DEPENDING ON RENEWABLE ENERGY: SOUTH AFRICA'S BEST DEVELOPMENT PATH

Written by Richard Worthington
Edited by Adi Frost
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PREFACE

To avoid catastrophic climate change the world has started moving away from burning coal to produce electricity and turning to renewable energy sources such as solar and wind. There is a high cost to people, societies and the planet in digging out and burning fossil fuels, processes that pollute water and air and take away agricultural land. The greenhouse gases emitted by burning coal and other fossil fuels are driving climate change, causing drought, flooding and rising temperatures.

Given the goal of global climate negotiations is to hold average future temperature increase below 2°C, are South Africa's current commitments to reduce emissions fair and adequate? This paper provides an overview of South Africa's energy system, national greenhouse gas emissions and anticipated emissions pathways and interrogates the range stipulated in national policy – the 'Peak, Plateau and Decline' or PPD Range. It finds not only that we can do more but that it is fair to do so and that it would be beneficial to people and the economy.

There are a number of ways to reduce our emissions. We can phase out fossil fuels, use energy much more efficiently, change the way we power transport, adopt more sustainable and less input-intensive forms of agriculture and make changes to industrial processes and product use. The greatest immediate opportunity lies in putting renewables at the heart of our future energy mix and realising the opportunities for decentralised development to extend access to modern energy services while enabling community-based projects for localised value creation.

A renewable energy revolution could unlock South Africa's social and economic development, but a change in the political economy is needed to move away from the current preoccupation with big power projects, centralised electricity production and a heavy reliance on coal. This paper looks at how, through the growing global and South African fossil fuel divestment movement, a change in attitudes toward vested interests and ethical investment has begun and how the social license of coal is being revoked. What began as a moral argument, lead by communities at universities and faith based organisations that chose to divest, has widened to a financial one as sovereign wealth funds, banks and pension funds are divesting due to the growing financial risks associated with fossil fuel companies.

Bold action by people, government and business is required to move to a low carbon economy. It is viable for renewable energy to make up 40% of electricity production by 2030 and 100% by 2050. To achieve this will first require a decisive political commitment to a renewable energy revolution, backed by a range of practical actions, including reforms to fossil fuel subsidies, programmatic support for localisation and the creation of Feed-in Tariffs to allow small scale and residential solar and wind producers to sell surplus electricity. With a greater ambition to reduce emissions and clear and coherent plans to develop manufacturing in renewable energy technologies, we can withdraw from our dependence on fossil fuels and accelerate the just transition toward renewable energy,

INTRODUCTION

Concentrated energy, as found in fossil fuels and contained in nuclear fuel, is highly conducive to the concentration of wealth. The dispersed or 'dilute' nature of renewable energy requires more human effort and/or material infrastructure to harvest and deliver on demand, thus offering slower returns on investment than taking ownership of concentrated fossil energy. Another significant modality for the concentration of wealth is the externalisation of many costs arising from extraction and processing of fossil fuels, whereby returns for capital far exceed the net value to society of the entire enterprise. Thus many of the benefits of using renewable energy have been intangible in market terms, in that they consist of not incurring the costs of concentrated energy that are not accounted, but borne by society at large and into the future.

Renewable energy is not inherently more costly to utilise than concentrated energy, when full-cost accounting and life-cycle analysis[1] are applied. This is well established, even when very conservative estimates of externalised costs are applied. However, this does not render renewable energy projects immediately profitable, and expectations of returns on investment in the energy sector are largely based on what has been achieved by extractive industries. Widely and freely available renewable resources, especially solar, are well-suited to localised development; they can be directly accessed by communities and households, avoiding or reducing cash payment to distant suppliers and providing a platform for skills development and employment.

We have allowed many aspects of our lives and economies to become dependent on the ready availability of low-priced concentrated energy, while the ownership or control of such resources is held by a diminishing number of transnational corporations and state-owned entities, most of which behave like private companies. Climate change is one of many negative impacts of fossil fuel use, but presents the most profound threats and irreversible impacts and the most urgent collective imperative. The energy transformation required runs directly counter to many vested interests and cannot be achieved on an incremental basis or without disruption, including innovative governance systems for directing investments for net value gain over the long term.

RENEWABLE ENERGY FOR DEVELOPMENT

If we see development as producing social change that allows all people to achieve their human potential, and take wealth to mean real value rather than currency – in other words the health and wellbeing of local and global communities, and the protection and enhancement of the environments that sustain them - then the development case for moving to renewable energy is clear. Ending the devastation caused by fossil fuel extraction and use, including local water and air pollution, displacement of people and food production and the global impacts of climate change, is reason enough to transition away from the established industry-driven energy system. Furthermore, renewable energy is by nature the resource most suited to inclusive development, promoting equality within and between present and future generations and extending access to energy services, as captured in the slogan: Renewable Energy is Peoples' Power. The technologies and the economic case work well at a local and residential scale, as well as at the scale of industrial power requirements.

Renewable energy here refers to sustainable use of constantly replenished energy resources, including solar, wind, ocean (energy in waves, tides and ocean currents), geothermal (drawing on heat rising from the earth's core) and biomass, with the requirement that the biomass is sustainably produced (sustainability criteria are understood to include the protection of human rights), as well as micro-hydro – small-scale use of energy in the water cycle without building ecologically or socially damaging dams. The sustainability of hydropower and biomass will be strongly dependent upon the local context and in the case of biofuel production the length of the

Echoing Albert Einstein, the eminent futurist Isaac Asimov observed some time ago:

> *"The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom."*

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supply chain may be critical – the more localised the resource use, the more sustainable it is likely to be.

A key indicator of the political economy of a country is whether energy policy reflects the belief that "development" requires the concentrated energy of fossil or nuclear fuels. For electricity supply the argument for the use of concentrated energy is commonly expressed in an insistence on the need for 'base-load plant'. The notion is that meeting base-load demand (the constant level of electricity use below which demand never dips) requires a particular type of generation plant and that this is not available using renewable resources. In fact we know how to manage the challenges that come with using variable[2] or fluctuating renewable resources to meet base-load demand, which is a requirement of the generation fleet as a whole and how the system is managed, rather than requiring a particular type of plant or fuel.

Energy is critical to development, hence the urgent need to start managing a just, people-centred transition: we need to build extensive renewable energy infrastructure before we stop burning fossils and this will take a lot of work; it can and should be work for all putting sustainability and job creation before the maximisation of return on capital. A recent article by the director of the Centre for the Study of Governance Innovation at the University of Pretoria addressed the issue of scale as a factor in South Africa's current failure to provide adequate energy. The following is extracted from the article 'Big is beautiful' is blinding our energy policy makers by Lorenzo Fioramonti, published in Business Day, March 27 2015:

> "R8bn overspent to buy diesel, the unprecedented tariff hike of 25% for consumers and Standard & Poor's rating downgrade. ...is just the tip of the iceberg of an approach to energy production and consumption that is obsolete, dysfunctional, unjust and polluting. SA's policy makers, but also many business leaders, like it 'big'.
>
> Bespoke energy plants like Medupi and Kusile (whose huge investments are a fertile terrain for corruption) are a relic of the past, when big and heavy infrastructure was perceived as a sign of progress. ... They are like the first computing machines, which used to occupy entire buildings and needed huge investment, in a time of iPads and smartphones connected through the 'cloud'.
>
> The Africa Progress Panel has singled out micro-grids as the most intelligent way forward for energy distribution. As we improve technology and localise production and consumption (thus reducing the waste associated with travelling long distances), energy intensity will decline significantly. The future is energy democracy: a universe of micro-and small producers of energy, which leverage their creativity to provide sustainable energy solutions, yet in clear regulatory frameworks. In the end, this is the very essence of democracy: we need to "empower" ourselves to be truly free."

There is a pervasive view that a certain minimum level of economic growth (measuring total economic activity as 'Gross Domestic Product – GDP) is a necessary precondition for addressing poverty and inequality. This is to insist that more is good: consumption has become an end in itself, waste is deemed a positive contribution to the economy and the increase in cancers is an opportunity for the pharmaceuticals industry. Not all of the champions of high economic growth are blind to such a paradox or issues of quality, some are just reflecting a pragmatic opinion that substantive redistribution is out of the question – that there won't be more for the poor unless there is more for everybody.

The justice and equity dimensions of supplying energy services are outstanding issues, independent of the need to transition to renewable resources, as they are with regard to access to land and water. There is mountainous evidence of injustice and increasing inequality under conditions of high GDP growth, just as there are many examples of governments increasing access to energy, water or land without recourse to the market or requiring commercial rates of return on investment. Fortunately, the interventions most required to address climate change will also support peoples' access to energy and water[3]. Reducing inequality and energy poverty with participatory local development planning are important foundations both for managing a just transition to low carbon economies and for effective adaptation to the escalating impacts of climate change.

> "Increasing coal use does not guarantee energy access. Industry often cites the IEA's New Policy Scenario as evidence that coal demand will

350.org/ Mohamed Ali

increase. Even this reference scenario only sees coal demand increase by 23% globally through 2030 and with coal losing market share. However this scenario only reduces overall energy poverty by a quarter, and in fact sees an increase in the number of people without access to energy in Sub-Saharan Africa."

– A guide to why coal is not the way out of energy poverty, Carbon Tracker Initiative, November 2014.

Most African countries have a limited commitment or lock-in to fossil fuels, at least for their domestic energy supply, whilst also having plentiful sources of sun, wind, biomass and/or geothermal and therefore the potential for renewables to compete for investment with new fossil fuel projects. Energy planning in Africa is still dominated by assumptions that the large-scale demand of industrial customers is required to support investments in energy infrastructure, and that this approach will deliver 'trickle-down' benefits to the populace at large. More attention can be given to localised and resource-efficient energisation options such as de-centralised, community owned local solar, wind and biomass projects.

Fortunately this dominant energy development approach is increasingly being challenged, most recently by the Africa Progress Report 2015: People, Power, Planet: Seizing Africa's Energy and Climate Opportunities. Prepared by a panel chaired by former United Nations Secretary General Kofi Annan the report noted: "The G7 pledge to mobilise resources to accelerate the creation of a low carbon energy system in the region could be a game changer; helping Africa grow and leapfrog to a sustainable low carbon future. This is good for Africa and the global fight against climate change." In its Overview section the Report states (p.14):

"For too long, Africa's leaders have been content to oversee highly centralized energy systems designed to benefit the rich and bypass the poor. Power utilities have been centres of political patronage and corruption. The time has come to revamp Africa's creaking energy infrastructure, while riding the wave of low-carbon innovation that is transforming energy systems around the world. Africa cannot afford to stand on the sidelines of the renewable energy revolution. It can play its part in this revolution and tackle the challenges of transitioning away from fossil fuels……. Millions of Africa's poorest people are paying among the world's highest prices for energy because of the cost barriers separating them from affordable, efficient and accessible renewable technologies."

Many countries are in th early stages of the fossil fuel investment cycle and need to make some tough choices soon. Such choices are made tougher by the failure of developed countries to take their fair share of the responsibility for reducing and avoiding emissions, or even to meet their own inadequate commitments to provide financial support to assist developing countries in adapting to their changing climates.

Choices made in energy development will have profound impacts far beyond the energy system, as highlighted in recent work on the 'food-water-energy nexus' that explores the long-term implications of energy options that are not reflected in project-specific cost-benefit analyses, even when externalised costs are considered. It is frequently assumed that this requires making "trade-offs" between competing objectives or interest groups, when on many issues we face mutually exclusive choices where failure to change practice in the short term will close out options for the future. In a water scarce country such as South Africa, careful land use is critical, yet some of our most agriculturally productive land is being turned over to mining, a process that uses large amounts of water. For example, proposed expansions of coal mining in Mpumalanga would take a significant portion of our most productive agricultural land away from food production.

ENERGISATION: RENEWABLE ENERGY ENABLES ACCESS TO ELECTRICITY

Economy-wide energy planning frequently glosses over issues of energy access, usually on the assumption that sufficient economic growth (as measured in GDP) will deliver universal benefits. However, the most affordable and resource-efficient means for delivering basic energy services in most contexts and poor communities would be bottom-up development that optimises the use of locally available resources and labour, to meet energy service needs with renewable energy. For example, biogas digesters are a low-tech option for converting biomass (a wide range of organic matter including animal waste is suitable) into methane, a clean-burning fuel for cooking and heating that can also be used to generate electricity. In most South African settings photo-voltaic (PV) panels with storage will be the best option for the services that only electricity can provide, while passive solar can provide water heating.

