WWF

REVIEW

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2010

50% BY 2030

Renewable Energy in a Just Transition to Sustainable Electricity Supply

CONTENTS

FOREWORD

by Dr Morné du Plessis

During the 2010 Soccer World Cup South Africa hosted teams from 32 nations in an event that served to mesmerise and distract in equal proportion. It is, after all, a delightful recreational event that is repeated every four years. By contrast in December 2011, South Africa will host some 200 national climate delegations, yet few would classify it as an event of vaguely similar stature and importance.

The truth is that the 2011 United Nations (UN) Climate Summit is without question one of the most important events that will ever be held. It will fundamentally determine the future shape and quality of life on Earth. We should not slacken our efforts to bring this truth to the attention of every person, business and government.

In this arena, South Africa and its people stand to play a most prominent role in ultimately bringing sense to the selfserving, short-sighted bickering that has typified previous failed attempts at reaching binding agreements on reductions in carbon emissions.

South Africa will again be in the international spotlight and the world will be watching to see whether or not we can host yet another successful event. More importantly for us as a country, our plans for meeting the bold climate change mitigation commitments we made in 2009, together with our progress in implementing measures to kick-start a just transition to a low-carbon economy, will be under close scrutiny.

The reality of our constantly shifting political and economic landscape is that it demands a dynamic approach to taking on the challenge of climate change. We need to constantly reinvent our understanding of human progress and potential.

What we still don't know about the full consequences of humanity's accelerating development and industrialisation is quite formidable. What we do know is truly intimidating, at best. And yet, down playing or even denying this reality has become a global industry.

What we know, what the science tells us unequivocally, is that we are running out of time to avert runaway climate change. We have at most five years to get the required reindustrialisation under way.

Never in the history of humankind has a single generation been handed the responsibility and opportunity to so dramatically change course, to evolve the way we work and live in ways that will wrest our fragile planet, and all who depend upon her, from certain disaster.

The changes we can and need to make in breaking our addiction to fossil fuels will carry benefits well beyond averting a climate catastrophe. Prioritising renewable energy will boost jobs, stimulate local industry, enable increased access to modern energy services through decentralised development and, in the long term, provide us with electricity at a cheaper rate.

However, the task is a monumental one and collective action is our only hope. For this reason WWF continues to campaign for a legally binding global climate deal, despite failure to reach such a deal at the UN Climate Summit in December 2009.

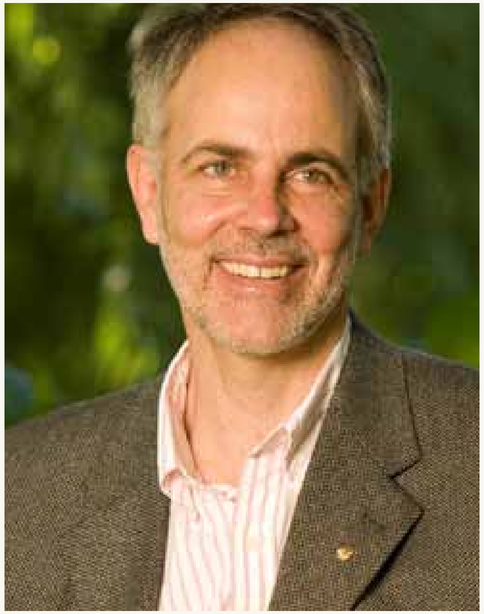
It is essential that South Africans effectively host and facilitate the conclusion of a multilateral treaty at the UN Climate Summit in 2011. Success will benefit the global economy and indeed our own economy far more than hosting the World Cup Soccer tournament.

South Africa has a particular responsibility to make key policy changes and take action on an appropriate response to climate change. We are one of the top-twenty greenhouse-gas emitters in the world and, as part of the group of emerging economies, the most influential African country in climate negotiations.

Responsibility aside, the volatility of the fossil fuel price and border tax measures to penalise carbon emissions will mean that if, as a nation, we are in the vanguard of low-carbon reindustrialisation, it will boost our competitiveness in the world economy, while also greatly expanding the value we derive from renewable energy resources.

Domestic actions to limit carbon emissions need not come at the expense of development imperatives, but could rather enhance development. This perspective was presented by President Jacob Zuma at the recent Green Economy Summit, where he pointed out that a green economy should "seek to address the interdependence between economic growth, social protection and the preservation of natural ecosystems".

We trust this publication will encourage increased public participation in on-going national policy and planning processes highlighted herein and hope to inspire all South Africans to become climate champions.



WWF CEO, Dr Morné du Plessis

"If we continue to plead ignorance on the actions necessary to contain the impacts of climate change, will our children forgive us?"

Dr Morné du Plessis, WWF CEO

INTRODUCTION

South Africa and its future power generation choices

by Richard Worthington and Laura Tyrer

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South Africa is at a crossroads in its energy development. With an economy founded upon and maintained by the burning of fossil fuels, South Africa faces critical choices around future power generation. The need for increased electricity capacity to meet development objectives coincides with growing awareness of the short- and long-term implications these decisions will have on our economy, society and the environment. Including extensive renewable energy technologies in our power mix offers great opportunities for local job creation and for making the best use of our natural resource base.

The country's international environmental commitments and ambition to remain competitive in the global economy mandate a major shift to renewable energy. This would also address socio-economic concerns, including the health impacts of local pollution, the risks of rapid fuel and electricity generation cost increases and other consequences of diminishing fossil fuel resources, including for raw materials for chemicals production. Southern Africa has about a quarter of the world's best solar resources on land, as well as bountiful wind, locally relevant micro-hydro energy and some sustainable biomass, with substantial potential for emerging ocean energy options.

Having based our industrialisation on the burning of fossil fuels, we have placed ourselves, as George Monbiot puts it, at the brief point between ecological constraint and ecological catastrophe. The increase of carbon emissions in the atmosphere from human activity has triggered an escalating increase in global average temperature that will have profound consequences for the world as we know it. Some unavoidable consequences of global warming include crop-yield decline, droughts, coral reefs and species losses. To stand a 50% chance of avoiding runaway climate change (the point at which the impacts of climate change trigger further effects that accelerate warming – such as melting permafrost releasing methane and warmer forests being more prone to runaway fires and releasing more carbon emissions), global average temperatures must be prevented from rising 2°C above pre-industrial levels. This requires that humanity as a whole becomes carbon neutral – stops adding carbon emissions to the atmosphere – well before the end of this century.

As part of the response to the threats posed by climate change, South Africa launched a process to develop a National Climate Change Response Policy at a Summit addressed by eight members of Cabinet in

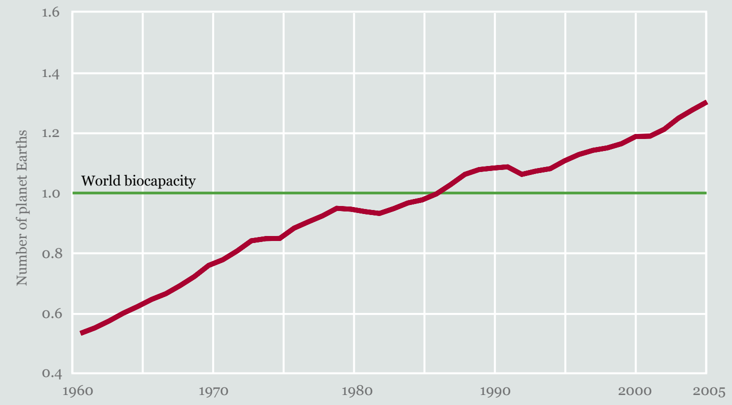
> *"Our Green Economy strategy must include ambitious targets for renewable energy to contribute to electricity supply."*
>
> Naledi Pandor, Minister of Science and Technology, Green Economy Summit

According to the Intergovernmental Panel on Climate Change (IPCC), carbon dioxide (CO_2) makes up more than three quarters of all greenhouse-gas emissions. CO_2 from fossil fuel contributes 56,6% of all greenhouse gases, while an additional 17,3% is contributed by CO_2 from deforestation and the decay of biomass. Methane (CH_4) from agriculture and waste makes up 14,3% and nitrous oxide (N_2O - mostly from fertilizer) contributes another 7,9% of the balance. Energy supply is estimated to contribute some 25,9% towards CH_4 and N_2O emissions. Industry, meanwhile, contributes about 19,4%, forestry contributes 17,4%, agriculture contributes 13,5%, transport, 13,1%, commercial and residential buildings 7,9%, and waste and wastewater contribute 2,8% to greenhouse-gas emissions.

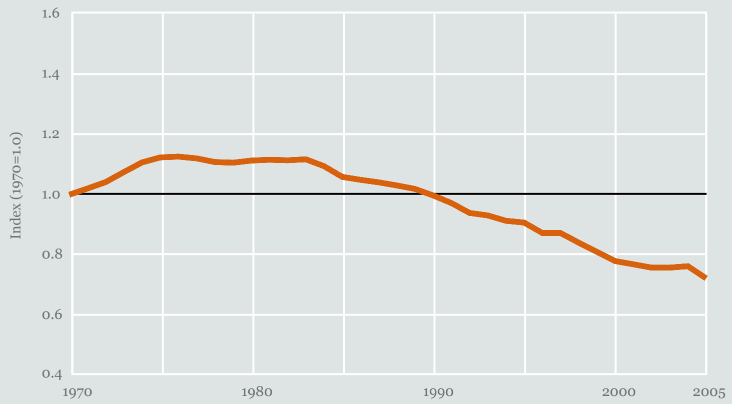
March 2009. A background discussion document circulated among stakeholders by the Department of Environmental Affairs in May 2010 provides an overview of the impacts of climate change and increasing climate variability in South Africa, which will affect almost every sector, and considers opportunities for adaptation responses. A White Paper is promised by the end of 2010, with a view to adopting legislation in 2011. The department is also in the process of drawing up greenhouse gas reporting regulations and compiling a climate change response database.

In May 2010 government announced its intention to develop a National Green Economy Plan at the Green Economy Summit, where President Zuma challenged the notion of a trade-off between faster economic growth and the protection of our environment, stating that the economic case for a healthy environment means that South Africa has "no choice but to develop a green economy". He also noted the need for Africa to make use of its abundant renewable energy resources. The briefing document: *Towards a Resource Efficient, Low Carbon and Pro-Employment Growth Plan*, notes a research finding that "If South Africa generates just 15% of total electricity use in 2020 using Renewable Energy Technology, it will create 36 400 new direct jobs, without taking any jobs away from coal-based electricity." (p.45) For an indication of the job-creating potential of renewable energy technologies please refer to study findings in the Appendices.

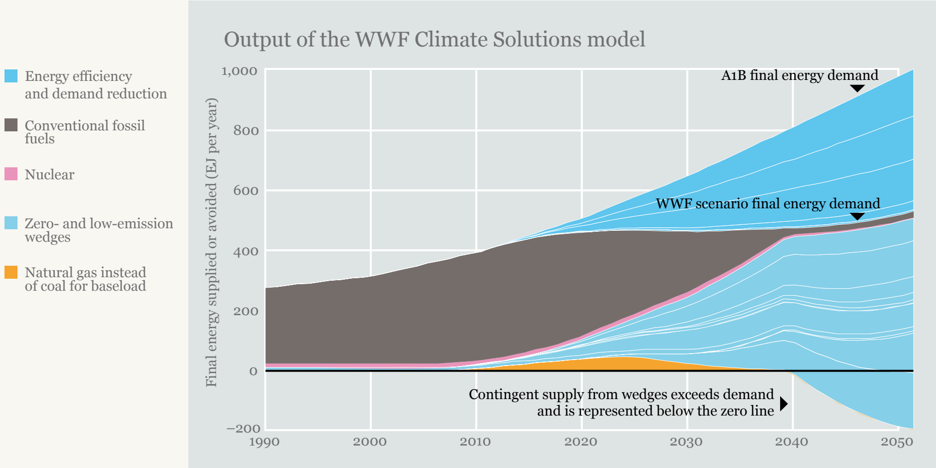
Humanity's Ecological Footprint, 1961–2005



Living Planet Index, 1970–2005



The Living Planet Report, published by WWF International in 2008, with an updated edition due around August 2010, clearly demonstrates the unsustainable



The top of the graph indicates a projection of energy demand growth under conventional assumptions, an indication of the energy services that will be required and the energy input required to deliver such services under a business-as-usual scenario. The upper triangle (roughly above 500 ExaJoules (10^{18} Joules) yearly, with joule being the measure of the energy service delivered) indicates the avoided conventional supply

nature of traditional development pathways, resulting in a global footprint 30% higher than the carrying capacity of our planet. This is illustrated in the graph above showing an index of global biocapacity (the ability of an ecosystem to generate ongoing supply of resources and absorb its wastes), relative to 1970, and compares this to the total extent of human consumption. Despite the biocapacity gains that have been achieved through technological advances, such as the widespread deployment of agricultural chemicals, these have been more than off-set by the degradation that has accompanied development. Energy supply is the greatest contributor to the exploitation of natural resources beyond our ecosystem's capacity for regeneration.

The Living Planet Report also puts forward global energy solutions, based on the work of several expert panels, including input by the International Energy Agency, as detailed in the first Climate Solutions report. This proposes a pathway to meet anticipated energy demand growth, primarily through improvements in the efficiency of energy applications and other demand management strategies. For example, solar water heating displaces electricity consumption by using energy that would otherwise not be used. Thus, strong growth in available energy services is achieved with minimal growth in total or final energy demand, thereby also allowing for supply to shift almost entirely to renewable resources by 2050.

