reconciliation studies, the prioritisation of water supply to strategic users and water use licences are publicly accessible.

The Department of Water Affairs should conduct a strict and robust water demand assessment for Kusile coal-fired power station, and any other kind of coal expansion in South Africa. These assessments would need to take into account the costs of inter-basin transfer schemes and the implications of climate change for future water availability, and must be made public.

Given that the Department of Water Affairs clearly states that water demand must be managed, and water used as efficiently as possible,[306] the most effective way to manage the water demand for the electricity sector is for Eskom to shift towards relatively 'water-free' renewable energy technologies. Accordingly, government departments (including the **Department of Water Affairs** and the **Department of Energy**) should ensure that Eskom immediately begins to shift significant investments towards renewable energy as an alternative to coal.

The impacts of choosing to invest in coal-fired electricity instead of renewable technologies have not been transparently assessed. Therefore, a thorough public investigation of the full water use of the electricity and coal mining sector should be initiated by the **Department of Water Affairs** in collaboration with the **Department of Mineral Resources** and the **Department of Energy**.

Detailed information about the decisions made around water use licences and coal mining should immediately be made publicly available by the **Department of Water Affairs** and the **Department of Mineral Resources**.

The **Department of Water Affairs** should ensure that activities at coal mines operating without valid water use licences are suspended with immediate effect until valid licences are in place.

The enforcement of appropriate legislation by the **Department of Water Affairs** and the **Department of Mineral Resources** is critical to ensure more effective and efficient water use, while also reducing operating costs.

Thus far, the government has not been able to produce overarching documentation that proves that South Africa's water resources have not in fact already been over-allocated. In the light of the fact that water is a common good, which the government has the responsibility to distribute equitably, the **Department of Water Affairs** must produce proof that South Africa is not already at the limits of the water that can be allocated.

Adequate measures must be taken by the **Department of Water Affairs** and the **Department of Mineral Resources** to urgently deal with Acid Mine Drainage, which holds the mining companies liable, rather than South African taxpayers.

Eskom

Eskom should produce and implement a 20-year renewable energy roadmap, outlining its commitment to begin investing in significant amounts of renewable energy.

Eskom is responsible for its supply chain. As a result, the utility must be accountable and held liable for ensuring that the coal mines that supply the utility do actually operate with valid water licences.

Eskom should explicitly quantify, and incorporate the negative externalities of coal-fired electricity generation into the costs of new coal-fired power stations. This information must be in the public domain.

Eskom should immediately begin a shift away from coal-fired electricity generation to relatively 'water-free' renewable energy electricity generation. Implementing an Energy [R]evolution would not only deliver sustainable electricity for all South Africans, but would drastically decrease the amount of water required for electricity production in the country. This would mean that nearly 50% of South Africa's electricity could be supplied by renewable energy by 2030.

The health, water and other social impacts of coal use and coal mining should be recognised, quantified and mitigated by the State and by polluters, including **Eskom**. This information must be in the public domain.

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COAL'S HIDDEN WATER COST

START HERE

AN ESKOM COAL PLANT UNDER CONSTRUCTION

KUSILE

WILL USE **2,9 MILLION LITRES** OF H_2O AN HOUR

173 TIMES MORE THAN WIND POWER WOULD USE PER UNIT OF ELECTRICITY

THIS WATER WILL COME FROM THE VAAL RIVER. THE CLOSEST WATER SOURCE, OLIFANTS RIVER, IS ALREADY TOO POLLUTED FOR USE BECAUSE OF COAL MINING AND ASSOCIATED INDUSTRIES.

Gauteng gets most of its water from the Vaal River

NOW WATER WILL BE DIVERTED AWAY FROM AGRICULTURE AND RESIDENTIAL USE IN ORDER TO FEED KUSILE COAL POWER PLANT

KUSILE'S COAL WILL COME MOSTLY FROM A NEW ANGLO AMERICAN MINE

THAT MINING IS EXPECTED TO HAVE A DRASTIC EFFECT ON LOCAL WETLANDS AND WATER SYSTEMS

Due to ESKOM'S reliance on coal

ESKOM'S TOTAL WATER USE

10 THOUSAND LITRES PER SECOND

Enough to fill **an olympic-sized swimmimg pool every 4 minutes**

in **1 day** Eskom uses enough water to grow almost **1 MILLION KGS** of maize

THE AMOUNT OF WATER FOR EACH PERSON IN THE WORLD IS DECLINING

BUT THE RATE OF DECLINE IS MOST DRAMATIC IN AFRICA

Eskom is classed as a 'strategic' water user under the National Water Act

This means **Eskom is guaranteed a supply of water**, come hell or high water

MIND THE GAP

17% THE DIFFERENCE BETWEEN SOUTH AFRICA'S WATER SUPPLY AND DEMAND BY 2030

WATER PRICES COULD **TRIPLE** AS WATER GETS SCARCE

TODAY'S PRICE OF WATER, PER UNIT **R7-R12**

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Greenpeace exists because this fragile Earth deserves a voice. It needs solutions. It needs change. It needs action!

Greenpeace is an independent global campaigning organization that acts to change attitudes and behavior, to protect and conserve the environment and to promote peace. It comprises of 28 independent national/regional offices in over 40 countries across Europe, the Americas, Asia, the Pacific and Africa as well as a co-coordinating body, Greenpeace International.

Greenpeace has been working in Africa to end environmental destruction and fighting for the right of Africans to a healthy environment since the early 1990s. Our campaigns focus on climate change, halting the destruction of tropical forests and preventing the degradation of marine ecosystems.