South Africa's energy policy recognises the rationale for focusing on energy service needs: "Government supports the concept of "energisation", i.e. the widening of access to a safe and effective energy package within grasp of low-income households and will promote its implementation where appropriate."[4] This concept appears to have been relegated to dealing with areas remote from the electricity grid, without direct support for the approach, which would require effective local government and public participation in Local Integrated Development Planning. In 2007 the DoE promulgated the Free Basic Alternative Energy Policy, explicitly targeting "areas most distant from the grid electricity" and tasking municipalities with implementation, without any additional resources: it lists just four fuels that municipalities should consider: Paraffin, Liquid Petroleum Gas (LPG), Coal and Bio-Ethanol Gel.

Decentralisation of the energy system will provide a more enabling environment for energy access interventions per se, as well as for growing utilisation of renewable resources. Localisation with social ownership, more engaged citizens and context-specific planning will be an important component of an inclusive low carbon economy. The Wesley-Ciskei wind power project, which has successfully competed in the bidding programme to supply renewable energy to the national grid, serves as an exemplar of incorporating of social ownership and is the first to be developed on community land in a 'Former Homeland' area. Just Energy, the first not for profit project developer to successfully compete in the bidding programme, has developed a business model that enables it to re-invest a substantial portion of the revenues it earns from developing the project back into equity for the local community to own.

THE EMPLOYMENT IMPACTS OF A RENEWABLE ENERGY REVOLUTION

The employment impacts of energy development choices, particularly the impacts of specific energy projects or procurements, are dependent upon a wide range of variables – they cannot be reliably predicted at a national level. However, some trends related to broad technology and resource options are well-established at the macro-scale and the extent to which these trends can be manifest at national scale can be strongly influenced by policy and energy planning, particularly through choices of the scale (and to a lesser degree the pace) at which to pursue particular options.

The vast majority of extensive international studies show that the utilisation of diffuse renewable energy resources is more labour-intensive than the utilisation of stock or concentrated fossil fuel resources.[5] This is hardly surprising and used to be widely recognised as a barrier to investment in renewables, by way of more extensive costs of labour making renewable options less profitable than stock energy options. This dynamic hindering renewables continued into the beginning of the 21st century, even as the labour-intensity of coal mining continued to decline. The labour-intensity trends have, as creation of employment has become a stronger political imperative, prompted proponents of fossil and nuclear energy projects to increasingly take recourse to 'multiplier effects' to project high job-creation numbers[6] for specific projects or programmes.

A major challenge to assessing the employment impacts (and other socio-economic impacts) of energy choices is the interplay of impacts within the energy sector and those downstream – particularly the impacts of energy prices (over the short term) on job-creation potential within the economy as a whole. A potentially negative economy-wide impact is more pronounced within an energy-intensive economy like South Africa's and is exacerbated by the dominant assumption that a combination of abundant coal and energy-intensive industries provides competitive advantage. As is evident from actual developments, downstream impacts of low energy prices have not been decisive or even demonstrably conducive to addressing South Africa's unemployment crisis.

To assess the employment impacts of energy development options with any degree of confidence requires a more holistic approach than project-by-project projections. In the grid-based electricity supply industry the most reliable way to ensure positive employment impacts is to identify well-established trends and consider how best to capitalise on them at a national level.[7] This requires government commitment to rapid deployment of renewable energy technologies at a scale that justifies a very high level of localisation (i.e. upwards of 1 000 MW per annum for an extended period). It also requires a more programmatic approach to procurement than the incremental and serial approach that has been developed to successfully initiate the uptake of renewables (i.e. the REIPPPP), and planning that is more dependable than Ministerial declarations.

The greatest immediate social benefits that are available through renewable energy development are in off-grid applications where there is inadequate access to energy services, but responsible 'energisation' will require a bottom-up approach with choices strongly determined by local circumstances. A fast-track approach is not appropriate to sound practice in energisation, where key factors for success are effective local government and participatory Local Integrated Development Planning. There are huge potential socio-economic gains available through energisation and a programmatic approach is desirable, especially for building public understanding of energy options and developing relevant capacity in local government, but localised initiatives should be community-based, rather than driven by national targets. Prospects for realising localised potential will be greatly enhanced if thriving local industries in renewable energy technologies, with economies of scale, are driven (or rather pulled) by strong demand in the commercial and grid-based sectors.

Decentralised deployment of RE technologies tends to be more labour-intensive than centralised projects designed to supply the grid, with or without using the grid for surrogate storage. Solar PV technology is already being used as a substitute for grid supply, sometimes in defiance of government regulations. The value proposition for PV integrated within distribution networks is currently determined mostly by the reliability[8] and pricing of centralised supply, while in the medium term it will be determined mostly by the regulatory regime. The pricing of PV panels – especially relatively small units – has recently been quite volatile and a publicly-owned enterprise or state-supported programme for large-scale local production would greatly enhance the prospects for localisation and price stability.

To have confidence in positive employment impacts arising from energy development choices requires an active and strategic role for the state, just not imposing terms on IPPs, such as for local economic development.

The measures needed to level the playing field for renewable energy are changing, as is the understanding of subsidies and how the existing energy system panders to an extractive 'development' paradigm. Many of the barriers to renewable energy have been in the mind-sets of Africa's elites, or those that advise and mediate finance to them, but recent advances in energy service delivery options and technology cost-reduction have rendered the dominant paradigm obsolete. The most crucial task to fully realise the public benefit potential of renewable energy is to develop governance and regulatory systems that curtail short-termism and redirect financing.

SOUTH AFRICA'S CURRENT ENERGY SYSTEM

For generations South Africa's primary strategy for energy development, and indeed for economic competitiveness in general, has been the monetisation of coal, primarily by way of large-scale electricity generation using low-grade coal. This has also underpinned trade strategy, as the value proposition for exporting coal with globally competitive pricing is based on combined revenue streams: from large-scale domestic coal sales at a low rate of return, mostly for burning in power plants as close to mines as possible, and more profitably from the higher grades of coal, mostly going to export markets.

A highly centralised energy system was designed to attract energy-intensive industries and suited a centralised and authoritarian state. This is most obvious in the adoption of CTL – the conversion of coal to liquid fuels, which has been unique to South Africa[9], driven by international isolation and constrained access to oil during the Apartheid regime, with energy security and the foreign exchange toll of oil imports over-riding any consideration of economic efficiency or impacts on people and the environment beyond the commercial value chain.

Today nearly three quarters of our energy is still derived from coal, with roughly half of all primary energy going into the electricity supply industry. In coal-fired plants around two-thirds of the energy in the coal is lost in the transformation process: the conversion efficiency of our existing coal-fired plants ranges from 34% in the most advanced (Medupi promises up to 38%), to well below 30% in older plants, even if they are being managed and are performing to specification. Traditional biomass use (burning plant material and animal waste) remains a significant primary energy input, though the national estimations of total use are rather speculative. In official statistics for 2006 it makes up 7.6% of total primary energy supply. Nuclear power provides up to 2%[10] (in a year without major outages) and the balance of energy input is from imported oil and gas.

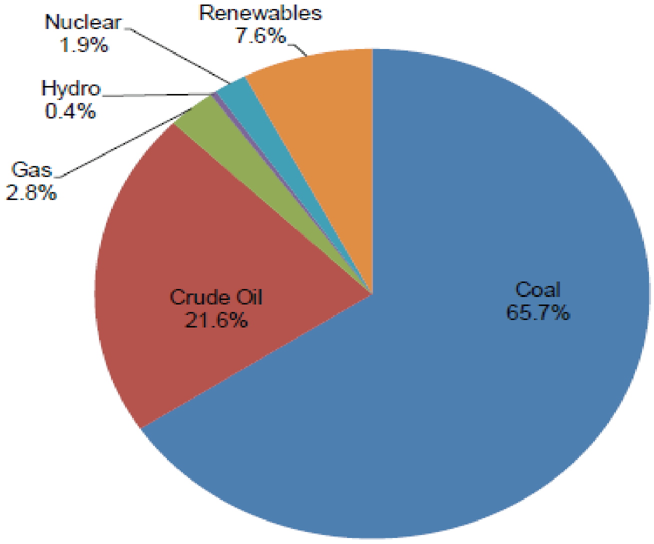


Figure 1: Primary Energy Supply for 2006, Total: 5560 PJ (DME, 2009)

Primary energy refers to the total energy content of inputs to the energy system, for example the energy content of coal going into power plants, which varies according to the quality of the coal. As fuels have different energy content (calorific value) by weight and volume, we use a standard energy unit to count their contribution i.e. PetaJoules. The refining of crude oil involves some 'losses' – energy dissipated in transformation – but most of the conversion losses in the liquid fuels pathway occur at the point of use, in inefficient internal combustion engines. Solar, wind and hydropower inputs generally enter the system as electricity, thus the only losses incurred are those common to all transmission and distribution systems. The direct application of solar heat in industrial applications and hybrid fossil-and-solar systems are emerging technology options that have not yet been considered in energy planning.

Electricity accounts for less than one third of energy available at the point of use and it is estimated[11] that 58% of energy use in South Africa is utilised in the form of heat, Imported gas is slowly increasing its share at end use, as well as being used as feed-stock for liquid fuels, and is expected to displace diesel for some electricity generation, and possibly much coal. Direct burning of coal and fuel oils, the bulk of which is used in heavy industry for process heat, e.g. for minerals processing, involves some losses at the point of use (far less than in producing steam to drive turbines to generate electricity). The contribution of solar water heating is beginning to be incorporated into energy data gathering and reporting, while data collection for biomass use, which has advanced significantly, is not yet fed into national energy statistics.

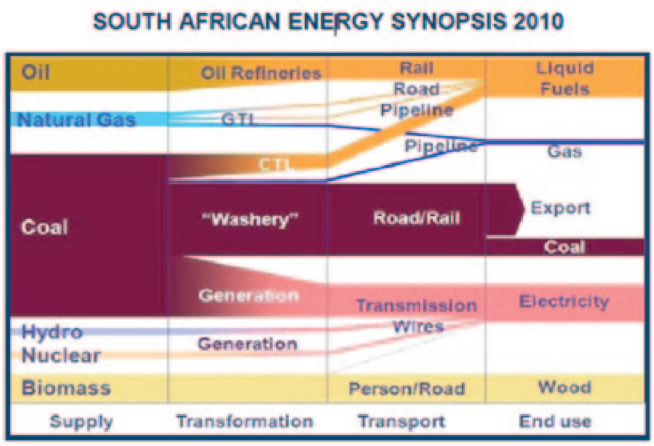


Figure 2: Overview of the energy systems, very roughly to scale.

The above snapshot of South Africa's energy system, from the cover of the most recent official statistics published by the Department of Energy, depicts energy flows from the primary inputs, through transformation into the energy carriers that are delivered to end users. Conversion of wood to charcoal (a fuel with far higher calorific value / energy content by weight) is an important component of the system in many parts of Southern Africa, but is not considered significant in South Africa. Energy use is reported according to energy carriers and where within the economy it is used, though the systems for attribution are not very sophisticated and do not provide details such as the amount of energy used for moving water around, for domestic food production, or the energy embodied in exported commodities.