A similar approach was taken in developing South Africa's Long Term Mitigation Scenarios (LTMS), a study mandated by Cabinet and completed with broad stakeholder participation in 2008. After modeling a business-as-usual projection of emissions growth to 2050, named the 'Growth Without Constraints' (GWC) scenario, mitigation options were analysed and presented as 'wedges' – graphic indications of the growing amount of emissions avoided over time, by a range of interventions, from energy efficiency and fuel switching to changes in agricultural and waste management practice. A second scenario, 'Required by Science' (RBS), suggests an emissions trajectory that would be required for South Africa to take a responsible role in global climate change response, based on the evidence available at the time of commissioning in 2006, before publication of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Some interventions, such as shifting to renewable energy resources, were modelled at different levels of ambition. The likely impacts of cross-cutting market mechanisms, such as a carbon tax, were also modelled. Indicative costings of all the 'wedges' or mitigation options were produced, although resources only provided for fairly generic economy-wide, socio-economic impact analysis. Packages of mitigation interventions were then modelled to see how far the 'wedges' could bring national emissions down from the GWC scenario, generating the alternative emissions trajectories depicted in Figure 4. Also depicted is the political agreement that resulted from Cabinet's consideration

"Our move towards a green economy is part of the country's long-term plan to grow the economy while mitigating the effects of climate change"

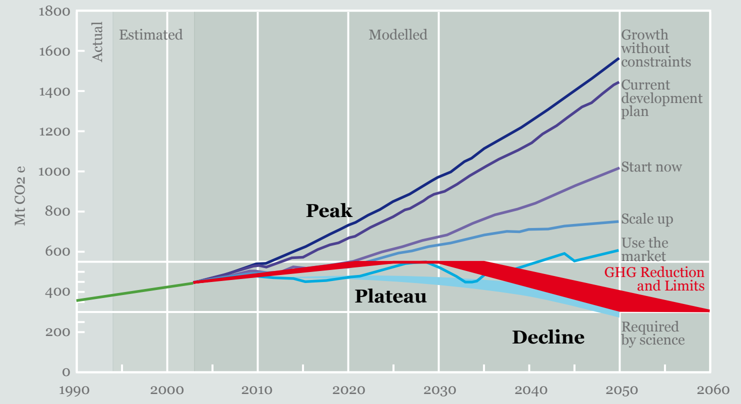
Buyelwa Sonjica, Minister of Water and Environmental Affairs, Green Economy Summit of the LTMS work: the objective for South Africa's emissions to peak between 2020 and 2025, stay stable for no more than ten years and then start to decline in absolute terms.

Building on the work done for LTMS, WWF commissioned the Energy Research Centre at University of Cape Town to study the costs of implementing an electricity target of 15% renewable energy by 2020, using the same model and assumptions. The study shows the potential for rapidly scaling up renewable energy input, in combination with energy efficiency interventions or under the application of a carbon tax (which could been seen as a proxy for externalised costs of conventional electricity supply), to deliver cheaper electricity in the short- to medium-term. Despite the relatively high up-front capital cost of renewable energy technologies, the generally shorter lead times (relatively quick installation) and the savings of zero fuel costs make a compelling case for an ambitious national target. An ambitious renewable energy target would also serve to secure international climate finance that contributes more broadly to South Africa's development goals. The findings were launched at a national conference in November 2008 and are summarised on pages 18 to 21.

Planning electricity supply in South Africa, a process that has recently been brought under the auspices of an Inter-Ministerial Committee (IMC) on Energy, has traditionally limited renewable energy to niche applications. A presentation to the consultative stakeholder forum NEDLAC (National Economic Development and Labour Council) on 28 June 2010, on behalf of the IMC, states that the existing Integrated Resource Plan (IRP1) for electricity supply provides for 1025 MW of renewable energy generation capacity by the end of 2013. In mid-2010 attention is focused on development of the new IRP2, which will cover a twenty-year period and is proposed to be promulgated in the government gazette in September 2010. The electricity IRP will be revised annually and will, in future, be informed by a comprehensive Integrated Energy Planning process, as required by the national Energy Act of 2008, which seems likely to be initiated before the end of 2010.

The outcome of a review of South Africa's White Paper on renewable energy (2003) and the setting of new mid-term targets is also due to be gazetted in November 2010. At the beginning of 2009 the National Energy Regulator of South Africa (NERSA) published a set of Renewable Energy Feed-In Tariffs (REFITs), determining the prices to be paid for electricity from a range of renewable energy technologies. However, the institutional arrangements needed to bring this market mechanism into practice, including development of a prototype power purchase agreement, have yet to be put in place.

LTMS Modelled and proposed emissions trajectories



Government has also decided to institute an Independent System and Market Operator, which will move the over-all operation of the electricity supply system out of Eskom. This should enable deployment of renewable energy technologies and involvement of independent power producers, but should not be allowed to further delay the awarding of REFIT contracts. The extent to which the REFIT will be made available to attract private investment in power supply will most immediately be determined by IRP2, of which a first draft was due in June.

WWF has proposed that work on a second new coal-fired power station, Kusile, should be stopped, at least until it has been properly interrogated under the Integrated Energy Planning process. Medupi, the first new coal-fired plant, using supercritical

WORKING FOR ENERGY

Electricity is not the optimal energy carrier for meeting all energy service needs and having a grid connection to industrial-scale power plants does not guarantee affordable access. While the affluent typically spend less than 2% of household income on electricity, a far greater portion of poor households' income is spent on energy services. Working for Energy is a recent addition to the Extended Public Works Programme that seeks to enable communities to participate directly in securing modern energy services, using locally available resources and appropriate technologies. State investment in Working for Energy will provide far greater value for the quarter of South African households currently without electricity than investment in large coal-fired power plants.

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technology, is due to be completed in 2014, with the first of six units of about 800 MW each coming on line 2012. Environmental impact assessments are being carried out on a further two large coal-fired plants, in Limpopo, and a new nuclear power plant using pressurised water reactors. Many civil society organisations are convinced that existing renewable energy technologies, primarily wind turbines and concentrated solar thermal power plants, which can integrate thermal storage to provide power throughout peak evening demand, offer viable alternatives.

WWF has been exploring supply options and impacts using the Sustainable National Accessible Power Planning (SNAPP) tool, a product developed by the Energy Research Centre and freely available to all stakeholders on request and via the WWF website. SNAPP was developed for analysis of proposed electricity supply plans by non-experts, using a simple interface linked to a set of spreadsheets, providing for a reference case and an alternative scenario. The tool is described on pages 22 to 33 where we present a renewable energy build plan consistent with WWF's advocacy positioning for a just transition to sustainable energy in a low-carbon economy.

Ahead of the 2009 climate negotiations WWF International released Climate Solutions 2, a study of global mitigation options and costs. It looks at the scale of the climate challenge and how it might be met while achieving sustainable development objectives, including universal access to modern energy services. After analysis of the mitigation required to avoid runaway climate change and the pace at which low-carbon development would be needed to reduce humanity's emissions, the study found that clean energy industries can achieve the shift to a low-carbon world, but will require an industrial transformation greater than any other in our history. A summary of the report can be found on pages 16 to 17 of this publication.

While avoiding runaway climate change is still possible, this will require extensive political will and action. The Fifteenth Conference of the Parties (COP15) to the United Nations Framework Convention on Climate Change (UNFCCC), held in Copenhagen in 2009, was disappointing. The Copenhagen Accord, of which South Africa was a negotiating party, was 'noted' by the COP, but not negotiated within the UNFCCC process. It is still not resolved whether a second commitment period of the Kyoto Protocol, after 2012, will be negotiated (with America still resolutely declining to participate in this implementation instrument of the Convention), much less how the 'rights to the atmosphere' or allocation of allowable emissions – sometimes referred to as the carbon space – might be negotiated.

While developed countries are responsible for up to 80% of the increase in atmospheric concentration of greenhouse gases to 2007, developing countries will come to dominate emission production in the future, even with the inadequate emissions reductions commitments so far put forward by developed countries. It is now well established that reducing global emissions will be a cheaper option than adapting to the impacts of climate change and variability that would result from global warming of 2°C or more. Nevertheless, many of the real costs of energy supply are still being deferred to future administrations and generations. The core challenge is to create a treaty for global cooperation that is both fair and effective in moderating access to an ecosystem service that has long been considered free and unconstrained.

An essential component in developing an effective multilateral response is to clarify the required extent and pace of mitigation, in other words the total allowable emissions, over time, that provide a positive prospect of avoiding runaway climate change. In 2009, WWF International commissioned environmental consultancy Ecofys to research the extent of such a global carbon budget and to

"We have no choice but to develop a green economy"

President Jacob Zuma, Green Economy Summit.

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examine different methodologies of apportioning the available budget between countries. The study shows that if global warming is to remain within 2°, carbon emissions will have to be reduced by 30% compared to 1990 levels by 2030 and 80% by 2050.

The study defines a carbon budget of about 1 800 gigaton (Gt) CO_2e between 1990 and 2100. Since 1990 about 40% of this budget has been used up, leaving the world with about 870 Gt CO_2e to emit up until 2050. Ecofys used three existing proposals for apportioning this 'carbon space' among nations, including one that quantifies the responsibility and capability of countries to produce a global allocation system. The latter is the least onerous for developing countries, but illustrates just how carbon-intensive South Africa's economy is, as it would require that we become carbon neutral by about 2035. Consideration of national circumstances will need to inform any application of such a system in international negotiations. Just how much of a global carbon budget we may legitimately lay claim to is briefly considered in pages 12 to 14.

South Africa announced mitigation commitments, in the build-up to the Copenhagen COP 15, that are conditional to international support, including financial support from industrialised countries beyond existing development assistance. Based on the LTMS, the country's commitment now recorded in the Copenhagen Accord is for emissions to peak, plateau and then decline, including a reduction of the growth of national emissions relative to business-as-usual (the GWC trajectory), by 34% by 2020 and 42% by 2025. Thereafter emissions will remain stable for up to a decade and then decline. We urgently need detailed and ambitious plans, including arrangements for concessional finance to kick-start renewable energy industries, if we are to attract the support and cooperation upon which this commitment is contingent.

As the host of COP17 to the UNFCCC in 2011, South Africa will be under close scrutiny, particularly as a member of the BASIC grouping (with Brazil, India and China) that is increasingly influential in efforts to achieve a multilateral agreement. Switching to renewable energy for electricity supply, which accounts for well over 40% of national carbon emissions, constitutes the largest and least disruptive opportunity for South Africa to de-link economic growth from emissions growth. The most immediate opportunity to reduce transport emissions is through switching from liquid hydrocarbons (petrol, diesel, kerosene) to electricity, both for the greater efficiency of electric motors compared to internal combustion engines and because electricity can be generated renewable resources.

The case for renewable energy is particularly strong under the paradigm of a developmental state, since opportunities for local community participation, maximising the use of locally owned resources, are consistently higher than for 'stock' or finite energy sources (fossil and nuclear fuels). Use of concentrated stock energy has served to concentrate wealth and given rise to a highly centralised energy supply system. Investment in electricity transmission and distribution must be designed to realise the benefits of decentralised generation and moving to a 'smart grid', that can be managed to optimise resource efficiency and accommodate feed-in by cooperatives and even households, across the full geographic range of the country.

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"We believe that by stimulating investment in green industry we will be able to contribute to the creation of decent work."

President Jacob Zuma,
Green Economy Summit

The key message of this publication is that we can not afford to neglect our renewable energy resources any longer, for a variety of reasons. These include the risks of fuel price escalation and taxes on carbon-intensive exports (over 38% of national emissions are embodied in, or accounted for, by exports), as well as the imperative to reverse natural resource degradation and depletion. A broad range of public benefits can be realised, including the consistently higher direct employment ratios of renewable options, particularly if we grow local renewable energy industries rapidly enough to replace the extensive coal-fired generation capacity that is due to be retired within the time frame of the IRP2.

Transformation to a low-carbon economy and society can be achieved through a just transition, if we act with speed and clear intent and are prepared to stop deferring the real costs of energy supply into the future. Ambitious targets are needed not just to guide planning, skills development and market mechanisms to compensate for historic and on-going subsidies to business-as-usual, but also to secure international cooperation and finance. South Africa should therefore plan to achieve at least 50% of electricity supply from renewable resources in 2030.

SHARING THE EFFORT UNDER A GLOBAL CARBON BUDGET

The earth's capacity to reabsorb carbon (carbon dioxide and other greenhouse gases) released into the atmosphere is limited and the rate of absorption is declining as man-made carbon emissions accumulate.

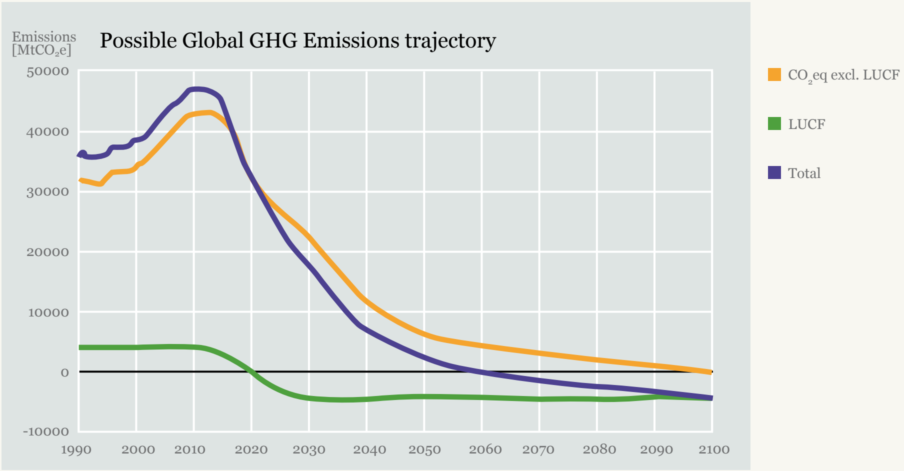
In order to avoid runaway climate change we need to stop adding to the atmospheric concentration of carbon as soon as possible. As a species we need to become carbon neutral well before the end of this century. The carbon budget is the acceptable amount of carbon to be emitted over a period of time.

In 2009 WWF commissioned environmental consultancy Ecofys, a leading research consultancy in renewable energy, energy efficiency and climate change, to research the extent of the global carbon budget, consistent with keeping global warming below 2°C. Further, the research looked at some methodologies of how the remaining available budget might be apportioned among countries.

How big is the global carbon budget?

The Ecofys study establishes that to keep global warming within the 2°C limit, carbon emissions will have to be reduced by 30% compared to 1990 levels by 2030. By 2050 global emissions, excluding those produced through land-use change and forestry (LUCF), need to be reduced by 80% compared to 1990 levels. If we assume that LUCF becomes a net sink, absorbing more carbon than it emits, this would bring us to a carbon budget of about 1800 Gt CO_2e between 1990 and 2100. Without LUCF as a sink, the available global carbon budget will only be about 1600 Gt CO_2e.