There have been various significant developments within the energy system in recent years, including an increasing contribution by renewable energy, that are identified in recent studies but are not yet reflected in official statistics. However, the big picture of where energy is used has not changed substantially from that shown in these diagrams from the 2010 Synopsis, showing the dominance of industrial demand, particularly in electricity, but also within total energy use, as reflected in energy demand, summarised in figure 4:

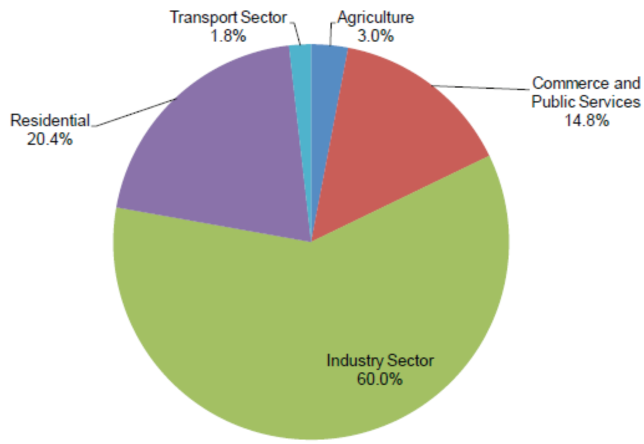


Figure 3: Electricity consumption by economic sector for 2006, Total: 700 PJ (DME, 2009)

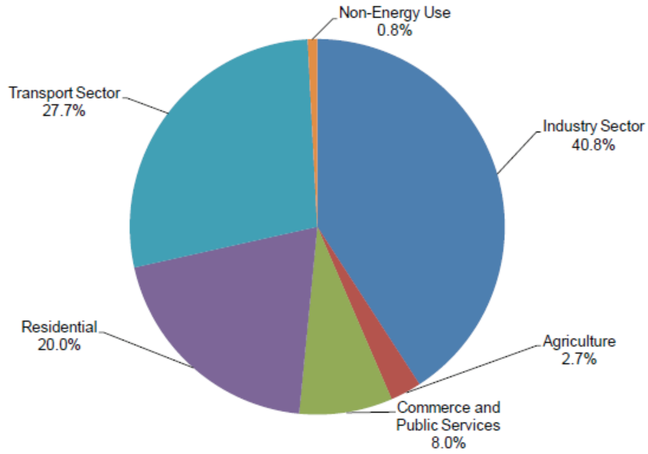


Figure 4: Energy demand by economic sector for 2006, Total: 2627 PJ (DME, 2009)

A crisis in electricity supply and infrastructure financing has drawn attention to the political economy of the industry, but a coherent energy strategy has yet to emerge and formal or transparent planning processes have effectively been abandoned. The future of energy supply in SA is highly contested, as is the expected demand, particularly for electricity. Demand projections have been revised downwards over recent years, but with demand clearly exceeding available supply, there is currently little basis from which to infer potential demand. An Integrated Resource Plan (IRP) Update Report published by DoE for comment, in November 2013, proposed a reduced electricity demand projection that is a lot more credible than that provided as the basis for the official plan in the IRP2010, but this report has been denied any official status and work is underway to produce an IRP2015.[12]

At the same time in South Africa the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP), in parallel with massive cost reductions in RE technologies globally, is bringing a disruptive change within and beyond the electricity supply industry, with advances in storage technologies significantly undermining the case for liquid fuels in transport and for a centralised energy system in general. While energy planning continues to treat disruptive change as undesirable[13] and to assume on-going domination of fossil fuels for the foreseeable future, the viability of such projected energy pathways is losing any credibility in forward-thinking development planning. South Africa has not yet established the information and analytical foundations for reaching consensus on what may be a "realistic" greater ambition for renewables, nor the political will to change the factors and parameters that determine what is deemed realistic, but there is growing recognition of the need for profound change.

EXTERNALISED COSTS OF COAL: SOCIETY PAYS, NOT THE POLLUTERS

In many cases it is people who end up carrying the true cost of burning coal and oil, and often communities living near mines and power stations do not get access to the electricity being produced. The energy companies that cause pollution pass off impacts including air and water pollution to the rest of society. The true costs and purported benefits of the current energy system remain highly contested, though the need to address the extensive externalised costs of energy, borne by society as a whole and not accounted for by the energy industry within commerce in energy, is recognised in the 1998 White Paper on Energy Policy.[14]

Estimations of costs not accounted for in the commerce of energy supply and use, from global impacts of climate change driven by greenhouse gas emissions, through to health care costs arising from local air pollution and roads damaged by coal trucks, cover wide ranges, even for the most directly traced and short term 'damage pathways'.[15] No amount of quantification and analysis can substitute for the exercise of moral judgement in planning our energy future, particularly in the area of cumulative and inter-generational impacts, but life-cycle analysis with full-cost accounting, however approximate, is essential to inform decision-making. We need to fully understand the risks of continuing the fossil fuel investment cycle, which is treated by many as unstoppable, or an inescapable characteristic of the capitalist system. Here the focus is on greenhouse gas emissions, often referred to simply as 'carbon'.[16]

To date there has been limited assessment of externalised costs of the South African energy system, but an indication of the extent of the costs that have been assessed, as well as the scale of valuations considered, is provided by the following table, drawing on a number of studies and submitted as input to the Department of Energy by the Energy Research Unit of the University of Cape Town:

Units: c/ kWh (2009 cents ZAR)	*Coal*	*Nuclear*	*Gas – CCGT*	*Diesel –OCGT*	*Biomass (incl biogas)*	*Hydro (small)*	*Wind*	*CSP*	*PV*
POWER GENERATION									
GHG emissions	48 (25 – 71)	0.3 (0.2 - 0.4)	27 (11 – 32)	45.5 (24 – 67)	4.3 (1.8 – 5)	0.15 (0.1 - 0.2)	0.8 (0.4 - 1.2)	0.7 (0.3 - 1.1)	2.8 (1.6 - 4.4)
Health impacts	1.35 (1.0 - 1.7)	0.03	0.34	0.22	0.39	0.05	0.09	0.09	0.19
FUEL (Production & Transport)									
Acid mine drainage	2.1* (0.4 - 3.9)	?	?	?	-	-	-	-	-
Biodiversity loss	0.7 (0.6 - 0.8)	0.1	0.39	0.9	0.13	0	0	0	0
Health impacts	0.36 (0.02 - 0.7)	0.15	0.14	0.15	0.05	0	0	0	0
GHG emissions	2.3 (1.3 - 3.3)	0.45	2.8	2.8	1.5	0	0	0	0
TOTAL EXTERNALITY COST (estimate)	~ 55	~ 1	~ 30	~ 50	~ 6	~ 0.2	~ 0.9	~ 0.8	~ 3
Benefits of electrification – positive externalities	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)	18 (4.7 - 24.2)
* A presentation by the Federation for Sustainable Environment (Pretorius, 2009) estimates the water damage externality from Eskom's coal mining needs at about R cents 38/kWh.									

External cost of electricity generation: contribution to the Integrated Resource Plan 2 for electricity, UCT ERC, 2010

The externalised costs attributed to specific impacts,– for example 'health impacts' are the total cost of local air pollution – are given in the form of South African cents per unit of electricity generated (kWh) from the different energy sources, including those arising from the production and transport of fuel (the figures in brackets note the range of valuations from different studies). A positive external value attributed to access to electricity is based on the avoided externalised costs of energy use in the absence of electricity, primarily burning coal, wood, paraffin and candles, with impacts ranging from indoor air pollution to poisoning and shack fires. Subtracting the positive externality from the costs provides a net value, which is positive for the five renewable energy options.

The table above does not claim to be comprehensive, for example the only consideration of waste management is under acid mine drainage. Valuation of the externalised costs of water pollution and water use are not well represented. The figures given for nuclear power are contentious, particularly in the area of fuel production, as there is no recognition of the impacts of routine radioactive emissions, or of legacy wastes of uranium mining (a significant contributor to toxic mine drainage) and no consideration of plant decommissioning.

THE SOURCES OF SOUTH AFRICA'S GREENHOUSE GAS (GHG) EMISSIONS

Energy supply and use accounts for almost 80% of South Africa's greenhouse gas emissions – by world averages our economy is highly energy-intensive. According to the Greenhouse Gas Inventory for South Africa, published by the Department of Environmental Affairs (DEA) in November 2014 and reporting on the years 2000 to 2010, coal combustion for electricity supply accounted for 55% of cumulative emissions: "4 204 640 Gt CO_2e over the 10 year period" or 2.3 Gt out of a total 4.2 Gt. According to the national Energy Balance released by DoE (not officially verified data), domestic coal use in 2010 accounted for 382 Mt or almost 70% of total national emissions; this includes the emissions from the coal-to-liquids conversion process, at around 60 Mt per annum, while the emissions of the liquid fuel being burned are counted under transport or liquid fuels. The GHG Inventory for South Africa notes: "The contribution of coal to primary energy decreased by 8% between 2000 and 2006, but then it increased by 5% between 2006 and 2009."

The figures for 2010 show that grid-based electricity supply accounts for 62.5% of all energy sector emissions and 45.7% of net national emissions (236 798 out of total 518 239 kilotonnes), thus the electricity supply industry offers by far the greatest potential for emissions reduction, since South Africa has more than enough renewable resources to use in place of fossil fuels.

The electrification of transport presents another opportunity to cut emissions though this is more challenging due to the popular appeal of the internal combustion engine and private vehicles and the extent of the supporting infrastructure dedicated to liquid fuel supply. This should greatly increase the share of electricity amongst energy carriers in the supply mix. The South Africa economy also has enormous potential for more efficient use of energy, through more energy efficient equipment or practices such as changing industiral production process, though the extent to which the identified 'technical potential' may be realised in the short term is another area of contestation over what may be deemed 'realistic'[17] for planning purposes.

The following graphs[18], derived from South Africa's GHG Inventory provide an overview of where our greenhouse gas emissions originate. In figure 5, electricity is not attributed to sectors but shown separately, thus the Industry and Residential emissions shown here are those from direct fuel use (unlike in figure 4 above, in which all energy is divided amongst energy using sectors). Figure 6 then shows the contributions of coal, oil and gas and other fuels to national emissions.

Figure 5:

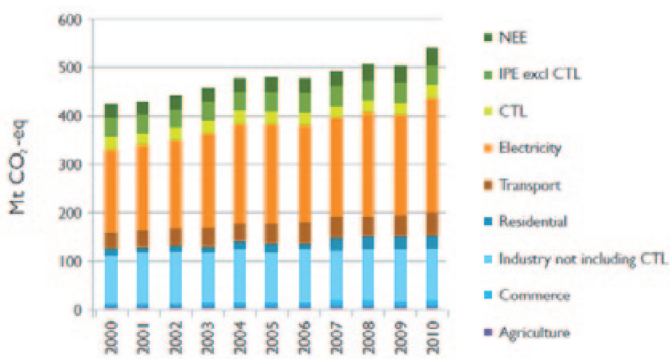
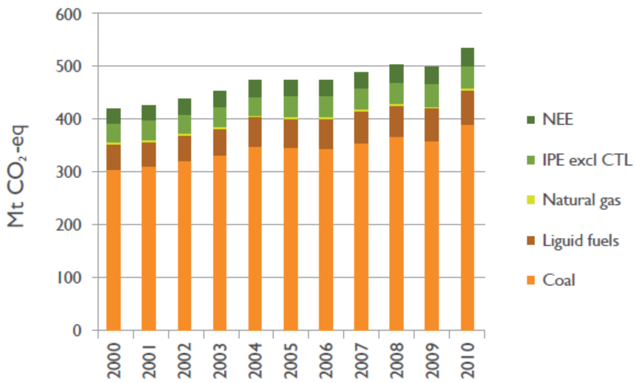


Figure 6:



SOUTH AFRICA'S PROJECTED FUTURE EMISSIONS

South Africa's National Climate Change Response Policy (NCCRP 2011), in addressing mitigation outcomes, describes a range for the national emissions trajectory called the Peak, Plateau and Decline (PPD) Range. This was subsequently elaborated in a briefing note, with the graph (shown below left), with lines for Low-, Mid- and High-PPD, from which one can calculate the cumulative emissions over the period 2010 – 2050, which yields totals of roughly 15 Gt, 19 Gt and 23 Gt respectively. The PPD Range is not proposed in policy as a basis for setting a national carbon budget, but these totals can be used to generate indicative trajectories, starting from emissions as reported for 2010 at 518 Mt.

The Mid-PPD as shown [in Fig 12a] is proposed by South Africa's Department Of Environmental Affairs as the point of reference for setting Desired Emissions Reduction Outcomes, while the High-PPD cannot be reconciled with a global goal of 2°C and could fairly be described as a national budget for a 4°C world. The PPD Range was derived from emissions projections first developed under the Long Term Mitigation Scenarios process that commenced in 2006 using emissions figures up to 2002, and generated trajectories for different scenarios that started to diverge from 2003.

As there has been no alignment with data that has subsequently become available, PPD covers a wide range in 2010, and is thus of little current relevance, offering no guidance for the short to medium term desired outcomes. If we want to consider a meaningful range, trajectories should start from the latest reported national emissions figure of 518 Mt in 2010. One way to do this while retaining some consistency with the policy range is to constrain trajectories to the same cumulative totals as Low-, Mid- and High-PPD.

Figure 12b shows these cumulative emissions as hypothetical trajectories, with the extrapolated 'Mid' and 'Low' not constrained to the PPD plateau, which DEA had stipulated for the decade from 2025. In this extrapolation 'Mid' ends at the bottom of the range given for 2050 (at 212 Mt), but 'Low' is not constrained by the lower level of the range. The shape of these trajectories for the period to 2025 is also informed by the Mitigation Potential Analysis and anticipated lifespan of existing coal-fired generation plants and will be discussed in later sections regarding alignment with a fair national contribution to achieving the global mitigation goal.

Figure 12a:

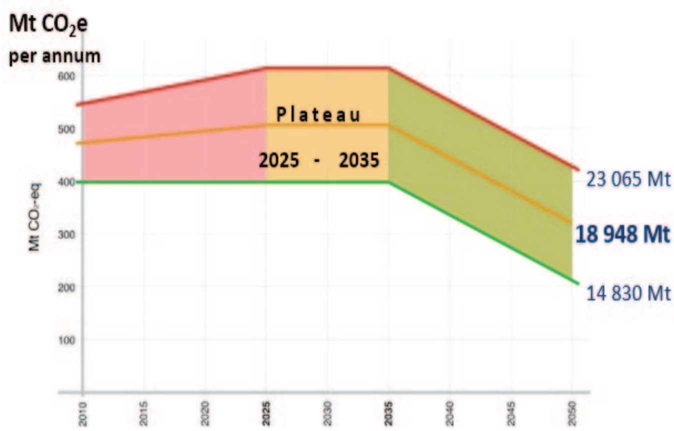
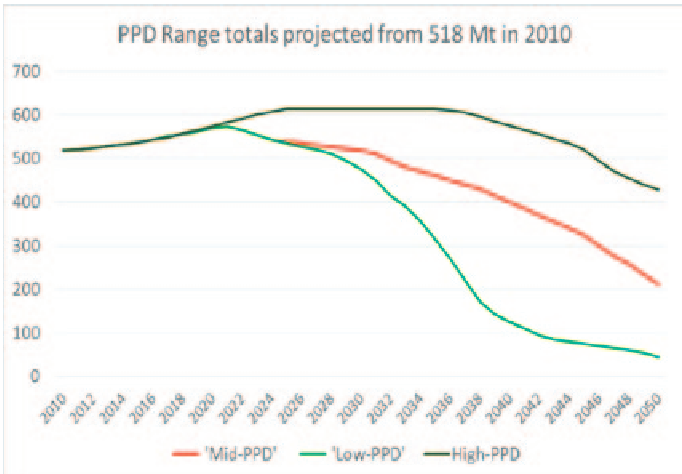


Figure 12b:



There are a number of ways to reduce our greenhouse gas emissions. We can stop burning fossil fuels to produce electricity, use energy much more efficiently, change the way we power transport, adopt more sustainable and less input-intensive forms of agriculture and make changes to industrial processes and product use.

A big-picture overview of mitigation options and their impact on the amount of emissions projected to be produced by economic sectors are provided by the 2050 Pathway Calculator for South Africa. Developed for the Department of Environmental Affairs (DEA) by the Energy Research Centre at UCT the Calculator is an on-line educational tool that offers the user 38 mitigation options that can be applied with settings for different levels of ambition – measures available across the economy, primarily affecting energy demand and supply. For example moving freight from road to rail, improving public transport, the introduction of strict building codes, and on the supply side rapid growth of renewables and no more coal-to-liquid plant.

This compliments the Mitigation Potential Analysis (MPA) study DEA published in November 2014, which provides macro-economic and socio-economic analysis of combinations of almost 200 "abatement actions" identified for detailed modelling. The MPA was not tasked with determining the maximum extent to which we might decarbonise our economy, or even the electricity supply industry, but it does make a valuable start on evaluating the identified mitigation actions for their 'net public benefit' i.e. exploring how development outcomes relate to choices amongst mitigation options and how the allocation of emissions 'allowances' or the application of carbon budgets could best serve social objectives such as growth in employment and security of clean water supply.

Consideration of abatement actions and mitigation potential generally start with a projection of future emissions: an hypothetical emissions pathway in the absence of concerted climate change response, to serve as a point of reference or baseline against which to assess mitigation potential. The MPA is careful to note that its baseline projection is not a scenario and should not be referred to as 'business-as-usual', as it was not considered as a credible development pathway. It uses data already several years old to generate a projection of emissions growth that is considerably higher than those in more recent work, such the projection in the 2050 Pathway Calculator. The Excel spreadsheet model that underpins the on-line Calculator tool, freely available for download, was updated early in 2015 with the latest economic growth projections, in which higher growth rates have been shifted forward in time and updated data has been used from South Africa's latest GHG Inventory (Nov. 2014).

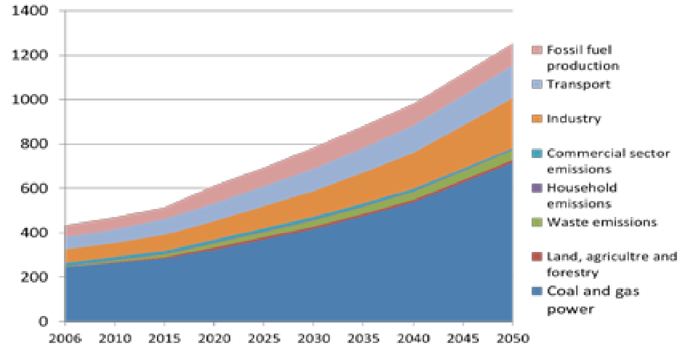


Figure 7: Reference case for the 2050 Pathway Calculator for SA (updated March 2015) in Mt CO_2e

The modelling behind the on-line Calculator tool also greatly smoothes the projections of emissions, energy supply etc., as it was developed to explore long term trends and the relative scale of impact of the interventions that users can activate. The focus is on the over-all shape of the emissions pathway i.e. when emissions peak and how sharply they decline and the shifts in sources of emissions rather than on the absolute values in any particular year.

A key question for South Africa is how the composition of the economy as a whole and particularly the relative role of mining is likely, or may be encouraged, to change; including how much primary minerals processing or more downstream beneficiation is supported by government intervention. The main driver and key input to the 2050 Calculator is a detailed projection of economic growth, provided by Treasury and based on the National Development Plan. One of the users' options is to select an alternative composition of sectoral contributions without changing the overall rate of economic growth projected. This allows for modelling a more pronounced shift from mining than is currently anticipated which significantly decreases the energy demand projection that the supply-side options have to meet. Experimenting with this on-line tool develops understanding of the scope and scale of mitigation opportunities and challenges and can illustrates some radical interventions on the supply side, as illustrated by the 100% renewable energy electricity supply mix by 2050, as in an Exemplar Pathway that was developed by Project 90 by 2030 using the Excel version of the Calculator tool, which allows greater flexibility than the online version.

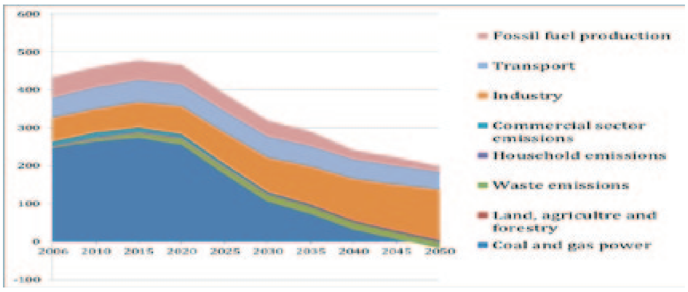
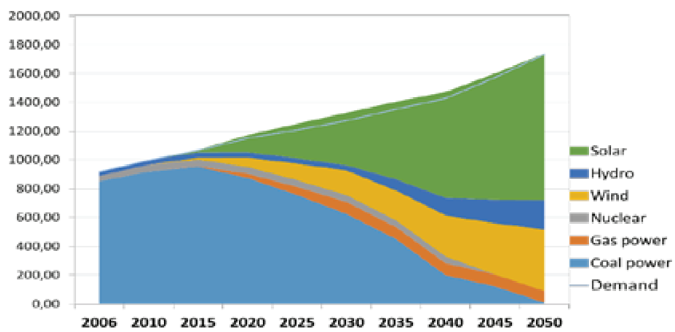


Figure 8: Emissions projection of a pathway with 100% electricity from renewable energy by 2050

The above emissions projection (Mt CO_2e per annum) for a Strong Decarbonisation pathway, with high ambition settings selected for all demand side interventions, includes phasing out coal-fired electricity generation, as shown in the electricity supply graph (in PetaJoules) Figure 9 below.

Figure 9:



This projection illustrates what is needed for South Africa to pursue a more ambitious, just transition away from coal and toward renewble energy electricity production. One accompanying question is what is may fairly be expected in terms of the speed and extent of this transition, given South Africa's broad-ranging developmental needs?

CARBON BUDGETING AND COAL CONSUMPTION

With the publication of the most recent Assessment Report by the Inter-governmental Panel on Climate Change (IPCC) there is a high level of certainty of what global carbon budget is likely to be needed to meet the United Nations Framework Convention on Climate Change (UNFCCC) goal of restraining future global warming within 2°C. In other words we now know the total cumulative emissions of greenhouse gases, from 2000 (or from 2010) to 2050 and beyond, that humanity can afford to release into the atmosphere.

To generate emissions figures that may be attributed amongst nations (or amongst income groups) one needs to choose a global emissions trajectory and a set of criteria for deciding how to then attribute emissions to each country. How projected emissions are distributed over time will also impact the prospects of stabilising average global temperatures. In projections of global emissions trajectories consistent with this goal, most models show net global emissions becoming negative from around 2070, in other words the entire global emissions budget is expected to be used up by about 2070.

The world has taken the first step in coal budgeting, with almost universal recognition that to hold to a 2°C future average global temperature increase, most of our coal reserves will have to be left in the ground permanently. Some studies indicate that 80% of identified fossil fuel reserves should be left sequestered in their geological formations to afford significantly more than a 50:50 chance of staying within 2 degrees, while others apply this proportion just to coal and some are still nervous to say more than two thirds. 'Reserves' are the sub-set of total resources that are considered to make economic sense to extract and are treated as viable assets in the valuation of companies by stock exchanges, 80% of such 'coal assets' listed globally should not be realised i.e. their carbon should not be released.

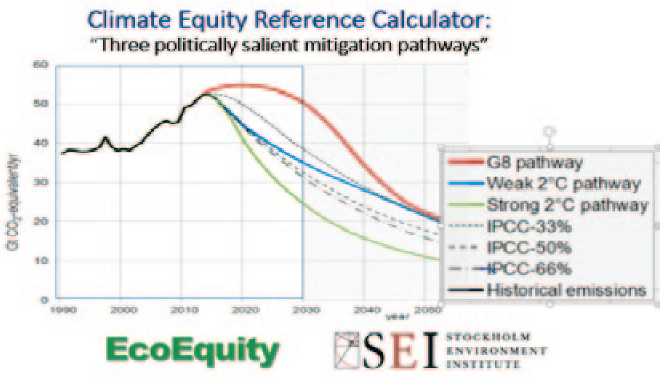
Questions of which or whose coal carbon should remain sequestered (or which applications of coal may be considered most justifiable) are effectively taboo, treated as an offence to national sovereignty, but answers can be found in applying the equity principle of common but differentiated responsibilities and capabilities (CBDRC) in Article 4.2 of the UNFCCC. This recognises differing national conditions and development needs of countries at different stages of development. While there are various ways to assess national responsibility and capability, as well as to extrapolate the elements of equity between countries and within countries themselves, there is considerable consistency in the big picture outcomes. Vast data-banks have been assembled to generate indices and comparative rankings, with emissions trajectories projected for countries, or economic sectors and on a per capita basis.

THE CLIMATE EQUITY REFERENCE CALCULATOR: AN EQUITABLE ALLOCATION OF EMISSIONS

One model which allows us to consider how to fairly allocate acceptable global emissions over time, recognising a right to sustainable development and based on the differing developmental status of countries and their historical responsibility for increased atmospheric carbon, is the Climate Equity Reference Calculator (CERC) developed by EcoEquity and the Stockholm Environmental Institute.[19] In this section we begin by examining the CERC model and then compare the outcomes to the PPD Range.

The CERC focuses on emissions over the period to 2030, by which time the emissions of virtually all nations should be on a downward trend, even if their relative responsibility and capability indicates that they are not accountable for the full extent of the mitigation that is required within their growing economies. In any attempt at an equitable allocation of global effort it emerges that 'developed' nations, as listed in Annex 1 of the UNFCCC[20] are required to do more than achieving carbon neutrality, by supporting mitigation interventions in developing countries. Whatever one thinks of the prospects of such levels of support ever being forthcoming, we should at the very least understand what an equitable allocation may look like and where in the world all the necessary mitigation could be achieved. From a national perspective, we can hardly expect to attract such support if we have not presented plans for how it would be used to deliver the required outcomes.

The CERC offers a choice of 3 global emissions pathways or trajectories, one a political proposition put forward by the G8 group of countries in 2009 and two derived from longer term outcomes-based carbon budgets. These are shown below with a vertical axis in Giga tonnes of CO_2 equivalent per annum, with trajectories produced for the Fourth Assessment Report of the IPCC in Figure 13.