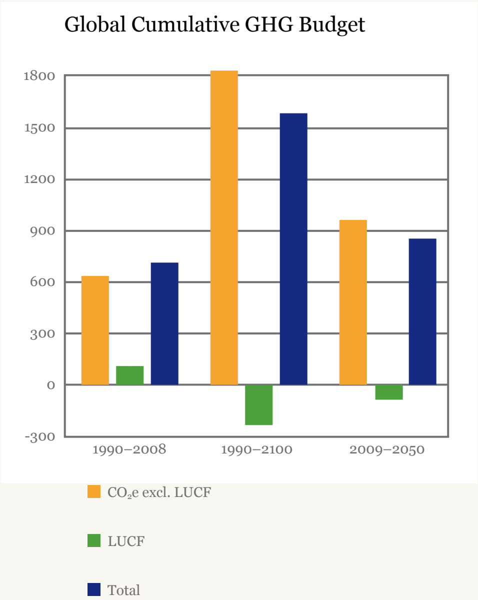
Since 1990 we have already used about 40% of our carbon budget, emitting about 730 Gt CO_2e globally, which leaves us with a balance of just 870 $GtCO_2e$ to 'spend' up until 2100 (without LUCF). This would give us an annual average of about 9.5 $GtCO_2e$ per annum. We currently emit almost five times that amount each year.

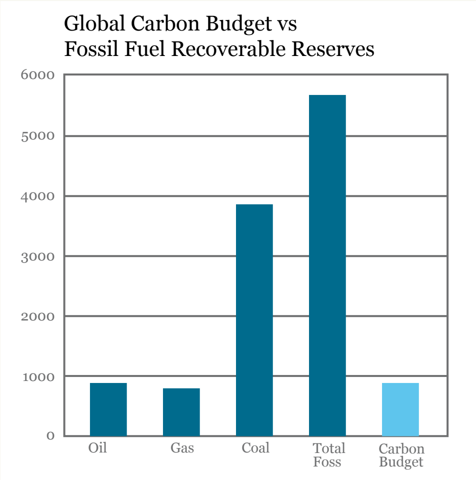


Possible global greenhouse-gas emissions pathway between 1990 and 2100 according to a global carbon budget of about 1800 Mt CO_2e (excl. LUCF) and 1600 Mt CO_2e (incl. LUCF)

Allocation of mitigation

80% Global Reduction	2050	2050	2050
Developed country emissions reductions % from 1990	80%	95%	100%
Developing country emissions % of 1990	22%	44%	52%
Developed country per capita emissions in tCO_2e/annum	2.8	0.7	0.0
Developing country per capita emissions in tCO_2e/annum	0.4	0.9	1.0





Global carbon budget requires not burning a significant proportion of total known fossil fuel recoverable reserves

It stands to reason that the longer we take to act, the more dramatic our actions will need to be. Starting absolute global emission reductions around the year 2015 would require global average emissions reductions of about 5% annually, which already is very ambitious. If absolute global emissions reduction only starts in 2020, subsequent global reductions of 8% annually would then be required.

If all the economically recoverable reserves of fossil fuels, as noted by the Intergovernmental Panel on Climate Change (IPCC) in 2001, were burned, the carbon released would amount to over 5000 Gt CO_2e, more than five times the carbon budget available.

How do we allocate responsibility for a global carbon budget?

In the Ecofys study, three methodologies are applied, to illustrate possible ways to share the global carbon budget:

Contraction and Convergence (C&C): Emissions targets for individual countries are set so that average per capita emissions converge from the countries' current levels, to a level equal for all countries in 2050. At the same time, the overall global rate of emissions starts to contract, or decline, to a safe level. This allocation approach does not consider historical responsibility (emissions to date) or national capabilities to undertake mitigation actions.

Common but Differentiated Convergence (CDC): As above, targets are set so per capita emissions for all countries converge to an equal level over the period to 2050. For industrialised countries (the highest emitters to date) the per capita emissions decline and convergence starts immediately. For developing countries per capita emissions convergence starts from the date when their per capita emissions reach a certain percentage of the (gradually declining) global average. This approach also gives little consideration to national capabilities to undertake mitigation actions.

Greenhouse Development Rights (GDRs): In this approach the carbon budget or allowance available to each country would be based on an index of historical responsibility and national capability, as well as the size of the country's population. A development threshold is set, based on a minimum income allowance per person income. All countries above the development threshold, expressed in average Gross Domestic Product (GDP) per person, will have to start reducing their rate of emissions, to move below their business-as-usual trajectory (emissions pathway). The amount of emission reductions required of individual countries is based on the responsibility and capability index, which will hold major industrialised countries liable for more mitigation than they will be able to achieve domestically.

For a graphic representation of these methodologies, please refer to Appendix.

What does each approach mean in reality?

The GDR approach results in negative emissions requirements. What this means is that the mitigation obligations of industrialised countries will in future be greater than their total emissions, requiring that they achieve further emission reductions elsewhere. This could be done by financing emissions reductions from land use or forestry (including Reducing Emission from Deforestation and Forest Degradation – REDD) or sequestering CO_2 through land use changes or carbon capture and storage (CCS).

C&C and CDC propose very low, but not negative, emission levels for industrialised countries, requiring greater mitigation efforts by developing countries. With GDR, developing countries and economies in transition (economies which are changing from a centrally planned economy to a free-market economy) have more 'carbon space' to grow, owing to relatively low historical and current per capita emissions, combined with limited financial capacity. Thus, industrialised countries (as listed in Annex I of the UNFCCC) would be required to reduce emissions collectively by 60% by 2020 under the GDR allocation, while the other approaches require reductions of around 40%.

Least Developed Countries (LDCs) are almost all exempt from emission reduction requirements under GDRs, while under C&C they are granted little more allowances than those anticipated under business-as-usual, up until 2020 and face reduction obligations after 2025. Even under CDC they still face reductions after 2030.

What is the carbon budget for South Africa?

South Africa has a highly carbon-intensive economy, with emissions per unit of domestic product and per capita among the highest in the world. As a result of long-standing policies favouring mining and other energy-intensive industries and a heavy reliance on low-quality coal for producing electricity and liquid fuels, South Africa also has relatively high historical emissions. Any budget contemplated by government will assume that recognition of our national circumstances would allow for a transition that doesn't compromise our development imperatives. The term 'development space' is sometimes used as a proxy for 'carbon space'.

South Africa currently emits well over 1 % of global emissions despite the fact that we represent less than 0.8% of global population and GDP. A simplistic approach might put our share of the carbon budget at about 1%, less than 10 $GtCO_2e$, for the period 2010 to 2100. The Long Term Mitigation Scenarios (LTMS) commissioned by Cabinet sets out a hypothetical emissions curve from 2003 called the Required By Science Scenario, the lower side of which would give South Africa a budget of about 16,4 Gt CO_2e for 2010 to 2050. Such a budget would be consistent with our international commitment to mitigation under the Copenhagen Accord: that in 2020 our emissions will be 34% below business-as-usual (the Growth Without Constraints scenario in LTMS) and 42% below business-as-usual in 2025, provided that we then steadily reduce emissions to about 50 Mt CO_2e yearly by 2050 (0,05 Gt CO_2e about 10% of our current emissions).

What the three methodologies mean for South Africa

Applying the GDR approach, wherein a country's historical responsibility is based on its estimated emissions between 1990 and 2010, South Africa would need to become carbon neutral by about 2035. This would demand a decline more severe than what occurred in economies that collapsed following the dissolution of the Soviet Union and would give South Africa well below 1% of the remaining global budget. Both C&C and CDC would involve even more stringent obligations for this country.

If we consider per capita emissions without global convergence, it is worth noting that if industrialised countries were to become carbon neutral by 2050 (net zero emissions), within the required global reduction to 80% below 1990 emissions in 2050, the average per capita emissions available to developing countries would be about 1 ton of CO_2e per person in 2050. Thus, if our population were to stabilise at 55 million and we assume an equal per capita share for all developing countries at this time, South Africa's 2050 emissions should be 55 Mt a year.

> *"Natural disasters affect women directly and severely because of their social roles and the impacts of poverty. When there are floods, cyclones, or drought, women bear the brunt."*
>
> President Jacob Zuma

CLIMATE SOLUTIONS 2: LOW-CARBON REINDUSTRIALISATION

A report to WWF International based on the Climate Risk Industry Sector Technology Allocation (CRISTAL) Model

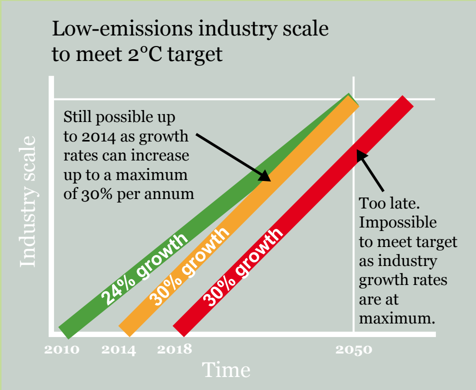
In preparation for the 2009 climate negotiations, WWF commissioned a study to examine whether low-carbon development could reduce the human contribution to carbon emissions enough to avoid runaway climate change. The study, Climate Solutions 2, found that the move to a low-carbon world can be achieved, but will need to be greater than any other industrial transformation in our history. The report looks at the scale of the challenge and how it can be met, while allowing for sustainable development and adequate access to energy services. It also highlights the opportunities for those investors and countries that take the lead in low-carbon development.

Climate Solutions 2 models two scenarios: global carbon emission reductions of 63% against 1990 levels by 2050 and reductions of 80% by 2050. Under both scenarios, every key low-carbon industry must be under its maximum rate of development by 2014. For the 63% reduction scenario, each of these industries must grow at between 22% and 26% every year until they reach a scale that provides reasonable certainty of achieving the necessary global emissions levels by 2050. The second scenario requires the reindustrialisation process to commence immediately with growth rates of between 24% and 29% every year until sufficient deployment is achieved. In addition, emission reductions from the forestry and energy efficiency sectors must be at the upper end of what is technically possible.

The good news is that the resulting economies of scale from these low-carbon interventions will create major long-term savings and returns when compared to the business-as-usual trajectory, especially in the energy sectors. The scale of renewable energy savings from 2013 to 2050 is expected to be in excess of US$41 trillion for the minus 63% scenario and US$47 trillion for the minus 80% scenario.

We have less than five years to get Low-Carbon reindustrialisation under way

The key constraint to meeting emissions reductions needed to prevent dangerous climate change is the speed at which the economy can make the transformation to utilising low-carbon resources and developing low-carbon industries and practices. Such development is currently too slow, with only three industries progressing fast enough. To avoid major economic disruption, indications are that world governments have a window of opportunity that will close between now and 2014. In that time they must establish fully operational low-carbon industries.



How to achieve a Low-Carbon Economy

The real-world constraints to industrial growth include access to skilled people, resources, plants and machinery for manufacturing, installation and operation, and access to capital for manufacturing and projects. Should the development of low-carbon industries be delayed, such constraints create a situation where industrial production cannot respond to price signals from the market. One foreseeable cause of delay is heavy reliance on mechanisms like emissions trading, which support the development of least-cost industries first, fostering a sequential industrial development process. Comparison between a sequential development scenario and a concurrent development scenario showed that for the sequential approach, emissions levels in 2050 are more than double those in the concurrent case when using the same industry growth rates.

A comprehensive plan for low-carbon industrial development is thus an integral part of the solution. An international program should be adopted to develop all low-carbon energy sectors concurrently – even those not initially profitable – and on an unprecedented scale. If the window of opportunity is missed then economically disruptive 'command-and-control' style government intervention will be necessary to focus industrial production on the climate change challenge.

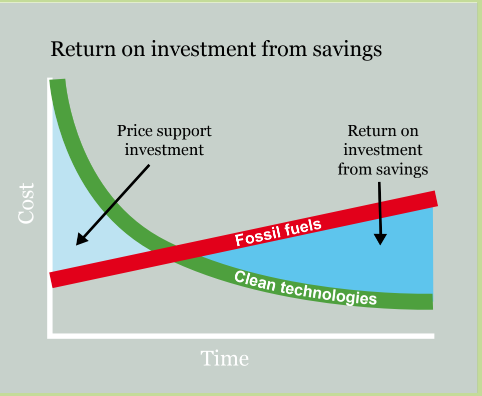
Investment and Returns

Changes in energy prices, driven by economies of scale, will be an intrinsic component of low-carbon reindustrialisation. Since the resources required for renewable technologies (i.e.

biomass, wind, sun, etc.) are obtained at zero or low cost, the core cost stems from building plants to extract that energy. Empirical evidence provides a reliable guide to the decline of future costs. By contrast, fossil fuel costs are likely to increase in price owing to rising fuel extraction costs and the costs associated with managing greenhouse-gas pollution. Assuming a conservative price increase for fossil fuels of 2% every year - excluding the costs of pollution, the point at which the first renewable energy industries start to create net savings is 2013.

This presents a long-term investment picture in which short term price support to achieve economies of scale is repaid with long term returns from the cost savings

This type of investment and return profile is most appropriate for institutional and pension fund investments. It may also



lend itself to the use of 'climate bonds' structured by governments, investors and industry to support this process. The investment required to cover the additional cost of renewable energy relative to fossil fuel energy is about US$6,7 trillion in the minus 63% scenario and US$7,0 trillion in the minus 80% scenario.

The industries that will lead the way

Clean energy generation, energy efficiency, low-carbon agriculture and sustainable forestry must lead the transformation to a low-carbon economy. Solutions that extract and store carbon from the atmosphere and biosphere such as biomass energy production with carbon capture and storage (CCS), while they are not included in Climate Solutions 2 scenarios, are also likely to be required at some stage, if constraints on fuels can be resolved.

Nuclear power (fission) is included in the scenarios based only on existing plants and plants currently under construction.

Stable Investment Environments

Low-carbon reindustrialisation will require all governments to create a secure, long-term investment environment to allow for major increases in the scale of production and installation of low-carbon technologies and infrastructure. This includes technologies and resources that will take two or more decades to reach commercial viability.

Investing in a Low-Carbon Economy — Costs and Returns

Long-Term Investment

Transforming to a low-carbon economy will require substantial investment in clean technologies. Many of these investments will eventually become commercially viable in their own right. If the ongoing costs of CCS up until 2050 are also included, these costs would be increased by as much as US$10 trillion. The modelling indicates that annual expenditure will peak at around US$375 billion a year in the minus 63% scenario and US$400 billion a year for the minus 80% scenario by 2025 and then start to decline. With sufficient up-front capital, energy efficiency measures will be cost-effective immediately or over a very short time period. Forest and CCS initiatives will require ongoing funding.