In order to determine what might be a reasonable 'fair share' of global emissions for each country – and the subsequent implications for mitigation measures – the Calculator also offers choices for how to determine national (or regional) responsibility and capability for mitigation, drawing upon a vast databank of national and global statistics. This includes the start date for counting emissions to assess historical responsibility (South Africa's preference for 1850 is chosen for the projection below) and a set of criteria for the assessment of the mitigation capability of a country or region.

The users' choices generate a Responsibility and Capability Index (RCI) that is applied to generate national allocations, which may be expressed in terms of a percentage of global RCI, emissions per capita, or national or regional trajectories. Once the settings have been selected the calculator provides "Country Report" projections, such as the following for South Africa for a 'Strong 2°C Pathway' –sometimes referred to as a 1.5°C pathway, (with perhaps 50% probability), which can be used to assess national trajectory propositions. The following graph shows South Africa's historical emissions from 1990 to 2013, followed by diverging projections or allocations to 2030.

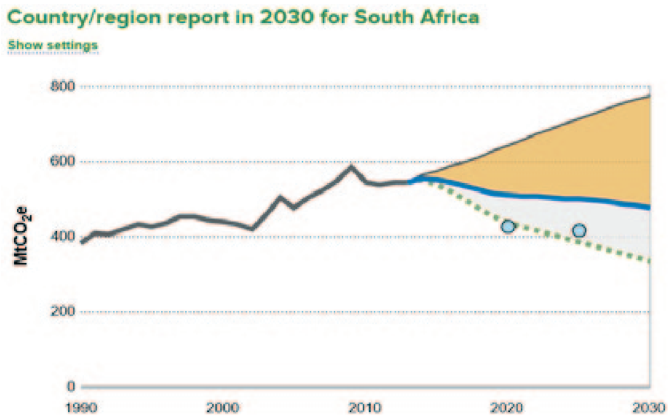


Figure 14

The climbing trajectory is a baseline emissions projection against which mitigation is calculated, which is derived from a global reference case and not offered as a national business-as-usual scenario, though it is very close to the reference case of the 2050 Pathway Calculator for SA. The solid mid-line, declining from emissions of about 550 Mt per annum (roughly what our current emissions are) down to 483 Mt in 2030, is calculated with the chosen RCI setting to be the national 'fair share' of acceptable global emissions or carbon space. The area between the baseline and the 'fair share' trajectory represents domestic mitigation required.

A particular feature of the CERC is that it attributes all the globally required mitigation amongst the 195 countries included in the database, according to a calculation of national capacities for mitigation: The dotted line indicates what national emissions should be, to achieve the selected global pathway, with additional internationally supported mitigation. This the area between the fair share and the required emissions outcome in developing country reports corresponds with an area in the country reports of the developed countries that indicate the mitigation that has to be achieved elsewhere. Thus the above graph shows that South Africa's emissions should be reduced to about 350Mt per annum in 2030, even though our 'fair share' of effort would leave national emissions above 450 Mt.

The two dots represent South Africa's international commitment, expressed as 34% by 2020 and 42% by 2025, here calculated from the CERC baseline, so they are well below government's interpretation of our commitments, which is based on the (outdated) business-as-usual projection that assumed strong economic growth that has not materialised.

COMPAIRING EMISSIONS PATHWAYS: SOUTH AFRICAN NATIONAL CLIMATE CHANGE RESPONSE AND CERC

In order to assess whether the extrapolated PPD range is consistent with an appropriate contribution to global efforts needed to offer a 50% chance of holding to a 1.5 degree future temperature rise pathway, we can now compare the 'Mid- and Low-PPD' trajectories with the CERC Country Report, below in Fig 15.

From this it may be observed that even a 'Low-PPD' trajectory is well above the required outcome for a 1.5° pathway, though it is consistent with what the CERC calculates as a national fair share. The extrapolated 'Mid' and 'Low' trajectories (below left) both peak in 2021 and start to diverge in 2024. The required emissions outcome pathway (declining from 2015 in right-hand graph) roughly corresponds to a 12 Gt carbon budget to 2050, which is shown below left starting to decline from 2018.

The 12 Gt pathway – the dotted line in left-hand graph – is one of many created in spreadsheets as part of the author's analysis exploring potential national emissions pathways, informed by working with several models and engagement in energy planning processes over the last decade and taking into account our existing infrastructure, such as electricity generation, without assuming that it will all serve out its projected lifespan. As in figure 12 b the extrapolations of Mid- and Low-PPD for the period to 2024 follow the same trajectory as the 'With All Measures' projection of the Mitigation Potential Analysis, peaking in the early 2020s as Medupi and Kusile come on line. The 12 Gt trajectory is far more hypothetical in the near term – in practical terms it would require something like an enlightened developed country sponsoring the early closure of an old coal plant by financing more renewable energy

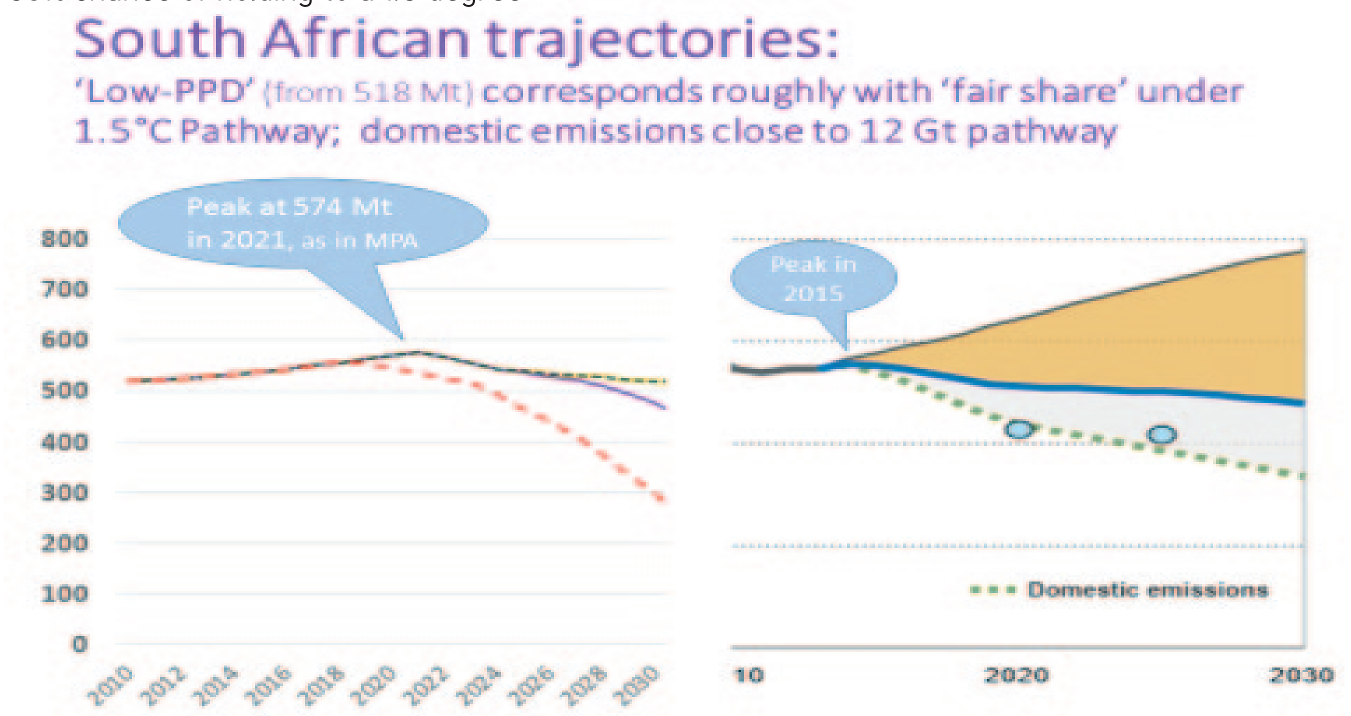


Figure 15

capacity than already committed to under the procurement programme, plus concerted energy efficiency interventions.

A similar comparison with the CERC Weak 2°C Pathway country report for SA suggests that 'Mid-PPD' might defensibly be put forward as a national 'fair share' of effort (with RCI criteria favourable to South Africa) towards the global goal; however, the 'Low-PPD' trajectory would still overshoot the required national emissions outcome (described in CERC as "domestic emissions") even with implementation of both domestic and internationally supported mitigation.

WHAT DOES AN AMBITIOUS EMISSIONS REDUCTION PATHWAY MEAN FOR SOUTH AFRICAN COAL CONSUMPTION?

Having developed a sense of what our national emissions trajectory should look like, as well as what we may claim as a fair share of a global carbon budget (below which mitigation should be supported by more industrialised countries), we have a context in which to evaluate the key scenario put forward in the South African Coal Road Map (SACRM), produced as an input to government's Integrated Energy Planning. A recent study (Burton& Winkler, 2014) analysed the carbon footprint of three SACRM scenarios to 2035, including one it calls "Low Carbon World". This name is misleading as the envisaged domestic coal consumption for the period would emit about 10 Gt of carbon dioxide, and this does not include related mining (methane) and transport emissions. Such a coal carbon budget, or claim to carbon space, is illustrated below with the extrapolated PPD trajectories (shown above left and in fig. 12 b), with a 12 Gt trajectory:

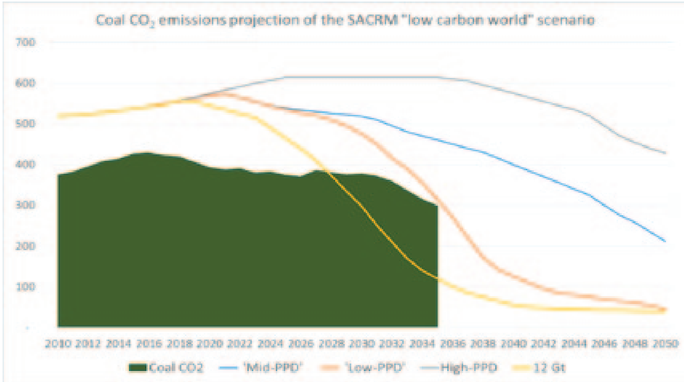
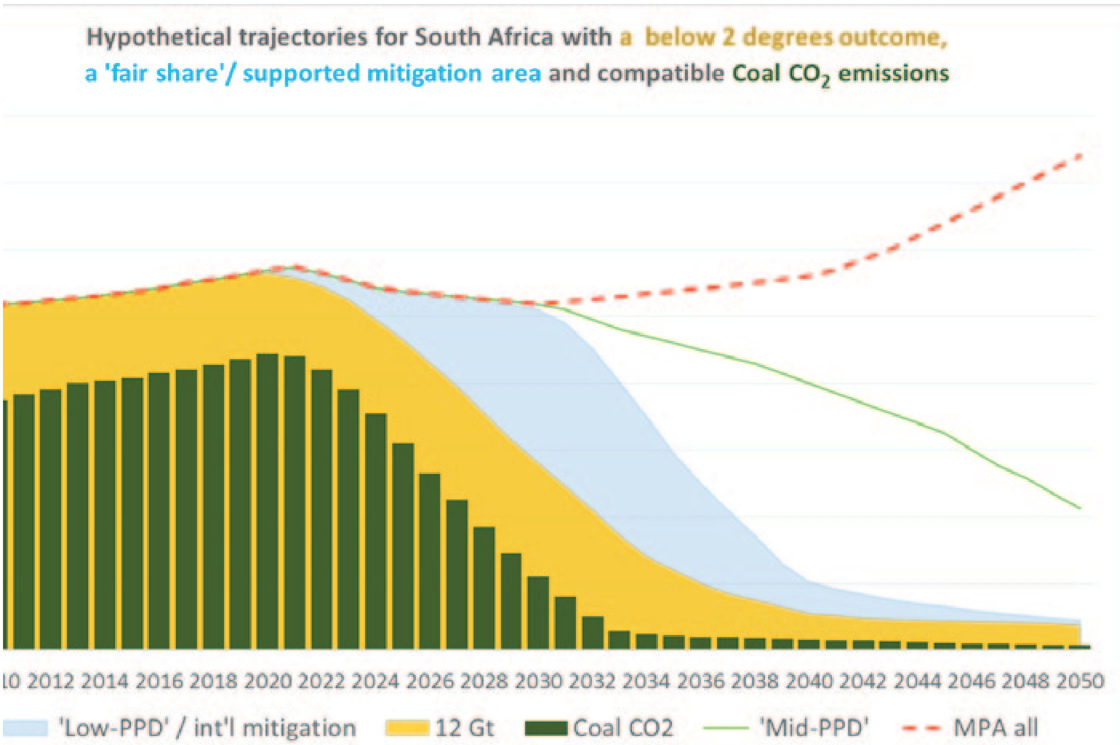


Figure 16

While the coal industry is not contemplating trying to achieve such a scenario, it could be argued (at best) that they have considered a scenario that may be consistent with a national fair share of global effort for a 2°C pathway (the 'Mid-PPD' trajectory), but the projected coal use under this scenario cannot be reconciled with a national emissions outcome consistent with this goal, much less with a 1.5°C pathway. To merit the name "Low Carbon World" a scenario for South Africa (recognising our developing country status) should limit domestic coal [Figure 17 above] with cumulative total of 7 750 Mt[21], which would be less than half of the coal reserves listed on the Johannesburg Stock Exchange in 2012.



The hypothetical allocation of a long term national carbon budget for coal, illustrated above, is informed by the 12 Gt trajectory, which is derived from the CERC projection of the necessary emissions outcome in South Africa for a strong probability of staying below 2 degrees. The shaded tarea above the 12 Gt trajectory and below national 'fair share' corresponding to 'Low-PPD, which constitutes a total of about 3 Gt, represents mitigation that Annex 1 countries must achieve elsewhere and that South Africa should package and present for international support.

CHALLENGING THE SOCIAL LICENSE FOR COAL USE

Access to electricity provides numerous social benefits, sometimes referred to as positive externalities of a supply system (see table p.10). The coal industry claims that its continuing growth over the coming decades is required to meet social and economic objectives, as reflected in the South African Coal Road Map. In so doing the industry invokes such positive externalities of electrification to lay claim to an indefinite social license to operate. It is an argument that is no longer justifiable.

In the 21st Century the only basis for such social license is our current dependence upon concentrated and centralised energy and is thus only valid for the period required to transition. If individuals persists on a course of action, knowing that it presents a clear and present danger to the rest of society and disregarding the consequences, we may call them sociopathic. Since we have other, more appropriate and effective means of achieving the desired development objectives – including safe and sustainably affordable energy services –, it is time to phase out fossil fuel investment.

In November 2014 the Carbon Tracker Initiative issued A guide to why coal is not the way out of energy poverty, in which it is noted that "Coal is not distributed well to serve Africa's energy poor. Only 7% of the people in sub-Saharan African countries who lack access to energy live in countries with producing coal assets." The analysis concludes that:

> "Increasing coal use does not guarantee energy access. Industry often cites the International Energy Agency's (IEA) New Policy Scenario as evidence that coal demand will increase. Even this reference scenario only sees coal demand increase by 23% globally through 2030 and with coal losing market share. However this scenario only reduces overall energy poverty by a quarter, and in fact sees an increase in the number of people without access to energy in Sub-Saharan Africa."

FOSSIL FUEL DIVESTMENT: WHY PEOPLE, UNIVERSITIES, FAITH ORGANISATIONS, BANKS AND INSTITUTIONAL INVESTORS ARE MOVING MONEY OUT OF COAL, OIL AND GAS

One measure of the way societies across the world are beginning to withdraw the social license of coal companies to operate is the rapid growth of the global fossil fuel divestment movement. Taking its inspiration from the divestment strategy of the South African anti-Apartheid struggle, author and divestment activist Bill McKibben highlights the moral argument: "the logic of divestment couldn't be simpler: if it's wrong to wreck the climate, it's wrong to profit from that wreckage." The financial case is equally compelling, as fossil fuel industries have fossil fuel reserves listed as assets that contain carbon far in excess of what can be added to the atmosphere if we agree to avert climate catastrophe. This constitutes a fundamental flaw in our political economy resulting in a growing 'carbon bubble' of of apparent assets that are heavily overvalued, as well as providing insupportable political leverage.

Perhaps the most important aspect of divestment is that it explicitly revokes a social license to operate in perpetuity and calls on investors to confront the consequences of holding assets that require releasing huge volumes of carbon (not to mention the Mercury, radioactive materials, etc.,) from geological sequestration. Divesting from fossil fuel 'assets' in general, or coal specifically, is a declaration that, whatever the merits of concentrated energy have been for civilisation to date, we must and will stop banking on burning fuels that will drive average global warming above 2°C.

While it is seldom explicitly stated, a substantial proportion of the business community are not only insisting that we all fatalistically accept unchecked global warming, but that it is futile to stop banking on it. However, such views are changing, particularly amongst pension funds, sovereign wealth funds and other institutional investors, as the financial risks attached to fossil fuels investments increase. Companies are coming under increasing pressure from a combination of incoming climate regulations, the plummeting cost of renewables and the volatility of oil prices, which is also increasingly affecting gas and coal prices.

> "Norway's parliament has formally endorsed the move to sell off coal investments from its $900bn sovereign wealth fund, the world's biggest. It is the largest fossil fuel divestment yet, affecting 122 companies across the world, and marking a new success for the fast-growing and UN-backed climate change campaign. A new analysis said the fund would sell off over $8bn (£5bn) of coal-related investments as a result." **– The Guardian, 5th June 2015**

In 2012 the investment and actuarial head of the Government Employees Pension Fund (GEPF), John Olifant, wrote in the Financial Mail: "In our view as the GEPF the next big systemic risk to the financial system and by extension pension funds' investment portfolios is the threat of fossil fuel assets becoming stranded as the shift to a low carbon economy grows." This was in part prompted by the Carbon Tracker Initiative publication Unburnable carbon: Budgeting carbon in South Africa, which estimated that burning the South African coal reserves listed on stock exchanges would emit 19.2 Gt CO_2e.

This is shown in Figure 10 below, with a range of carbon budgets that have been suggested for 2010 – 2050 and with an allocation to coal based on the current contribution of coal to total national emissions. Budget D at 18 Gt tcomes close to the cumulative total of emissions contemplated in the National Climate Change Response Policy (NCCRP), as explained above.

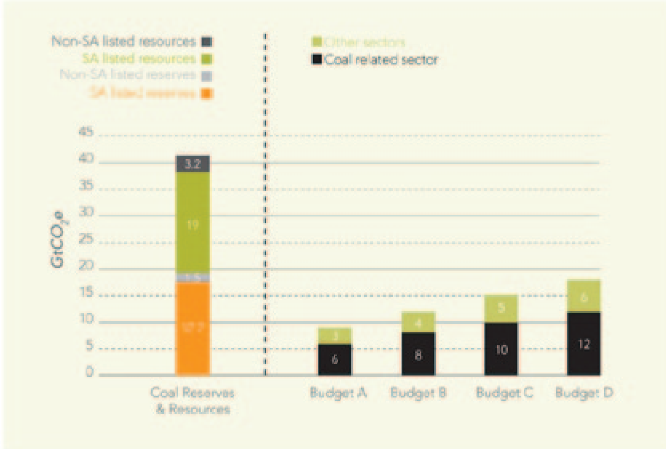


Figure 10

Divestment is not a market mechanism, though it seeks to impact upon markets beyond the immediate shift of investment. As long as the market value of energy supply companies requires assured future earnings from fossil fuels – driving the continual search to secure new fossil reserves exceeding their current production –, we are caught in a self-perpetuating cycle: divestment campaigning does not claim to be sufficient to break us out of this cycle.[22] It is but a step towards a more rational and moral approach to investment management with a global and long-term perspective; hopefully a catalytic step that will prompt investors to promote 'market', fiscal (e.g. tax shifting) and governance reform and defuse the threat of a carbon bubble – what an economist might call an "unmanaged market correction".

The nature of our 'market' system and investment valuation methodology renders the wholesale shifting of investments from fossils to renewables an apparently "costly" exercise, since choosing not to use any fossil fuel reserves is counted as a cost – the foregone use is deemed 'lost' production – while foregone use of renewable energy simply isn't considered. Such 'loss' of revenue is put into perspective by global analysis, such as the findings of an international panel published in 2014 entitled *Better Growth, Better Climate*[23], examining how a low-carbon economy can be designed and delivered on the ground, particularly in developing countries. The report shows that low-carbon infrastructure investments are barely more expensive (around 5%) than high-carbon and will pay for themselves over time in lower operating costs. Most importantly, they will bring multiple economic and social benefits that make them a rational economic choice even before their climate benefits are considered.

The latest report of the New Climate Economy project: Oil Prices and the New Climate Economy, (May 2015) warns that oil prices are impossible to predict and their volatility is costly to the economy – it will delay business investment and lead to job losses which can hurt the global economy. However: "Savings of US$2 trillion to 2030 are estimated from reduced investment in fossil fuel power plants in a low-carbon scenario. Reduced demand for fossil fuels could potentially also lead to further savings of US$3.7 trillion along the supply chain of fossil fuels. This includes reduced investment in the exploration and transport of fossil fuels." Such would be the opportunity costs of failing to move investment away from fossil fuels.

International negotiations would ideally broach the issue of a global 'write-down' or retirement of fossil assets, though a global carbon tax is considered by many a more credible prospect – preferably with revenues deployed globally and equitably. Any responsible management of the transition to a low carbon economy will have to include the wealthy letting go some of the assets to which they currently hold claim. The key question is the rate at which we can grow renewable energy and associated industries and the electrification of transport. A core component of this question is how to mobilise finance for the massive growth required – divestment will have far greater traction with availability of a range of investment vehicles or facilities beyond individual project finance.

Addressing direct coal use in industries where substitution is not an available option is more complex. It would make sense to start differentiating investments associated with supplies for specific applications, such as in the metallurgical industries where coal provides more than heat to the process, which may merit a social license into the foreseeable future, as such applications would consume coal at a relatively small scale. Indeed, it would be prudent to estimate how much allowance should be made for such niche applications over the long term and which countries or reserves justify special treatment. For South Africa this may be a significant portion of the 12.7% (as per available figures) coal use that is not for electricity generation and liquid fuels, as shown in this overview from the 2010 Synopsis:

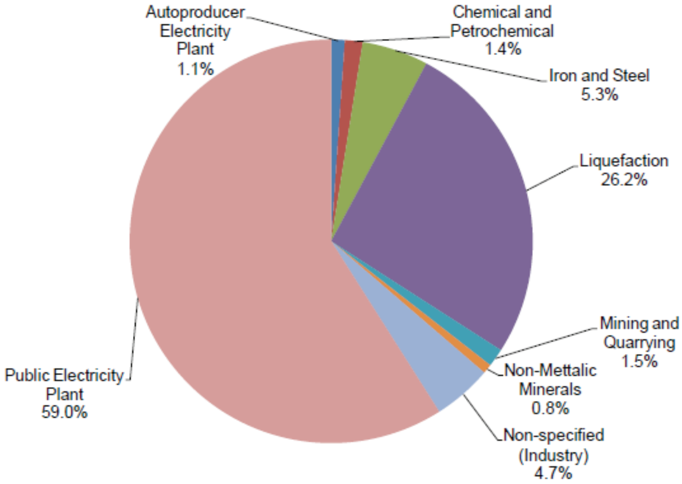


Figure 11. Coal consumption by industry sub-sector for 2006, Total: 2653 PJ (DME, 2009)

FOSSIL FUEL SUBSIDIES: LEVELLING THE PLAYING FIELD FOR RENEWABLES

Current financial practice regarding energy involves numerous forms of direct or indirect government subsidies, from corporate tax incentives and publicly-funded infrastructure for extractive industries, through to pro-poor measures, which are often only available to those within the current fossil-dependent energy system such as Free Basic Electricity.

The Executive Director of the International Energy Agency (Maria van der Hoeven) noted at a recent event that "in 2014 fossil fuel subsidies exceeded US$500 billion: four times the subsidies for renewable energy."[24] Van der Hoeven also noted that between 2008 and mid-2014 high energy prices had been the key driver for subsidy reform, but that current lower prices reduce the budgetary urgency for governments to take action.

A working paper published by the International Monetary Fund (published in May 2015) estimates that fossil fuel companies will benefit from $5.3 trillion dollars of global subsidies in 2015, compared to just $121 billion dollars committed to renewable energy. In calling for reform it notes: "The fiscal, environmental, and welfare impacts of energy subsidy reform are potentially enormous. Eliminating post-tax subsidies in 2015 could raise government revenue by $2.9 trillion (3.6 percent of global GDP), cut global CO_2 emissions by more than 20 percent, and cut pre-mature air pollution deaths by more than half."