Implications for Government, Industry and Investment

To avert runaway climate change, an international agreement on carbon emissions must be augmented by a programme to rapidly develop a broad suite of low-carbon industries. This means that:

- The private sector must be prepared for a massive scale-up of the low-carbon sector and not stand in the way of this transformation. Economies of scale will deliver cost reductions.
- The investment community must commit tens of trillions of dollars, but can be rewarded with secure substantial long-term returns.
- Governments must create a stable long-term investment environment that fosters a secure market for all low-carbon industries and their investors.

Conclusion

Research shows that if reindustrialisation across all low-carbon sectors – including clean energy, forestry and agriculture – does not get under way until after 2014, then the probability of exceeding 2°C of warming and the risks of runaway climate change occurring moves above 50%. If population growth, GDP growth or fundamental lifestyle choices were curtailed over the long term, the low-carbon industry growth rate requirements may be eased somewhat. The good news is that the resources, technologies and industries required for the transformation are all available; the rates of growth are plausible and the trillions of dollars of investment required are within the capacity of the institutional investment sector.

CHEAPER ELECTRICITY WITH RENEWABLE ENERGY

Costing a 15% target for 2020 for South Africa

In 2008 WWF commissioned Cape Town University's Energy Research Centre to undertake a study exploring the implications of South Africa aiming to generate 15% of its electricity from renewable resources by 2020. The study considers the effects of such a target on the total cost of electricity production, investment in electricity infrastructure, and national carbon emissions. Achieving a target of 15% will pose institutional, financial and policy challenges and several options were considered using the two most promising renewable energy technologies for South African conditions, namely wind and solar thermal power.

The study used the modelling framework of the Long Term Mitigation Scenarios (LTMS), a multi-stakeholder process undertaken by government and completed in 2008. During the course of the study, new research on wind resources in South Africa was encountered indicating that the potential for wind power is far greater than previously thought. Since these findings are relatively new, both the LTMS assumptions and the new assumptions were used to reach a range of costs for a large-scale wind energy programme.

The model ensures that energy system requirements are met i.e. that energy demand is equal to supply, that a specified reserve margin is maintained and that technologies have a limited life. It was also assumed that delivery of the target will begin in 2015, when the first new renewable plants will come online and produce 2.5% of South Africa's electricity, which will increase linearly until reaching 15% in 2020.

The following three cases were modelled to explore various ways in which the target of 15% could be met:

Case 1: Wind power modelling using the same assumptions as the LTMS on South Africa's wind resource

Case 2: Wind power modelling using new and more optimistic research on South Africa's wind resource

Case 3: Model constrained to use an equal amount of wind and Concentrating Solar Power (CSP) using the more optimistic wind resource assumptions

Each case was further modelled in conjunction with a demand-side (consumer use) energy efficiency programme.

	Coal	Wind	Solar Thermal	% new coal displaced
Reference	12.7	0.00	0.00	-
Case 1	2.94	8.76	6.90	76%
Case 2	6.92	18.27	0.00	43%
Case 3	4.03	9.08	5.09	67%
Case 1A	0.74	5.76	7.26	94%
Case 2A	5.19	16.43	0.00	57%
Case 3A	2.51	8.29	4.59	79%

New generation capacity in GigaWatts (GW) for each scenario, commissioned from 2015 to 2020

	AF reserve margin*	Peak demand (GW)	Total installed capacity (GW)
Reference	15%	57.48	66.18
Case 1	14%	57.48	72.61
Case 2	18%	57.48	79.2
Case 3	16%	57.48	72.21
Case 1A	15%	53.04	65.6
Case 2A	19%	53.04	73.46
Case 3A	17%	53.04	67.23
Nuclear	15%	53.04	66.46
Nuclear efficiency	17%	53.04	62.39

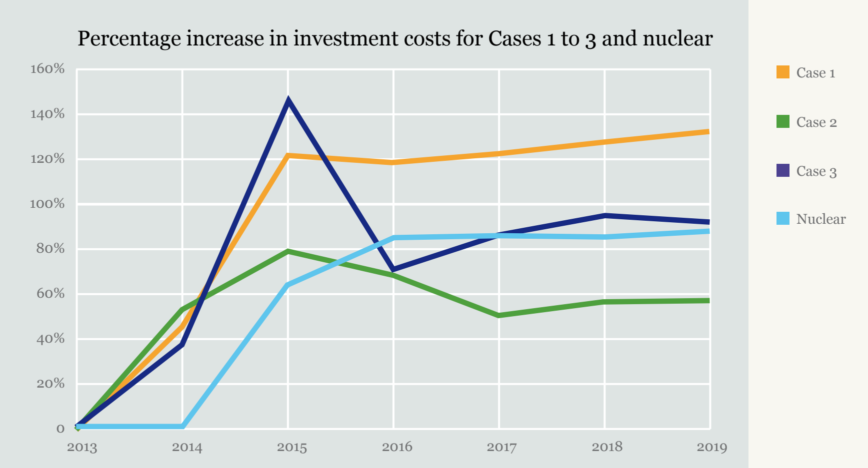
Reserve margin, peak demand and total national capacity in 2020

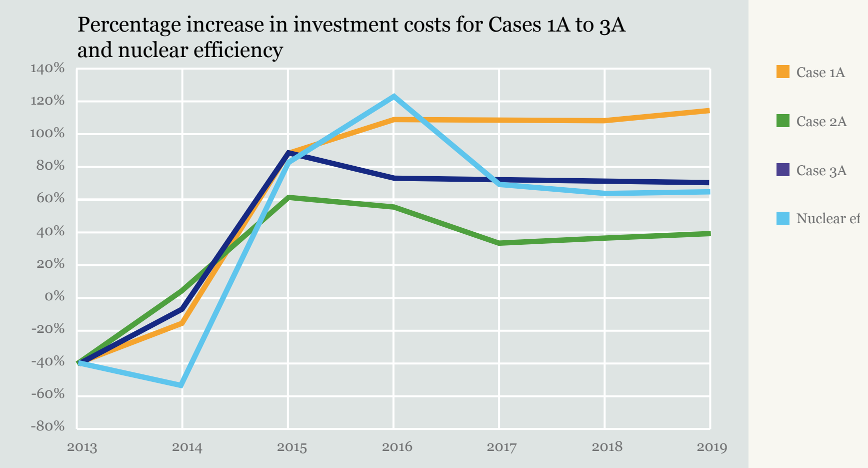
* In calculating the reserve margin (the spare generation capacity), and Availability Factor (AF) has been used to add built capacity, which is 1 for all plants except wind, where it is 0.23 for the lower resource estimate, and 0.39 for the higher availability factor.

KEY FINDINGS

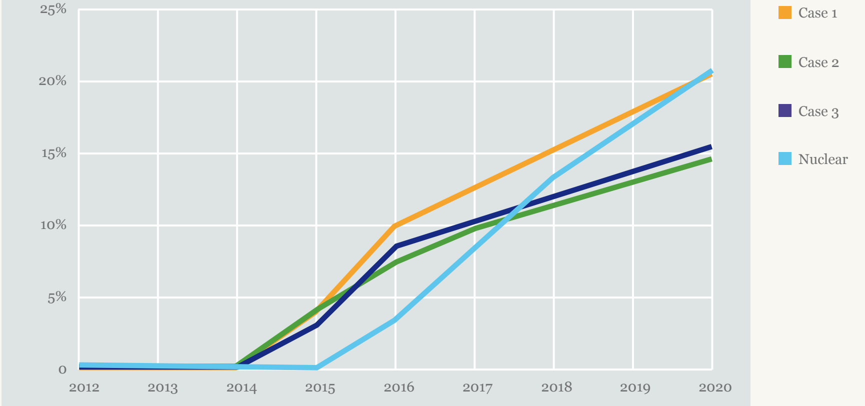
- Reaching a 15% renewable energy target by 2020 will not cost the earth: by 2020 average electricity costs will only be slightly higher (about 15%) than the baseline (the business-as-usual scenario).
- Combined with an energy efficiency programme, average electricity costs will be lower than the baseline for most of the 2015-2020 period.
- With the addition of carbon finance for both the efficiency programme and the renewable energy programme, average electricity costs will drop to 18% below the baseline by 2020.

The most promising scenario is a mix of solar thermal and wind, which benefits from the lower cost of wind and the ability of solar thermal plants to contribute to peak demand.

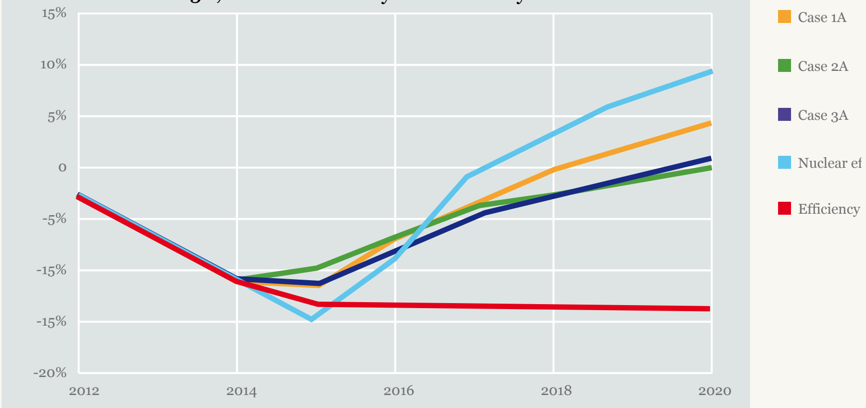




Percentage increase in total annual electricity production costs, Cases 1 to 3 and nuclear



Percentage increase in total annual production costs, Cases 1A to 3A, nuclear efficiency and efficiency alone



Emissions reductions for all renewable energy scenarios were similar:

A 15% renewable energy target would contribute to emission reductions of around 165 Mt of CO_2e over the period 2006 to 2020, with reductions of up to 400 Mt when combined with an energy efficiency programme. By 2020, annual carbon emissions reductions from the target would be 14% for the electricity sector, constituting 6,5% of total national emissions. The modelling indicates that by itself, such a programme would have less of an impact on the electricity price than the 2008 tariff increase.

The alternatives to coal, for electricity supply in South Africa, are renewable energy and nuclear. This study indicates that the renewable energy option is cheaper than nuclear. Indeed, if partner programmes such as energy efficiency are also implemented, the overall cost with renewable energy will be lower than business-as-usual.

Four areas were identified where partner programmes would help reduce costs:

- Research and development
- Infrastructure development
- Industrial strategy
- Energy efficiency

An industrial strategy based on increasing the content of locally manufactured components in renewable energy plants, and developing a competitive edge in solar thermal technology internationally, would funnel much of the required investment back into the local economy. This would create more jobs than current plans and ultimately earn significant export revenue as the rest of the world begins to impose greater economic constraints on carbon-intensive products and materials. If carbon finance is added, the picture becomes even more positive for renewable energy. Trading 'white' certificates (documents certifying that a certain reduction of energy consumption has been attained) for energy savings is another promising option for financing the numerous benefits of efficiency, including: creating employment, saving the country money and avoiding the risk of blackouts up to at least 2012.

The main challenge – financing the renewable energy programme – could be accomplished through a feed-in tariff, tradable renewable energy certificates, international climate-related finance, and subsidies for technology development. Support for technology, finance and capacity for developing countries is promised as part of the future of the international climate agreement, currently under negotiation. In order to meet the target, however, planning should have been concluded by 2010. Optimal implementation would require sophisticated policy-making and a high degree of coordination between key stakeholders. South Africa has the necessary institutional, technical and physical infrastructure to achieve this.

A renewable energy target of 15% for 2020 comprising wind and solar thermal energy, particularly if combined with partner programmes such as an energy efficiency programme, will provide significant greenhouse-gas mitigation, together with air quality, health and ecosystem service co-benefits to South Africa. There are also opportunities for the country to develop a competitive advantage in solar thermal technologies, and establish South African industry and technicians as front-runners in this area of the rapidly expanding international renewable energy sector.

A clear, certain and mandatory target is crucial to the success of the renewable energy programme. This target must be supported by a well developed regulatory framework. The study proposed that this framework be comprised of feed-in tariffs combined with subsidies and tax incentives for the development of the solar thermal technology, and investment in expertise, capacity and capability as leaders in this international sector.

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RENEWABLE ENERGY SCENARIO IN SNAPP

by Richard Worthington and Laura Tyrer

South Africa's electricity system faces a number of critical challenges. Among these is to serve the electricity needs of a growing economy and provide energy services to the poor, while incorporating climate change mitigation measures and other environmental considerations. In the process of considering future power options, it is imperative that realistic assessments are made of the technical requirements and the economic and environmental consequences of specific electricity supply choices.

Traditionally, such options would be considered using electricity planning systems based on complex models that are challenging, time-consuming and expensive to run. As a result, a relatively small range of alternative power supply options are usually considered, and the assumptions on which they are based are not easily tested, leaving some electricity supply options unexplored. The consequence of our increasing understanding of climate change and our consequent responsibility to preserve the environment for future generations is that electricity planning has an imperative to break away from business as usual and phase out fossil fuel use.

South Africa's growing electricity demand and inadequate supply capacity is driving an urgent approach to developing an electricity supply plan for the next twenty years, through an integrated resource planning process. Since the power generation technology decisions that are made now will have significant socio-economic and environmental impacts over several generations, it is imperative that this process is properly scrutinised.

To enable stakeholder engagement in establishing such a new capacity build plan, WWF commissioned the design of a highly simplified modelling tool, by the University of Cape Town's Energy Research Centre (ERC). The Sustainable National Accessible Power Planning tool, or SNAPP, allows users to compare a proposed scenario or resource plan, against a reference case that may be considered business-as-usual, and generate outputs and impacts in real time. Stakeholders are thus able to interrogate proposals for South Africa's new build plan using objective cost analysis, environmental impacts and the reliability of the system.

Integrated Resource Planning

Integrated resource planning is a planning process that is used to consider the different options available for meeting future electricity demand. The process should identify the resource mix that will avoid unnecessary electricity cost escalation, while achieving the goals of reliable service, economic efficiency, resource efficiency and environmental protection. It should also take into account the interests of different electricity consumers, as well as the interests of current and future generations. An Integrated Resource Plan (IRP) should incorporate supply-side and demand-side interventions.