The vast difference between these assessments of "subsidies" arises from different use of the term, as the working paper explains: "It focuses on the broad notion of post-tax energy subsidies, which arise when consumer prices are below supply costs plus a tax to reflect environmental damage and an additional tax applied to all consumption goods to raise government revenues." Whereas: "The International Energy Agency (IEA) reports its estimate ...based on the price-gap approach, which compares the end-user prices with reference prices. The reference prices consist of supply cost inclusive of shipping cost and margins and any value-added tax. The latest estimate indicates that fossil-fuel consumption subsidies worldwide amounted to $548 billion in 2013, (IEA 2014).

Whether using a more inclusive or restrictive definition of subsidies, it is clear that simplistic claims that renewable energy is "too expensive" are more a reflection of huge market distortions that have become built into the system and taken for granted, than a conclusion drawn from robust comparison of the merits of different technologies and resources. The IMF working paper also notes: "These subsidies primarily reflect under-pricing from a domestic (rather than global) perspective, so that unilateral price reform is in countries' own interests...This suggests that most of the environmental benefits from energy subsidy reform would accrue to the local population."

Subsidy reform is urgently needed to avoid digging ourselves deeper into fossil fuel dependency, but is a complex undertaking that requires government to confront vested interests. It is generally easier to add measures, such as a resource rent tax on the profits of extractive industries, or a levy on non-renewable electricity generation, than to remove existing subsidies that have come to be accepted as part of 'market conditions'.

THE ELECTRICITY SUPPLY INDUSTRY: MOVING BEYOND FOSSIL FUELS AND CENTRALISED ENERGY PRODUCTION

Looking beyond traditional energy infrastructure and supply models is not only desirable for ensuring universal access to basic energy services (including for productive activities), but has increasing appeal for established users as the costs of renewable energy technologies continue to decline and the price of grid-based electricity continues to climb. The electricity supply industry is facing major disruption regardless of climate change, as the four-fold decrease in the costs of PV and rapid progress in electricity storage technology allow the affluent the option of opting out of utility service.

Shifting generation from fuel-based to renewable energy technologies presents significant system management challenges, such as load balancing and voltage fluctuation and the expansion of storage capacity, and will require substantial investment in transmission infrastructure. 'Smart grid' technology is required both to support small-scale generation embedded within a distribution network (with optimal system oversight, end-user monitoring and demand management), and for increasing the potential for optimal matching of demand and supply, decentralised generation and optimising energy efficiency. In South Africa much of our grid is anyway in urgent need of refurbishment, but is not the only driver of change, as a recent Power and Utilities Survey concluded: "Today's power utilities market is facing major disruption... Power companies are pulling the plug on conventional generation."

THE SCOPE FOR RENEWABLE ENERGY

We have examined what could be considered the necessary emissions reduction in South Africa that would contribute to meeting the global goal to hold average temperature increases to below 2 degrees, and the implications for coal investments are stark. However we interpret our commitments or what we consider to be conditional upon international support, a radical change of our energy mix is required to end our dependence on coal, most rapidly for electricity supply.

There is no question whether South Africa could grow electricity generation capacity from renewable energy sources very rapidly to overcome supply short-falls within a few years. This potential has been clearly demonstrated by the recent procurement programme for independent power producers (REIPPPP) and the extent of the projects waiting with financing secured that have not been accommodated in the procurement process. There is a compelling case for why we should. The primary question is how to overcome non-technical barriers, such as political reticence and Eskom's aversion to having its monopoly eroded. The other question is how best to balance the imperatives of both rapid and sustained roll-out and the localisation of renewable energy industries with broad-based participation.[26]

A 2008 research study established the viability of renewable energy providing 15% of electricity supply by 2020[27] with long term cost savings; subsequently the costs of RE technologies have actually declined faster than assumed in that study. From our present situation we are unlikely to achieve more than 10% of grid supply by 2020, if we strive for a decent balance between short lead times and socio-economic and environmental impacts. This would require some 12 000 to 14 000 MW of generation capacity (depending on the mix of wind and solar technologies), which would be an appropriate initial step, consistent with expansion to some 40% of electricity supply by 2030. This is illustrated in the electricity supply graph below (p.25) for the Strong Decarbonisation pathway developed as an exemplar of the 2050 Pathway Calculator for South Africa. We may be getting on track to achieve 10% before 2020, as in June 2015 the DoE confirmed that the RE IPP procurement programme had been expanded with a mandate for a total of 12 600 MW of solar and wind power, that will hopefully all come on line before 2020.

More programmatic approaches, along with clear plans as the foundation for long term investment, are needed to develop local industries. The option of Feed-in Tariffs for particular technologies or applications, including as a municipal utility option for households and the commercial sector, should not be neglected simply because this mechanism was set aside for a concerted programme of project-based procurement with competitive bidding. South Africa is amongst the top five countries developing Concentrated Solar Power (CSP) technologies for electricity generation, incorporating thermal storage, but so far we lack the ambition or coherent strategy to maintain a leading role

The current context of supply shortfalls highlights the value proposition of renewable energy, as elaborated in these key findings of a recent study by the Council for Scientific and Industrial Research of macro-economic impacts of the 600 MW of wind and 1000 MW of photovoltaic (PV) capacity feeding electricity into the grid:

> "This study addressed the questions how much fuel costs the first 1 600 MW of wind & PV have saved during the year 2014, by reducing utilisation of diesel-fired gas turbines and the expensive part of the coal fleet, and how much of "unserved energy" they have avoided that would have been necessary without them. In 2014, renewable energy generated financial benefits in the form of fuel-saving and macroeconomic value of R 5.3 billion (which is 2.42 R per kWh of renewable energy), while they costs only R 4.5 billion in tariff payments to the IPPs (2.08 R/kWh)"

Renewable energy is the central component of a low carbon economy and should become the foundation for all electricity generation, with natural gas restricted to a strategic role to support supply systems management, such as back-up capacity available on demand to maintain grid stability. Low-carbon transport requires replacing most liquid fuels with electricity, but will also require biofuels, produced in accordance with strict social and environmental criteria, which could also replace some direct use of fossil fuels in industry. There is great potential for sustainable biofuel production in much of Southern Africa, but also significant risks, which are exacerbated if 'economic efficiency' determines the modes of production. Urgent work is needed to avoid a commercial biofuels industry following the extractive and abusive precedents of the oil industry and to support localised biomass processing for resource-efficient energisation.

Low-carbon energy supply infrastructure will require a healthy minerals industry – the material requirements have been assessed on a global scale for a scenario of 100% renewables by 2050 and while they are daunting, the materials are available. Globally we need to plan for discerning and optimal use of the products of extractive industries and South Africa has a lion's share of the required materials. Our natural resource endowments are such that we could be one of the first countries to derive all our energy requirements from renewable resources. To generate 100% of our electricity from renewables will be a lot easier (though it becomes more costly with every new coal-fired plant built) and could be accomplished by 2050.

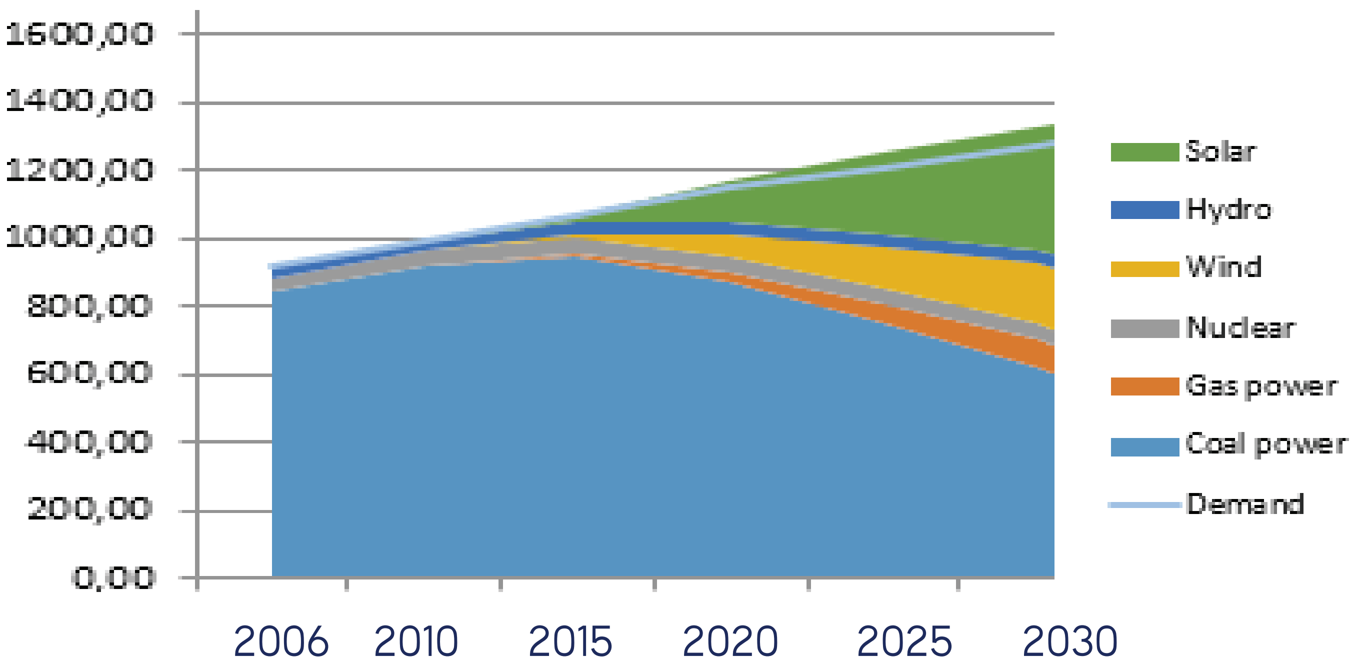
South Africa is currently a prime destination for renewable energy investment, achieving a strong spurt of growth,but commitment to creating a new nuclear industry would push renewables back to the side-lines, denying us the opportunity to join the vanguard of the renewable energy revolution. To realise the inclusive development benefits of renewable energy requires maintaining strong demand for manufacturing from the grid-based supply industry. A target of 40% of electricity by 2030 is not only realistic – in a world that does not give up on social justice and climate change mitigation – but also the most assuredly beneficial long-term industrial strategy available, and would have the added benefit of crowding out irresponsible investment in an ailing nuclear industry.

The following graph is a snapshot to 2030 of the electricity supply projection in the Exemplar Pathway by Project 90 by 2030 alluded to above and illustrated in figure 9 (p. 14, with corresponding emissions shown in figure 8). It was created with the Excel version of the 2050 Pathway Calculator for South Africa, which is available for download via the DEA website: www.environment.gov.za. It is an illustrative projection, smoothed out by the modelling (which does not anticipate load-shedding or delays in Medupi commissioning). The modelling is based on official growth projections and planning assumptions, to meet a modest growth in electricity demand, as this pathway includes aggressive energy efficiency and conservation interventions. By 2030 this pathway has some electrification of transport and the role of electricity in the supply mix has started growing.

Figure 12: Electricity supply from 2006 to 2030 with renewable energy providing 40% -- Solar: 27.5% (365 PJ); Wind: 12.8% (170 PJ); Coal: 47% (624 PJ); Gas: 6.3% (84 PJ); Nuclear (Koeberg): 3.6% (48 PJ); Hydro: 2.8% (37 PJ); Demand: at 1273 PJ is slightly less than supply, allowing for export of 54 Pj

Shifting the trends of energy investment is at the heart of a just transition to a sustainable, equitable society that must become carbon neutral well before the end of the century. Two strategies have been described, with an emphasis on divestment as a kick-start, a practical and moral foundation and subsidy reform as an essential accompniment. To unleash the renewables revolution in South Africa will require a clear commitment and robust planning and implementation of a new strategic approach, with the key priorities as follows.

- A decisive strategy with clear targets and enabling institutional arrangements is fundamental to ensuring the development of local manufacturing industries in renewable energy technologies, particularly in solar energy – including a target of at least 40% of electricity supply from renewable resources by 2030.
- South Africa has very strong prospect for being a world leader in solar technologies, which are sure to undergo exponential growth internationally, while we have slim chance of becoming a significant player in nuclear technology, even with fleet procurement, in an industry that is in decline in terms of share of the world energy market. Solar is the better value proposition for the people of South Africa, even if issues of nuclear safety and waste legacy are set aside, but the political commitment to developing a new nuclear industry presents a major barrier to realising our renewable potential, particularly in the current constrained financing environment.