What is SNAPP?

The Sustainable National Accessible Power Planning (SNAPP) tool is a sophisticated set of linked spreadsheets, using Excel software, designed to make analysis of electricity plans more accessible to stakeholders. It allows interrogation of government's proposed IRP, as well as the implications of assumptions and input data and resulting technology choices, without undertaking the complex modelling on which the plan is based. SNAPP does not currently incorporate the influences of the electricity transmission or distribution system, or options for the evolution of these systems, but rather simulates the South African electricity system at the generation level.

SNAPP is freely available on-line and comes with a full set of input data and assumptions, as well as some alternative data sets that can be activated at the user's discretion. All data and assumptions can be changed, from demand projections, technology and fuel costs to application of a carbon tax. The tool provides for a reference case, intended to reflect prevailing or proposed plans, and an alternative scenario, and will automatically generate some graphic comparisons of differing outcomes.

The user specifies future investments in the South African generation system, choosing from a suite of plant options (to which additional options could be added). The tool calculates the costs, investment requirements, probable impact on the over-all cost of generation and the emissions implications of the proposed scenario. It also calculates the resultant capacity and energy reserve margins and Loss-of-Load Probability (LOLP) factor and presents a range of other indicators, such as the percentage of supply drawing on renewable resources.

A BRIEF HISTORY

In the US, during the strong, consistent economic growth of the 1960s, bulk electricity supply easily matched the growing demand for power supply and simple trending techniques were sufficient in addressing future electricity supply requirements. However, following the oil price crisis in the early 1970s (the result of the Arab oil embargo and events such as the partial meltdown of the 3-Mile Island nuclear reactor), less economic growth and rampant inflation highlighted the unpredictability associated with electricity planning. Around this time, environmental issues also became a consideration in electricity supply. An understanding emerged of the importance of balancing the need to build power plants with using less energy, which evolved into the concept of demand side management, and more efficient use of electricity. The complexity of planning analysis eventually resulted in least-cost planning and the emergence of integrated resource planning.

SOUTH AFRICA IN CONTEXT

In the early 1970s, South Africa's intensive build programme to meet the country's burgeoning industrial electricity demands resulted in an excess of electricity supply. This situation was exacerbated when development aspirations post 1994, which anticipated the full use of the excess capacity, were not realised. However, a later period of steady economic growth in the new democracy brought with it the realisation that the pace of growth was likely to outstrip South Africa's electricity generation capacity.

The prospect of a shortfall necessitated the return to service of three power stations that had been mothballed in the 1980s, as well as urgent planning for additional capacity. Despite early warning signs, South Africa was unable to remedy the situation in time, resulting in an electricity capacity reserve margin well below 10% and the country was plunged into a national electricity emergency in 2008. The South African government has come under pressure to create demand- and supply-side programmes that will ensure security of electricity supply.

The National Energy Act, promulgated in 2008, requires that the Department of Energy publish an annual 20-year Integrated Energy Plan (IEP), covering total energy supply, which would also inform the design of an electricity IRP. The IEP is required to plan for South Africa's energy needs in a holistic manner that considers available resources, socio-economic impacts and opportunities, implications for the economy as a whole, and environmental concerns. A partial IRP was published on the last day of 2009, but preparations to undertake the required IEP only started in 2010, with a view to delivering an IEP by the end of 2011. Meanwhile, government is in the process of developing an IRP2, to be completed and gazetted in September 2010.

All energy planning will need to accommodate South Africa's international commitment to reduce carbon emissions below a business-as-usual trajectory (the Growth Without Constraints scenario as per the Long Term Mitigation Scenarios commissioned by Cabinet) by 34% by 2020 and 42% by 2025. This international commitment is conditional to securing financing, capacity building and technological support, nevertheless, we have to align planning now if we are to have a real prospect of achieving this level of mitigation and have any prospect of securing the international support to do so.

Electricity generation accounts for about 27% of energy supply in South Africa, but nearly half of carbon emissions. Moving to a low-carbon economy will require an increase in the electricity proportion of energy supply, particularly for transport, but as this is not considered in the IRP2 process it is also not considered here. Electricity demand projections may need to be revised upwards in future and this should be interrogated in the IEP process. For the short- to medium terms such fuel-shifting could be accommodated through more aggressive efficiency and demand-side management measures. As electric vehicles can be charged during the period of lowest demand, utilising capacity that would otherwise go unused, it would take a substantial shift in composition of the vehicle fleet to impact on total required capacity.

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All indicators respond to investment choices in real time, meaning that the indicators change as new generation units are added or subtracted from the investment plan. As the LOLP indicator involves a time-consuming calculation, this can be put on hold and run only after the investment plan has been fully specified. Work is continuing to develop an indicator for job creation, which can be added into the tool when it becomes available. The technology parameters include learning rates (anticipated cost reductions for emerging technologies) and graphic analysis includes the ability to check the use of individual technology types, compare cost curves over time and compare emissions from individual technologies and from different scenarios.

Although much simpler than fully-fledged simulation models, SNAPP offers a high degree of technical rigour for users who wish to explore plausible future electricity scenarios for South Africa. SNAPP builds on the modelling work undertaken for the Long Term Mitigation Scenarios (LTMS) process and a subsequent study costing a target of 15% renewable electricity by 2020. The built-in assumptions and demand projections are broadly in line with those being used by government and Eskom.

Inputs:

The SNAPP tool is loaded with an electricity demand for South Africa until 2030 that is broadly consistent with that used by Eskom, including the national objective of strong economic growth and relatively conservative projections of demand-side management and energy efficiency achievements.

Eskom's adequacy report was used to calculate the electrical energy demand growth downstream of transmission and distribution up to 2014. Beyond 2014 growth was calculated according the LTMS Reference Case, with commercial and industrial energy efficiency interventions - projecting slightly less net demand growth than Eskom. The LTMS growth forecast assumes business-as-usual economic growth as the main factor defining electricity demand.

The projection assumes that imports and exports of electricity between South Africa and neighbouring countries remain as they currently are. As the emphasis is on reliability of supply and an investment plan for South Africa, the projected demand does not include demand that is supplied from electricity imports.

In addition to assuming successful implementation of Eskom's demand-side-management programme, the tool allows users to include solar water heaters and distributed, non-grid-connected photovoltaics as a means to reduce projected demand. The projection provided in the tool includes 3.2 million unit of each in place by 2030.

Based on these assumptions (see demand projection table), electricity dispatched upstream of transmission, excluding what will be required to power the stations themselves and before transmission losses, is expected to increase from 260 000 GWh in 2010 to 453 000 GWh in 2030. Within this projection and assuming industrial energy efficiency measures as

ELECTRICITY DEMAND PROJECTION

		2010	2011	2012	2013	2014	2015	2016	2017
National Electricity Demand Growth IND eff (LTMS)		3.0%	2.2%	2.5%	2.8%	3.3%	3.2%	3.2%	3.1%
National Electricity Demand (Distribution)	GWh	206 905	211 427	216 770	222 878	230 286	237 610	245 323	252 914
Energy dispatched upstream of transmission (excl. PS input)	GWh	259 502	264 496	270 467	277 345	285 769	294 091	302 875	311 516
Peak Demand on national system incl exports		38.82	39.57	40.47	41.49	42.75	44.00	45.31	46.61

per the LTMS, National electricity demand growth will increase from 3% in 2010, peak between 2025 and 2028 at 3,5% and decline to 2,5% in 2030.

The technology parameters used to calculate the levelised costs of the available electricity generating technologies in the study period take into account capital costs, fixed operations and maintenance costs, variable operations costs, efficiency, availability, lifetime, unit size and forced outage rates of plants for each technology. Technology cost curves are based on 2008 data and are represented in 2008 Rands/ MWh. These costs can be calculated with or without the cost reductions anticipated by technology learning and development, as technologies mature. In the reference case and proposed scenario below, technology learning is included in the cost calculations. The chosen discount rate of 10% can also be adjusted.

The tool provides fuel cost projections for the costs of coal for existing plants, coal for new plants, natural gas, diesel, paraffin, pressurised-water reactor (PWR) nuclear fuel and pebble-bed modular reactor (PBMR) nuclear fuel. The tool's preset fuel parameters are specified in Rands/ GJ for all energy carriers, then converted to Rands per MWh of output using the efficiency of the specified technologies, and are based on figures used by government, primarily drawing upon the third National Integrated Resource Plan (NIRP3). Fuel costs can be adjusted, either as a time series, or as an annual percentage increase from the base year. Thus multiple versions of scenarios can be produced to test sensitivity of the average costs of supply to specific fuel costs.

WWF's Reference Case and Preferred, Renewable Energy scenario:

Using the SNAPP tool, two options for new generation capacity over the period 2010 to 2030 are considered here. The outcomes of the reference case, based on Eskom intentions reflected in the investment plan published in 2007 (lots of new coal and nuclear), are compared to the outcomes of a renewable energy scenario, which prioritises renewable energy technologies. Both plans maintain a reserve capacity above 15% and an energy reserve margin above 10%, with a loss-of-load probability no higher than 0.01%.

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	3.2%	3.2%	3.2%	3.3%	3.2%	3.3%	3.3%	3.3%	3.5%	3.5%	3.5%	3.4%	2.5%
	260 904	269 254	277 962	287 093	296 351	306 206	316 380	326 975	338 368	350 217	362 418	374 865	384 100
	320 630	330 171	339 762	349 856	360 099	371 051	382 383	394 216	406 995	419 940	432 927	445 453	453 413
	47.97	49.40	50.83	52.34	53.88	55.51	57.21	58.98	60.89	62.83	64.77	66.65	67.84

The demand projections assume that national average distribution losses remain constant at 12,48%, while National Average transmission losses remain constant at 3,80% for the duration of the period of the study.

WWF's Reference Case

The Reference Case, seeking to be consistent with Eskom's new build plans, is fairly aggressive, providing more capacity in the next decade than required by the demand forecast: four large new coal-fired plants with supercritical technology (19.1 GW) are brought on line in quick succession: Medupi, Kusile, and 'Coal 3 & 4 in Limpopo' (as they are referred to in the on-going environmental impact assessment process); a new nuclear plant starts to come on line in 2022 to deliver a 'fleet' of nearly 15 GW by 2030; towards the end of the period the plan also brings in 7.2 GW of coal plant using Integrated Gasification Combined Cycle technology, which is far more compatible with possibilities for carbon capture and storage than supercritical plant. Modest deployment of renewable energy reaches 3.3 GW of wind and 2.1 GW of solar in 2030.

In the Renewable Energy Scenario there is no new nuclear, Medupi is the only supercritical coal-fired plant and renewable energy technology deployment grows as rapidly as is considered feasible (consistent with the Climate Solutions 2 approach), to have in place in 2030: 9.5 GW of wind power at 30% availability and 12.7 GW at 25% availability (due to less favourable wind conditions); a total of 35.6 GW of concentrated solar thermal power, of which 33.2 GW is central receiver technology, which is given a higher availability factor in the modelling inputs (though some technologists maintain that trough technology will become the cheapest solar option).

The share of supply from specified renewable resources is slightly below 15% in 2020, but would reach 15% if cogeneration, which is not counted in the renewable energy indicator, were to mostly use biomass as a fuel. However, by 2030 renewable energy account for over 50% of supply. If the more optimistic projections of photovoltaic technology advances are borne out, this would play a far greater role than envisaged here, with potential cost savings. The lower availability factors of renewable energy plants is reflected in a total installed capacity of 71.8 GW, compared to the 60.5 GW total of the Reference Case.

Both plans include some pumped storage, though many old-school experts still believe considerably more would be needed to support the role of 22.5 GW of wind capacity. The demand-side management programme (which is integrated in the demand projection component of the SNAPP Tool and is thus the same for both build plans) includes considerable off-grid photovoltaic capacity, to a cumulative total of 2.225 GW, as well as a solar water heating that provides a power saving of 6.3 GW (coal-equivalent)

While the Renewable Energy Scenario is highly ambitious in terms of rapid scaling up from a the current very small base, the

Investment Plan: Reference Scenario

Plant Description	Unit Size MW	2010	2011	2012	2013
Existing coal Large	564	0	0	0	0
Existing coal Small	114	0	0	0	0
OCGT liquid fuels	120	0	9	0	0
PWR nuclear	1350	0	0	0	0
Hydro	95	0	0	0	0
Landfill gas	30	0	0	1	1
Biomass	80	0	0	0	0
Supercritical coal	794	0	0	2	2
Wind 30%	1	100	0	100	100
Wind 25%	1	0	0	0	0
Solar thermal central receiver	100	0	0	1	0
Solar thermal trough	100	0	0	0	1
Solar PV	5	0	0	0	0
Combined cycle gas	387	0	0	0	0
PBMR	165	0	0	0	0
IGCC	550	0	0	0	0
Co-generation	100	1	1	1	1
Pumped storage	333	0	0	1	1
Interruptible load	1	0	0	0	0
Reliability indicators					
LOLP	0.03%	1.84%	0.5%	0.1%	0.01%
Reserve (AF) – including imported capacity	15%	15.4%	17.0%	19.5%	21.6%
Energy reserve margin – including net exports	10%	17.4%	16.8%	19.2%	20.9%

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total new (GW)
	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	3.4
	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	2	1	0.9
	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	4	0	1.9
	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	14.9
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
	2	1	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0	19.1
	100	100	100	100	100	100	100	100	100	100	100	100	200	200	200	200	200	2.5
	0	0	0	0	0	0	0	0	0	0	0	0	100	200	500	500	500	1.8
	0	0	0	0	0	1	1	1	0	0	0	0	1	1	2	3	1	1.2
	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	1	0.7
	0	0	4	6	0	0	0	0	0	0	0	0	0	0	4	8	8	0.2
	0	1	0	0	0	0	0	2	1	0	0	1	2	1	2	1	0	4.3
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	3	2	7.2
	0						0	0										0.4
	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	1	2.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0.01%	0.01%	0.01%	0.00%	0.01%	0.01%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	21.8%	21.1%	21.3%	21.4%	21.2%	21.1%	20.7%	20.1%	22.9%	23.2%	21.5%	19.7%	18.9%	18.4%	18.4%	17.0%	17.3%	
	21.7%	21.4%	22.1%	22.8%	23.0%	23.1%	21.3%	21.2%	24.8%	25.5%	23.8%	23.0%	24.5%	27.0%	28.7%	28.2%	29.8%	

rapid increase in the share of renewable energy in the 2020s is primarily a result of a large number of existing coal-fired plants that are due to be retired in the period under study. The tool does allow for planning to extend the life of some existing plants (and the reference case includes 4.3 GW of such supply), but opinion is divided on how cost-effective the necessary refurbishments would be, particularly as some base-load plants are being run for mid-merit supply, which involves greater wear and tear. The critical challenge of the Renewable Energy Scenario would be to develop local industries to the scale where they can replace the large scale of plants being decommissioned, including 22 GW of concentrating solar thermal power required in the six years from 2025.

The renewable energy scenario envisages the following contributions to a total of 340 GWh electricity sent out in 2020:

- Wind: 11.8 GWh (10.5 at 30% availability) – less than 4% of total
- Concentrated Solar Thermal: 27.5 GWh (20.5 from central receiver) – 8% of total
- Biomass: 6.3 GWh (incl. ~1.6 from landfill gas)
- Cogeneration: 4.1 GW (of which a substantial portion could be biomass-fired)
- Pumped storage: 7.7 GWh

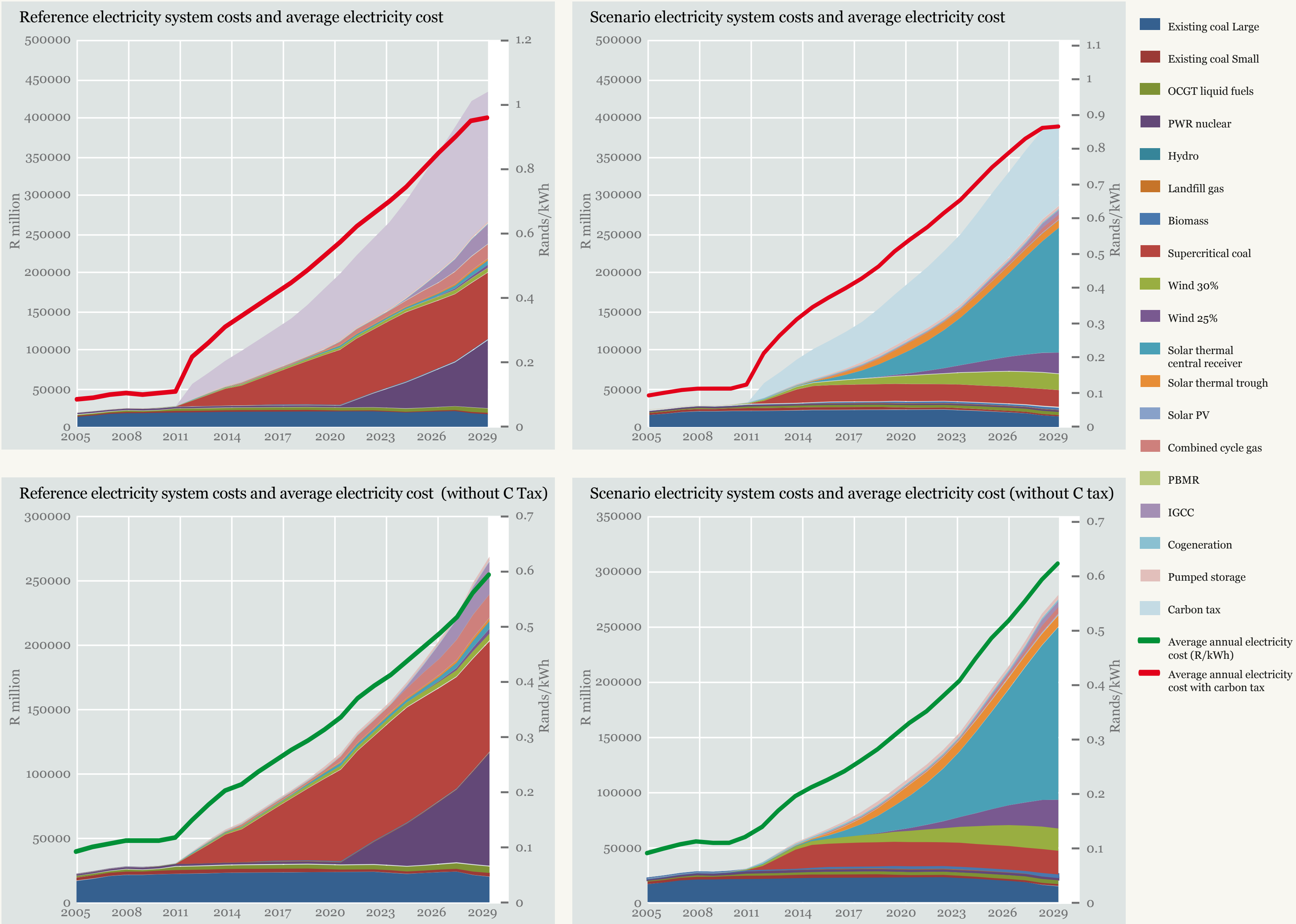
In 2050 the renewable energy scenario envisages about 12% supply from wind, 40% from concentrated solar thermal and about 2% total biomass contribution

Investment Plan: Alternative Scenario									
Plant Description	Unit size MW	2010	2011	2012	2013	2014	2015	2016	2017
Existing coal Large	564	0	0	0	0	0	0	0	0
Existing coal Small	114	0	0	0	0	0	0	0	0
OCGT liquid fuels	120	0	6	1	0	0	0	1	0
PWR nuclear	1350	0	0	0	0	0	0	0	0
Hydro	95	0	0	0.02	0.02	0.02	0.02	0.02	0.02
Landfill gas	30	0	1	0	1	0	1	1	1
Biomass	80	0	1	0	0	0	1	1	0
Supercritical coal	794	0	0	1	2	2	1	0	0
Wind 30%	1	100	200	300	300	300	300	400	500
Wind 25%	1	0	0	0	0	0	0	0	0
Solar thermal central receiver	100	0	0	1	0	0	1	3	5
Solar thermal trough	100	0	0	0	1	0	1	2	4
Solar PV	5	0	1	0	0	0	1	2	2
Combined cycle gas	387	0	0	0	0	0	0	1	0
PBMR	165	0	0	0	0	0	0	0	0
IGCC	550	0	0	0	0	0	0	0	0
Co-generation	100		5	5	0	0	0	0	
Pumped storage	333	0	0	0	1	1	0	1	1
Interruptible load	1	10	20	40	0	0	0	0	0
Reliability indicators									
Loss of load probability	0.03%	2.26%	0.33%	0.10%	0.01%	0.01%	0.01%	0.01%	0.00%
Reserve (AF) – including imported capacity	15%	15.4%	16.5%	16.6%	18.8%	20.0%	19.3%	19.1%	18.7%
Energy reserve margin – including net exports	10%	17.1%	18.0%	19.5%	21.2%	21.9%	21.4%	20.0%	18.3%

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total new (GW)
	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	1	1	0	0	0	0	1.2
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0.02	0.02	0.02	0.02	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
	0	0	2	0	0	0	0	0	0	0	0	2	0	0.6
	0	0	0	0	0	0	0	0	0	0	0	0	0	4.8
	500	500	600	600	600	600	800	800	800	600	500	200	0	9.5
	0	200	400	600	800	1000	1200	1500	1500	1500	1500	1500	1000	12.7
	7	10	12	14	16	20	24	30	33	36	40	40	40	33.2
	4	4	4	4	0	0	0	0	0	0	0	0	0	2.4
	2	2	2	3	4	4	5	5	6	6	8	10	12	0.4
	0	0	0	0	0	0	0	0	1	0	0	2	0	1.5
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	0	0	0	0	0	0	0	1	0	0	1	1	0	1.7
														1.0
	2	1	0	0	0	0	0	0	0	0	1	0	0	2.7
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
	19.1%	19.4%	18.1%	16.9%	17.1%	17.9%	17.4%	17.4%	17.8%	18.4%	19.6%	19.0%	20.3%	
	16.5%	15.5%	13.6%	11.8%	11.9%	12.4%	11.4%	11.5%	10.9%	10.6%	11.1%	10.2%	10.4%	

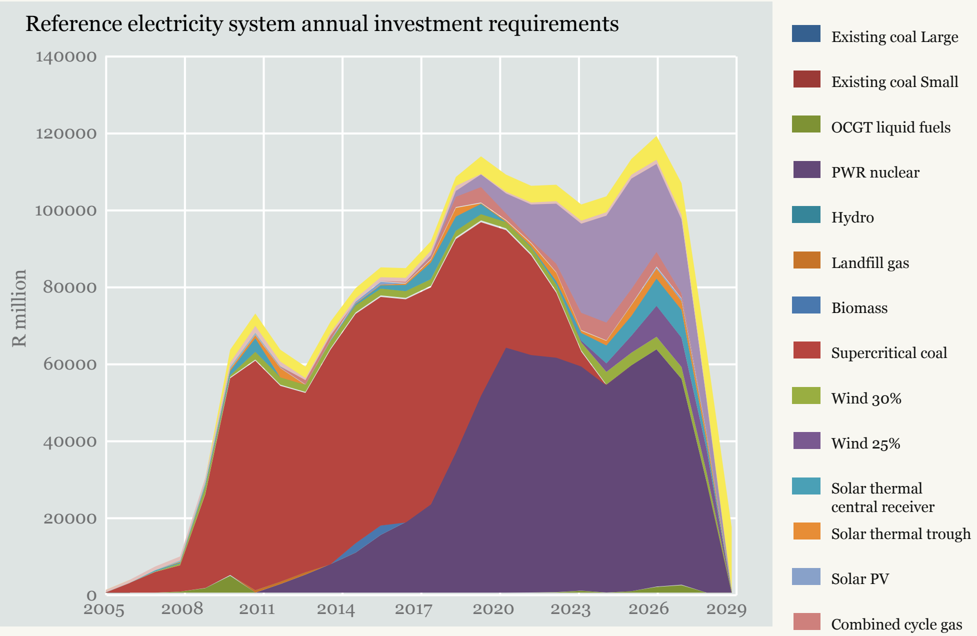
Comparison of Reference Case and Renewable Energy Scenario:
Two cost comparisons have been done, the first using costs as supplied by ERC (see appendices for more detail) and a second where the capital cost of three key technologies have been increased, consistent with recent market prices: nuclear, supercritical coal and wind. With these adjustments and without a carbon tax, the average cost of supply for the reference case is R0.04 lower than in renewable energy scenario in 2030. With the pre-set capital costs, the difference is greater, at about R0.13. A moderate carbon tax (reaching R150/tC in 2015 and R600/tC in 2030) eliminates the difference with pre-set capital costs, while using updated costs the carbon tax renders the renewable energy scenario the cheaper option, by about R0.10.

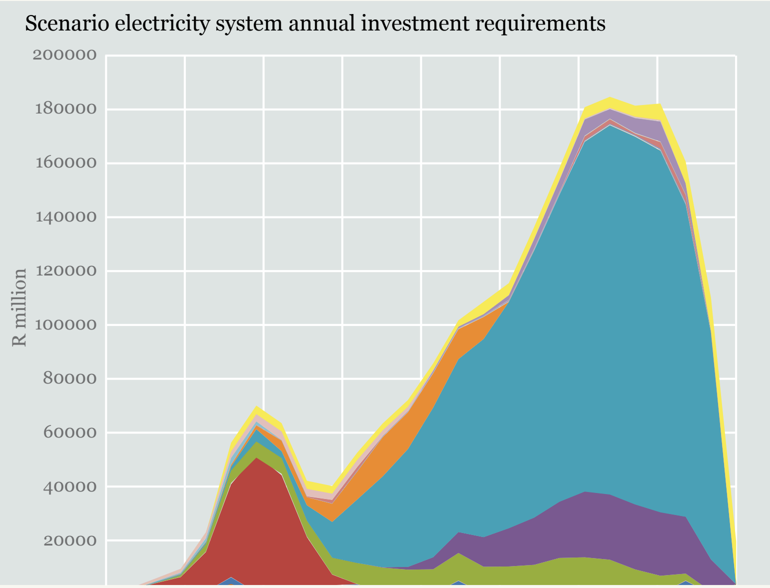
Note that the average cost of generation, including from existing and fully paid-off plants, reflects the annualised capital cost of all plants, plus actual fuel and operations and maintenance costs for all plants in the system. It is shown in constant (2008) Rands, unlike cost projections in Eskom's tariff applications, and the SNAPP average cost indicator only reflects the investment costs once a plant is commissioned, while Eskom includes expenditure on current build projects. The actual electricity price consists of other components as well, and is regulated. The aim of this indicator is to compare the costs of new build scenarios. It does also imply the sort of impact generation costs are likely to have on prices.