- Integrated Energy Planning (IEP) is the appropriate context to determine, in consultation with stakeholders, the optimal growth path for renewable energy at a pace conducive to localisation and a scale sufficient to replace old coal-fired plants, several of which are unlikely to achieve their projected lifespan; however, as useful as IEP could be, we do not need to wait for a successful national IEP process to proceed with scaling up from recently established foundations.
- It is time to accept that the days of coal must be numbered and a plan be formulated for responsibly phasing out coal use in power supply; any prospect of a third coal-fired plant (like Medupi) should be ruled out; any proposals for life extension of existing plant should be abandoned.
- A Feed-In Tariff for small-scale embedded generation (feeding into the distribution network) from renewable energy should be introduced and financed at a national scale.
- Transparent and accountable integrated planning is required for transmission and distribution development and modernisation adopting smart grid technologies, including consideration of decentralised storage and prospects for regional cooperation in electricity supply system management.
- The Working for Energy programme under EPWP should be scaled up with a programmatic approach, particularly to facilitate community-based sustainable biomass energy and related natural resource management (CBNRM).
- Enabling the effective application of participatory Local Integrated Development Planning to advance energy access and decentralised energy development at community level requires a national programme of support to local government, linked to a facility offering education and training at community level.
- A crucial task to fully realise the public benefit potential of renewable energy is to develop governance and regulatory systems that curtail short-termism and redirect financing.
- Financial sector regulations that favour short term returns to shareholders over long term risk management should be revised, informed by a review of energy subsidies and prospects for subsidy reform (including the National Treasury initiative on environmental fiscal reform), along with innovation of investment options to finance low carbon infrastructure.

CONCLUSION

To avoid catastrophic climate change we will have to displace fossil fuels with renewable energy, in a matter of some decades. The quicker we do it the less we will pay, if we think in terms of a generation rather than an election cycle, and the more we gain across all metrics (other than gross consumption), from human health and security to ecological stability and shared prosperity. Our centralising development pattern and accelerating resource depletion cannot be sustained, but humanity in all its diversity and the biosphere as we know and participate in it can be sustained, with the damages of climate change probably contained. Fortunately we do not need to be driven by fear, as the opportunities of less intensive modes of production and wasteful consumption and withdrawing from our dependence on concentrated energy offer growth in real wealth on a decentralised basis.

The challenges arising from the global change we are working in the world go well beyond climate and giving up the convenience and quick returns of concentrated energy is one of the more manageable, involving opportunities and net value gains along with transition pains. We have found ways of financing the capital costs of renewable energy infrastructure, but to realise the full potential for public benefit we need government, particularly at the local level, to enable and support social ownership in the energy system; we need to not only 'monetise' renewable resources through power procurement agreements, but also to finance bottom-up and decentralised development. Since incremental change in the energy system is by definition inadequate to meet the climate challenge, we will have to evolve beyond a predominantly competitive economic system and international relations.

The current uses of 'emissions space', or the carbon cycling capacity of the biosphere, are a product of history and far from optimal for any outcome other than profitability. Carbon budgeting takes account of the status quo (e.g. that inefficient industrial operations cannot simply be turned off, or immediately be taxed equivalent to the social cost of emissions), without assuming 'grandfathering' – according free rights to current polluters to continue their emissions. We can devise methodologies for prioritising developmental outcomes through the optimal allocation of a long term carbon budget, though we will need to improve our information management and our measures of progress to achieve the integrated assessment and planning that such an holistic application of carbon budgeting requires. However, we do not need a highly detailed or prescriptive picture of the outcomes of a just transition to start big picture budgeting and planning for the renewable energy development that will kick-start the transition to a low carbon economy.

Ultimately achieving no net human addition of carbon to the atmosphere will require many interventions beyond the energy system, including massive forest restoration, changes in agricultural practices and consideration of the full ecological footprint of our dietary choices. The challenges are immense, but we know how to get started and it includes changing the way we measure economic success and requires reversing the concentration of wealth. Some say this cannot be done – they will be right for as long as we believe them.

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ANNEXURE:

llustration of the Climate Equity Reference Calculator (CERC) allocations, as percentage of global effort, to groups and countries:

Responsibility & Capability Index times series – percentage of global total

Country or Group	2010	2015	2020	2025	2030
Annex 1 (developed countries)	77.99	73.69	71.55	69.14	66.70
Non-Annex 1 (Developing)	22.01	26.31	28.45	30.86	33.30
LDCs (Least Developed)	0.26	0.26	0.27	0.29	0.31
North America	35.22	33.85	33.00	31.90	30.77
Western Europe	25.60	23.53	22.72	21.87	21.01
China	3.99	7.27	8.80	10.44	12.02
Middle East and Africa	4.72	4.97	5.11	5.27	5.44
Africa	1.50	1.51	1.57	1.64	1.71
Sub Saharan Africa	1.13	1.15	1.17	1.19	1.22
Algeria	0.11	0.12	0.13	0.14	0.15
Angola	0.04	0.04	0.04	0.05	0.05
Ghana, Mozambique, Uganda	0.00	0.00	0.00	0.00	0.00
Nigeria	0.05	0.06	0.06	0.07	0.08
South Africa	0.69	0.70	0.70	0.71	0.73

The allocation of Responsibility and Capability (RCI) follows the global split between developed and developing countries in the Convention (the former listed in Annex 1), reaching a 2:1 ratio by 2030; South Africa accounts for 46% in 2010 and 43% in 2030 of Africa's RCI allocation and for about 60% of the effort allocated to Sub Saharan Africa over the period.

CERC settings for determining RCI include (main selections):	
Responsibility weight: 0.5	Include non-CO_2 gases: yes
'GDR' threshold: $7,500	Include emissions embodied in trade: no
Include land-use emissions: yes	Cumulative emissions since: 1850
Global mitigation pathway: 1.5° pathway	Use mitigation smoothing: yes

ENDNOTES:

[1]For example the full life-cycle of oil production and use includes: exploration – from sonar geological surveys to drilling; extraction – not ignoring occasional spills; refineries – including routine emissions in densely populated areas; distribution – pipelines, trucking and retail outlets; combustion of fuels – incl. paraffin, petrol and diesel, heavy fuel oil (with some product serving as chemical feed-stocks for plastics and agricultural inputs); and waste management.

[2] Renewable energy is often characterised as "intermittent", as a way of exaggerating these challenges.

[3] Not all of the interventions that have been suggested to address climate change would have positive impacts or development 'co-benefits'; some involve high risks or sacrificial zones; in some cases benefits are contingent upon how and where it is done, for example large-scale biofuel production for global markets has involved wide-scale human rights abuses and ecological degradation, although with suitable lands, sound governance and sustainable practices biomass energy can have a valuable role to play both in transition and over the long term.

[4] p. 32 of the White Paper on Energy Policy for RSA (1998)

[5] For example Wei, Patadia, and Kammen (2010) which reviewed and summarised findings of a range of studies; IRENA (2013), Renewable Energy and Jobs, International Renewable Energy Agency, Abu Dhabi.

[6] This practice of promising jobs has become commonplace, but in the energy sector the fossil fuel proponents rely far more than their RE counterparts on projected and more speculative downstream impacts.

[7] There has been some exploration of this under a Solar Technologies Road Map process, the results of which have yet to be published

[8] Whether one can rely on the grid for surrogate storage, or the value-add of reliability justifies dedicated storage.

[9] The technology was developed in Germany in the build-up to the Second World War, being adopted to ensure liquid fuel supplies for the Nazi war machine and abandoned after the fall of Hitler's regime.

[10] The nuclear industry prefers to count the heat energy produced by a reactor as the primary input of nuclear fuel to electricity generation, following the precedent of counting the energy content of coal input, and thus yielding a higher reckoning of the contribution of nuclear power, but this conveniently overlooks the extensive energy used in the production of nuclear fuel – the enrichment of uranium being the most energy-intensive step in a long fuel production cycle. Most energy statistics count the electricity generated as the primary energy input of nuclear power.

[11] This figure was noted in presentation materials during the development of Solar Technology Road Maps, which have not yet been published.

[12] No official statement regarding an IRP2015 has been found but officials have informally confirmed that work is expected to be delivered in the third quarter of 2015

[13] See The Tyranny of Realism – Integrated Energy Planning in SA in 2014, published by Project 90 by 2030

[14] This most succinctly stated in the Executive Summary (p.8): "Government policy is to remove distortions and encourage energy prices to be as cost-reflective as possible. To this end prices will increasingly include quantifiable externalities."

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ENDNOTES CONTINUED:

[15] There are different approaches to quantifying externalised costs; a 'direct' approach (as favoured by Eskom) is to trace the pathway of damage caused and put a price on it, while more holistic approaches consider more systemic impacts and costs to society, with less focus on the attribution of costs to specific polluters.

[16] 'Carbon' is commonly used as shorthand for greenhouse gases (GHGs), as emissions and as the cumulative concentration in the atmosphere, even when using CO_2equivalent as the standard unit of measurement, which quantifies different gasses in terms of equivalent impact (radiative forcing); Note: mass of Carbon content is sometimes used as the basis of an alternative unit of measurement, whereby a tonne of CO_2 is counted as 278kg of Carbon (CO_2 / 3.66).

[17] Identifying opportunities for more energy efficient equipment or practices – the technical potential – needs to be matched by assessing implementation prospects in context, including the pay-back period of associated costs and how disruptive any retro-fitting, major change of a production process, or behaviour, or regulatory regime may be.

[18] Opportunities for and Costs of Mitigation in South African Economy, Andrew Marquard, Hilton Trollip and Harald Winkler, Energy Research Centre, University of Cape Town, 2011; published by Department of Environmental Affairs.

[19] The interpretation of equity employed in the CERC is an elaboration of the Greenhouse Development Rights approach first published in 2007. The Calculator is available on-line at www.ecoequity.org

[20] Several parties to the Convention have argued that the division of the world in the listing of 'developed countries' in Annex 1 of the UNFCCC, adopted 20 years ago, should be replaced by some new system of differentiation, while many developing countries argue that the division should remain at least until Annex 1 countries have done much more to discharge the responsibilities they accepted as part of the agreement.

[21] This is not to suggest that such a coal consumption pathway is an optimal outcome for SA or the best allocation of emissions under such a carbon budget, but rather to observe that to be consistent with a 'low carbon world' an allocation to coal must be no greater than this.

[22] Much of the critique of divestment campaigning is actually a complaint that it does not provide a complete and comprehensive solution to this conundrum.

[23] Panel co-chaired by Nicholas Stern and Trevor Manuel.

[24] A Briefing Note of the Side Event on "Fossil Fuel Subsidy Reform and Investments in Clean and Affordable Energy", published by the International Institute for Sustainable Development (IISD), Volume 172, Number 23, 27 May 2015: http://www.iisd.ca/climate/fossil-fuel-subsidy-reform/

[25] 13th PwC Annual Global Power & Utilities Survey: Energy transformation - The impact on the power sector business model - - www.pwc.com/utilities - published October 2013

[26] This phrase refers, inter alia, to social ownership of the means of production, looking beyond the current provisions for Independent Power Prooducers, as well as to 'energisation' as called for in the 1998 Energy Policy.

[27] As above, this refers to the proportion of GWhr despatched, rather than to the rated capacity of generation installed (MW), which is the figure preferred by government e.g. in publicising IRP2010 (but does not take account of different availability factors for different technologies).

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ABOUT 350AFRICA.ORG

We are part of a million-people strong global climate movement that campaigns through grassroots organising and mass public actions in 188 countries. The number 350 means climate safety: to preserve a liveable planet, scientists tell us we must reduce the amount of CO_2 in the atmosphere from its current level of 400 parts per million and rising, to below 350 ppm.

Climate change will hit Africa hardest so this fight is about climate justice. Many of the poorest Africans, women and children are already facing more drought, floods and extreme weather that threaten their livelihoods and push food prices up. The fact is climate change is going to affect all of us.

We believe that an African grassroots movement can hold our leaders accountable to the realities of science and the principles of climate justice. That movement is rising from the bottom up all over the continent and is coming together to champion solutions that will ensure a better future for all.

ABOUT FOSSIL FREE AFRICA

South Africa's dirty banks are greenwashing their work while funding Africa's growing addiction to fossil fuels at the same time. Behind closed doors, banks like Nedbank are financing massive coal power stations, oil refineries and drilling rigs. This contributes to climate change, uses and pollutes huge amounts of scarce water and affects people's health.

As part of the global divestment movement, the Fossil Free Africa campaign is calling on banks like Nedbank to stop funding future fossil fuel projects and for people of conscience, universities and faith based organisations to commit to divesting from coal and oil.

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