Average generation costs, using recent market prices for three key technology capital costs (see appendix for analysis with the SNAPP pre-set costs)

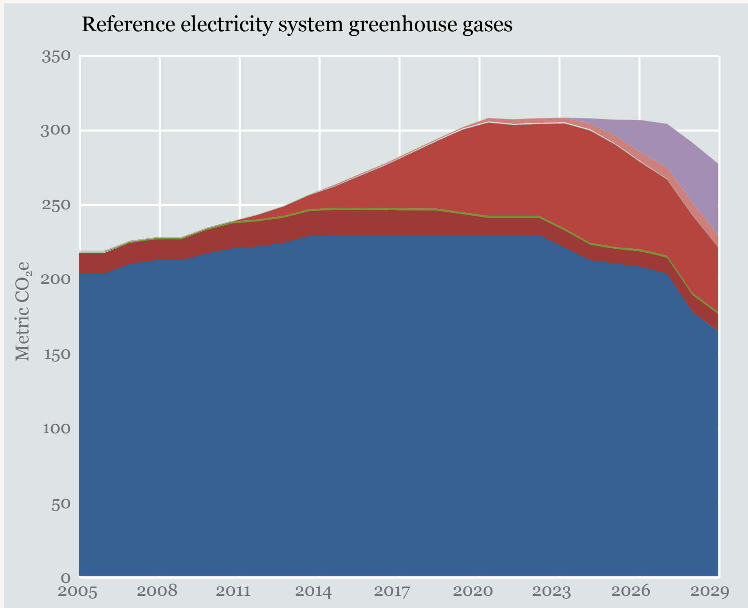
Annual capital investment required is considerably greater for renewable energy technologies than coal, though as demonstrated here, the impact on average generation costs is largely off-set by fuel and other operation and maintenance costs, and more than off-set when a carbon tax is applied. Using updated costs, capital investment is similar for the reference case and renewable energy scenario until about 2020, but increases to over R180 billion per annum by 2024 in the renewable energy scenario, while for the reference case it peaks at R120 billion per annum. (The divergence starts earlier and the difference in requirements is greater when using the pre-set costs (see appendices for further information)

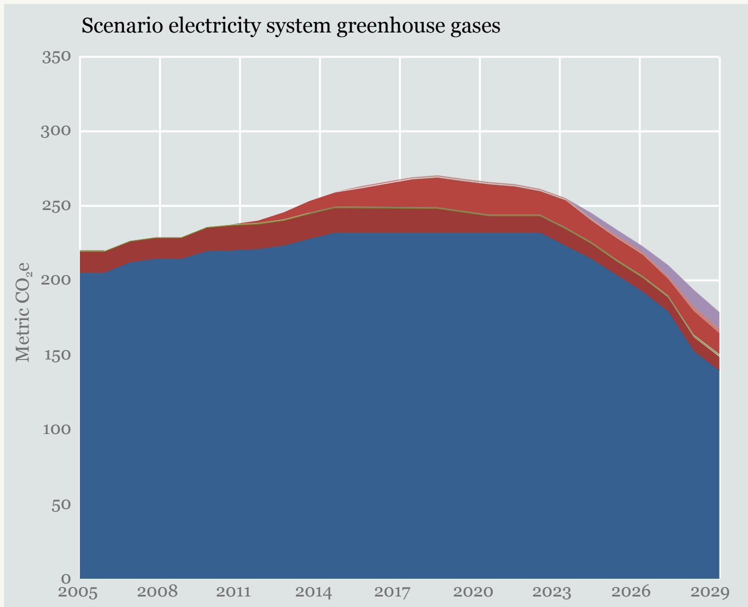


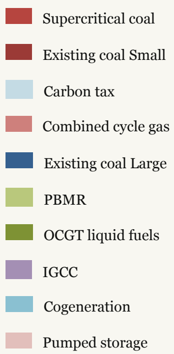


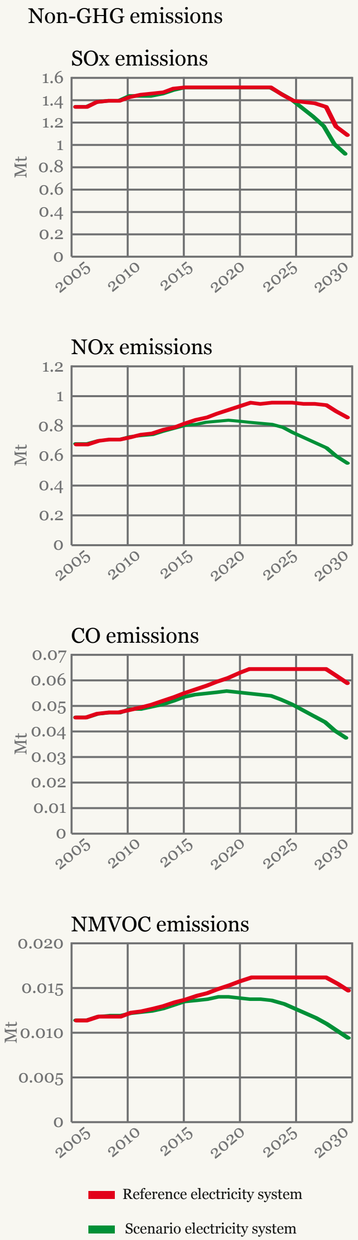
Annual investment requirements using recent market prices for three key technology capital costs

Emissions:
Greenhouse-gas emissions in the reference case exceed 300 $GtCO_2e$/annum from 2020 for at least eight years, which would make it very doubtful that South Africa could stabilise total emissions at about 500Mt/annum from 2020, as per the international commitment. In the renewable energy scenario emissions peak within 270 Mt in about 2020 and then start to decline, moving below 200 Mt before 2030. If South Africa establishes affordable capacity for safe and secure geological carbon storage, the most efficient application would be for IGCC, thus removing the emissions portion added last (top right) in the graphs. Local air pollution emissions projections are reported in the appendices.









Conclusions

WWF South Africa draws the following conclusions from the development and analysis of the reference case and renewable energy scenario:

The average cost of electricity generation would not be significantly more expensive for an renewable energy-intensive new build plan, compared to a plan based on Eskom's published intentions, and the difference would be off-set by a gradually rising carbon tax.

Achieving a 50% target for renewable energy contribution to electricity supply does not involve unrealisable growth rates for relevant industries; however, meeting the capital investment needs will require implementation of measures to mobilize private sector finance (such as REFIT) and concessional funding.

Prevailing new build plans are not consistent with the imperative to limit South Africa's greenhouse-gas emissions, and would involve under-utilisation of expensive infrastructure if commercial and industrial efficiency ambitions are realised.

There are viable alternatives to the construction of Kusile, while proceeding with Kusile would compromise prospects for renewable energy investment in the short term and thus the prospects of developing local industries in time to replace retiring plant in the 2020s; planning for even more coal-fired plant, following Kusile, would probably be fatal to prospects for South Africa developing a competitive role in renewable energy industries.

South Africa should adopt a target of at least 50% of electricity supply from renewable energy by 2030.

Targets for 2020: Immediate and dedicated efforts are required if we are to develop local industries to the point where renewable energy options are available at the scale required to replace coal-fired plants that are due for decommissioning in the 2020s. These include short-term commitment to deployment similar to the following, by end 2020, consistent with a target of 15% of electricity supply (18% of installed capacity, excl. pumped storage):

- 4 600 MW wind – with 4 000 MW at 30% availability
- 6 000 MW of solar power – using both central collector and trough solar thermal technology
- 800 MW utilising biomass, incl. dedicated biomass plant, landfill gas and some cogeneration
- 2 300 MW pumped storage (including Ingula, already under way; might incl. other storage options)

In the short term: In 2017, when Kusile is scheduled to come on line, the total wind capacity should reach about 2 400 MW and concentrating solar thermal 1 800 MW, with some 650 MW of biomass (incl. landfill).

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"Government needs to implement an immediate, rapid roll-out of an ambitious renewable energy programme in the country. Such a programme would have health, employment and energy security benefits."

Tasneem Essop, WWF South Africa

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FINANCING OPTIONS FOR A 15% RENEWABLE ENERGY TARGET

by Saliem Fakir

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South Africa's energy mix, being reviewed as part of the Integrated Resource Plan 2 (IRP2) process, should look to include a renewable energy target of 15% by 2020 as a basis to set up a larger renewable energy component of 50% by 2030.

The IRP2 process seems to be non-committal on this issue because it has already made the assumption that renewables will be too costly.

There is already a convergence of climate change issues, with the energy mix debate and industrial development. But convergence will not happen without a solution to the finance question for which creative options need to be looked at.

This is something the Department of Public Enterprise (DPE) and the Department of Trade and Industry (DTI) is beginning to look into. The DPE and DTI are likely to have their finance options study completed by the end of 2010.

The current Renewable Energy Feed-in Tariff (REFIT) does not accommodate the financing of a large-scale renewable energy programme. It is therefore crucial to identify ways in which such financing can sustain the economies of scale necessary to help boost renewable energy within the energy mix and deliver the industrial co-benefits.

Such a programme will only add to grid stability and lower our carbon emissions in the long term, transforming our energy from the current high carbon intensity of coal power to a low-carbon grid mix.

Financing is a challenge due to high upfront cost of renewable energy. Of the finance required for coal-fired power stations about 50% relates to up-front capital costs; the remaining 50% is required for fuel as well operating and management costs. By comparison, of the finance required for renewable energy, 80% to 90% goes towards capital costs and the balance is need for operating and management costs. The challenge is to

"Government needs to implement an immediate, rapid roll-out of an ambitious renewable energy programme which would have health, employment and energy security benefits."

Tasneem Essop, WWF South Africa

identify long-term funding but also to find ways to reduce the capital costs.

There are two approaches which can be taken.

The first is to identify the top-up amount that needs to be paid above the economic cost of electricity production, usually associated with levelised cost for coal-fired power stations. The top-up finance is required in order to make the renewable energy project financially sustainable over the plant's lifespan, between 20 to 30 years depending on the technology used. The crucial question is therefore not really the economic cost but is around the top-up finance needed.

The second approach is to look at ways of financing the expanded REFIT. Some of the upfront costs could be provided by attracting international finance through the finance mitigation obligations of industrialised nations with regard to their mandate to reduce global emissions. That could be facilitated through the UNFCCC structures or through bilateral arrangements in which grant funding is given.

It should be assumed that this finance will not last throughout the period required by the REFIT but it would at least kick-start the financing of renewables by initiating the expanded REFIT. Most of the other finance will have to be sourced domestically and be guaranteed by national government. Domestic sources should in time displace international financing.

One of the avenues for domestic finance could be through a carbon tax. The current 2c/kilowatt levy could be considered a carbon consumption tax that is charged through the electricity price.

Alternatively, a high energy user tax could be levied through a green tariff obligation for high-energy users on top of the discounted price they currently pay for electricity derived from the Eskom grid.

The benefit would be increased export competitiveness in a more carbon-constrained world, by reducing the carbon intensity of both raw and refined/manufactured materials/goods.

This scenario would improve investments in renewable energy, a boon to the many companies who have a stake in the growth of this sector as they will have to supply steel, cement and other materials.

We should also consider the availability of concessionary finance which can enable the reduction of capital costs.

Concessionary finance would be provided at a more discounted rate than the rate provided by commercial financiers. This would in turn reduce the project financing required by renewable energy initiatives.

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It would also reduce the REFIT burden in that the top-up subsidy would not have to be so onerous if it were implemented with significant inflationary impacts and transfer costs to consumers. It would be at a level that is financially sustainable and ensures that electricity remains affordable.

Critical for the success of an expanded REFIT is to generate greater economic benefit and value than the current the REFIT system, which is designed on the premise of a once-off, low-quantity integration of renewable energy into the grid.

Our work shows we can up the ante for renewables. Considerable value can be generated through the localisation of production of wind and concentrated solar components manufacturing if the right scale of renewables become part of the energy mix. While with wind localisation potential stands to be lower the opportunities for almost 100% localisation for concentrated solar is much better.

Original Equipment Manufacturers (OEMs) have been eyeing South Africa for a long time as a strategic place to invest in.

A low renewable energy target is not ideal for developing green economy-related initiatives. Part of the green economy sector would be clean technologies of which renewable energy would be a strong feature.

Cost issues are usually used by opponents of renewable energy as a barrier to considering renewable energy as a way to diversify South Africa's energy mix. Our work shows that there are creative options for long-term financing, available to boost the economies of scale for renewable energy.

AFTERWORD

"We, the leaders of the world, need to seize our historical responsibility to act now to safeguard the future of humanity and the planet it inhabits. We owe it to current and future generations."

President Jacob Zuma, address at COP15 in Copenhagen

There are some, including representatives of influential stakeholders, who will scoff at the objective of 50% renewable electricity by 2030 in South Africa. While a range of experts assert that we are about to reach the peak of global oil production, others maintain that human ingenuity and technology innovation will enable oil production to keep increasing to 2030 or beyond. The latter are often the same people who cannot believe that we can achieve 100% renewable energy supply. The most entrenched assumption is often simplified as: we must have coal or nuclear power to provide baseload electricity supply.

How we meet baseload demand is ultimately a product of how the whole electricity supply system is designed and managed, in conjunction with demand management measures, and should be addressed through comprehensive integrated energy planning. Insisting that a particular type of generation plant, such as nuclear, is essential to meeting baseload demand is an anachronism. South Africa experienced loss of baseload supply from a nuclear plant when a stray bolt took 900 MW of capacity out of the system for several months in 2006. In France several nuclear power stations had to be shut down during a heat wave, for lack of sufficient cooling, leaving Parisians without power. It is unclear how many of the estimated 15 000 deaths might have been averted had air conditioning and other services not been deprived of this 'despatchable' electricity supply. Some of our coal power stations, deemed 'baseload plants', are heading for early retirement due to their being ramped up and down to meet mid-merit demand.

It is widely recognised that Concentrating Solar Power (CSP) alone can provide baseload supply by incorporating sufficient thermal storage. A CSP plant with some thermal storage and some gas co-firing would generally be more efficient, and far more cost-effective than separate solar and gas plants. Wave and ocean currents provide a fairly constant resource for power generation, but the relevant technologies are still in early stages of development.

The potential contribution of wind power to baseload supply will depend on the predictably available resource base across the geographic area covered by an integrated transmission and distribution system. To characterise all wind power as intermittent, regardless of the scale and spread of installed capacity feeding into a particular national or regional system, is a misrepresentation. The potential contribution in South Africa is currently contested. Some wind power companies claim that, with a portfolio of upwards of 10 GW of capacity well spread around our coastline, 40% of generation output would be constantly available. However, some experts suggest that we should not rely on more than 10% of such a wind portfolio for baseload.

Demand-side management is mostly associated with curtailing or shifting peak demand, but should also contribute to maintaining adequate supply throughout the daily demand profile. A strong case can be made for expecting energy-intensive industries to develop more flexibility in their demand, for example, by maintaining some storage capacity of their own or developing production processes less vulnerable to dips in electricity supply. Preferential tariffs are already available to large-scale users that enter into interruptible supply contracts.

Another key consideration for sustainable supply and resource efficiency is the energy return on energy invested (EROEI). This exposes a particular challenge to the prospect of a new nuclear industry in South Africa, which would add substantially to electricity demand for at least 10 years before making any contribution to supply. Production of nuclear fuel, including uranium mining, enrichment and processing, is an energy-intensive process, as is plant construction. Renewable energy technologies provide higher rates of EROI, particularly wind. .

The EROI of fossil fuels is diminishing as we move to reserves that are less easily accessed (e.g. deepwater drilling, tar sands) and as increasing needs for pollution control increases energy use at the generation plant.

One thing the SNAPP tool does not do is assess adequacy of baseload supply. Much work remains to be done to ensure that the electricity system can handle a high proportion of renewable input while meeting the needs of energy-intensive industries, for which constant supply is critical to the efficiency of their processes. A 15% contribution from renewable energy poses no particular challenge for electricity supply management and brings benefits of decentralisation. Growing this to 50% will require rigorous integrated energy planning and sophisticated operation of a smart and extensive grid, but also bring benefits of localisation, community participation in optimising resource efficiency, and reducing the challenges and true costs being deferred onto the next generation.

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APPENDICES

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Introduction

Jobs per $1 million invested				
Industry	Direct	Indirect	Induced	Total
Solar	5.4	4.4	3.92	13.72
Biomass	7.4	5.0	4.96	17.36
Wind	4.6	4.9	3.8	13.3
Smart Grid	4.3	4.6	3.56	12.46
Coal	1.9	3.0	1.96	6.86
Oil and gas	0.8	2.9	1.48	5.18
Nuclear	1.2	1.8	1.2	4.2

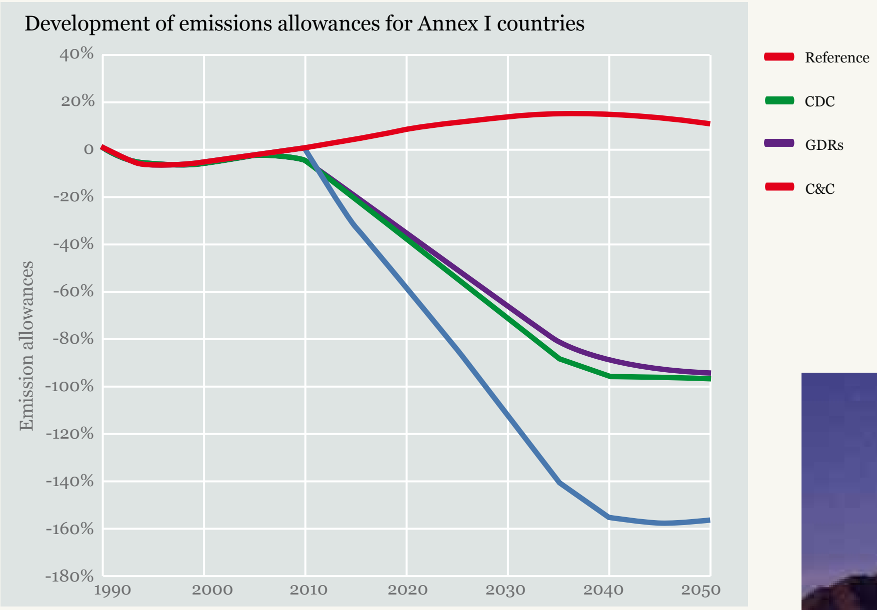
Source: Heidi Garrett-Petier and Robert Polin, University of Massachusetts Political Economy and Research Institute.
Note: Multipliers derived using IMPLAN 2.0 with 2007 data. Infrastructure multipliers and assumptions are presented in *How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth*, Political Economy Research Institute. January 2009. http://www.perl.umass.edu/235/hash/efc9f7456a/publication/333

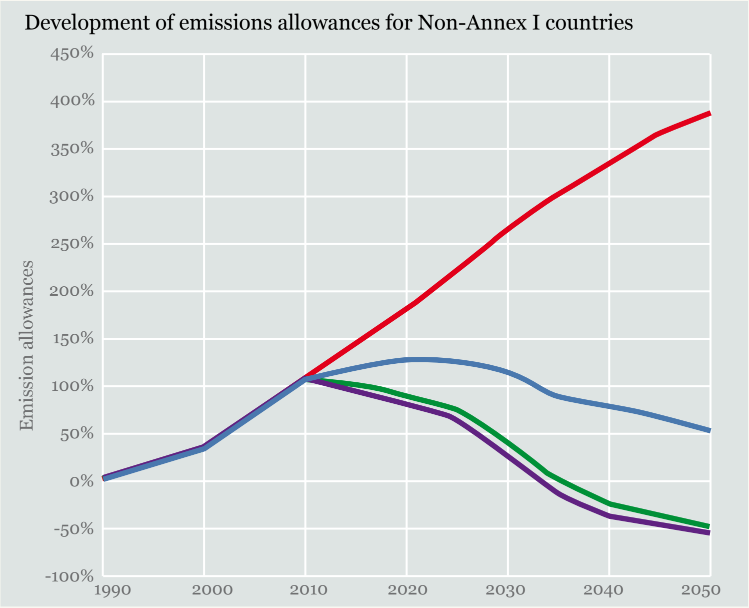
Conventional energy technologies	Direct jobs per		Renewable energy technologies	Direct jobs per	
	MW capacity	GWh generated		MW Capacity	GWh generated
Coal (current)	1.7	0.3	Solar Thermal	5.9	10.4
Coal (future)	3.0	0.7	Solar PV	35.4	62.0
Nuclear	0.5	0.1	Wind	4.8	12.6
Nuclear BMR	1.3	0.2	Biomass	1.0	5.6
Gas	1.2	0.1	Landfills	6.0	23.0

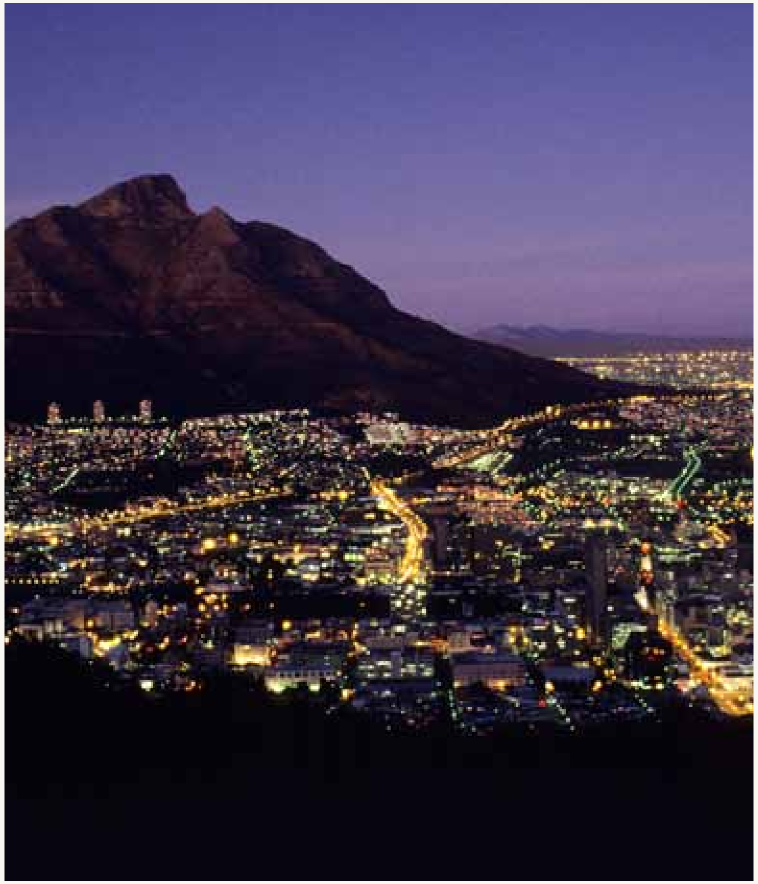
AGAMA Energy 2005

Sharing the effort under a global carbon budget

Development of emissions allowances for industrialised countries, as listed in Annex I of the UNFCCC, and developing (Non-Annex I) countries, shown as deviation from 1990 emissions levels (0%) up to 2050, under the different effort sharing approaches (CDC, GDRs and C&C – see page 13).







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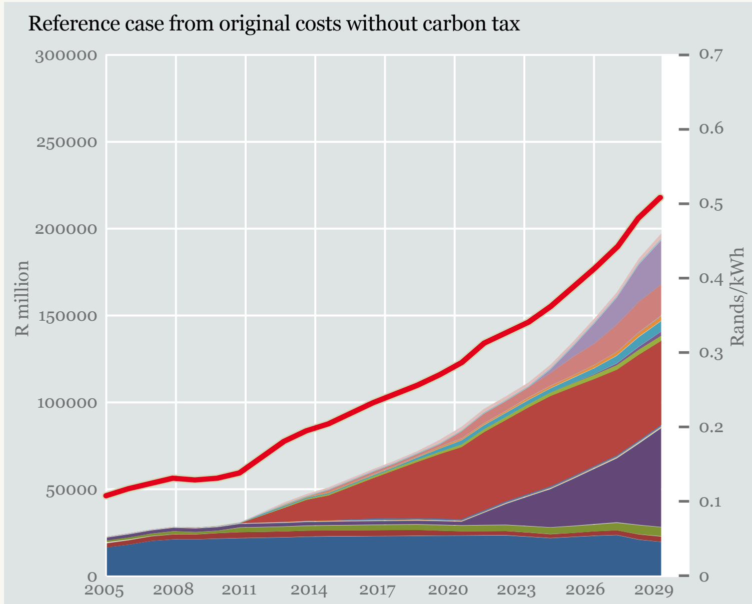
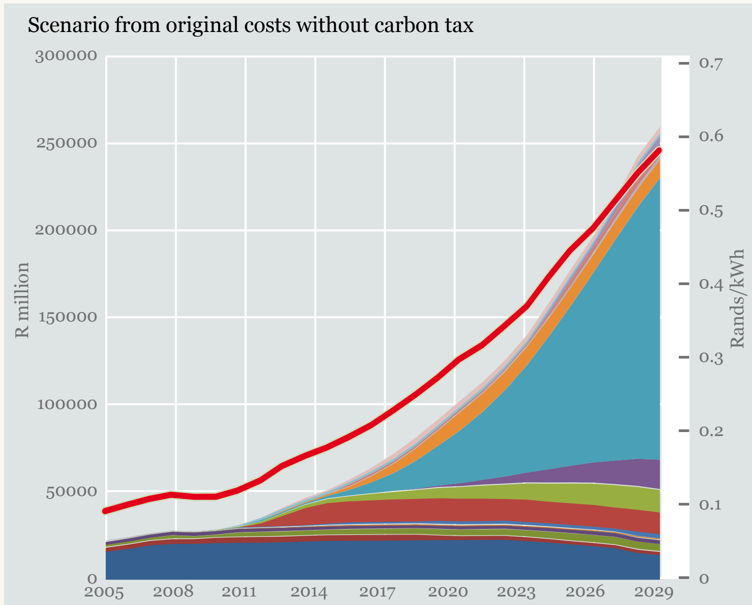
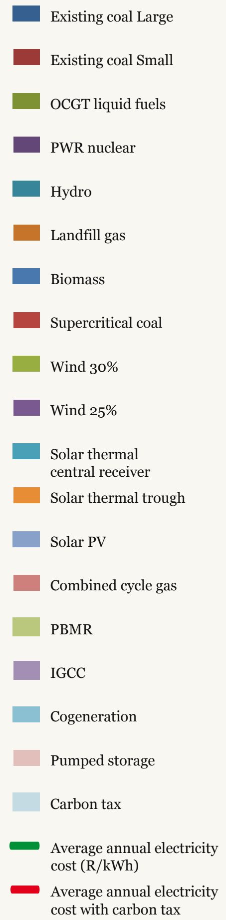
Renewable Energy Scenario in SNAPP







System cost and average generation cost of reference case and renewable energy scenario, using prices as pre-set in SNAPP tool based on previous government planning inputs

“Even disregarding the real and imminent threat of climate change we find compelling reasons to be looking at a shift from fossil fuel based energy to alternative, renewable energy, together with better management of our energy usage.”

Saliem Fakir, WWF South Africa

GLOSSARY

Annex I Parties	The industrialised countries as listed in this annex to the UN Framework Convention on Climate Change, which originally committed to return their greenhouse-gas emissions to 1990 levels by the year 2000 and have subsequently accepted emissions targets for the period 2008 to 2012. They include the 24 original OECD members, the European Union, and 14 countries with economies in transition.
Carbon capture and storage (CCS)	A set of technologies for capturing CO_2 emissions and securing them in some form of storage or sequestration. In SA this would mean pumping it underground, if safe and secure storage capacity can be found. Some oil wells have been pumping CO_2 back into geological formations as a means of maintaining well pressure, as well as reducing emissions. For fossil fuel power stations the technologies are still under development.
CO_2e	A common unit to measure different greenhouse gases, based on the climate forcing impact of carbon dioxide.
Cogeneration	Cogeneration (also combined heat and power, CHP) involves optimising the use of the energy output of thermal processes – either using heat from production processes, otherwise vented, to generate electricity, or using waste heat for direct heat applications, e.g. piping to local community central heating systems.
Economies in Transition (EIT)	Those Central and East European countries and former republics of the Soviet Union in transition from state-controlled to market economies.
Emerging Economies	Nations in the process of rapid economic growth and industrialisation. Currently, there are 28 emerging economies in the world, with China and India being by far the two largest. South Africa is also considered an emerging economy.
Feed-in Tariff (FIT)	Tariffs established by a national regulatory authority as appropriate for the purchase of power from a specific resource or technology. Mostly applied to electricity generated from renewable energy (REFIT), recognising the net value to society and intended to attract independent power producers.
Gt	Gigaton: One billion tonnes. 1 GT = 1 000 Mt = 1 000 000 kt
Greenhouse gases (GHGs)	Gases which, in the atmosphere, are responsible for causing global warming, resulting in climate change and variability. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Less prevalent – but very powerful – greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Land-use change, and forestry (LUCF)	A greenhouse-gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.
Least Developed Countries (LDCs)	The World's poorest countries. The criteria currently used by the UN Economic and Social Council (ECOSOC) for designation as an LDC include low income, human resource weakness and economic vulnerability. Currently about 50 countries are designated by the UN General Assembly as LDCs.
Levelised Costs	The present value of the total cost of building and operating a generating plant over its economic life, converted to equal annual payments.
Long Term Mitigation Scenarios	The Long Term Mitigation Scenarios (LTMS) research process was mandated by Cabinet and led by the Department of Environmental Affairs & Tourism from 2006 to 2008. The primary purpose was to quantify and put a cost to mitigation opportunities in South Africa, to inform national policy and our positioning in multilateral climate negotiations.
Loss of Load Probability	A measure of the probability that total system demand will exceed available capacity during a given period; often expressed as the estimated number of days over a long period, frequently 10 years or the life of the system.
Reserve margin (AF)	The amount of installed generation capacity, over and above what is needed to meet peak electricity demand levels, to provide for planned and unplanned plant outages.

LOW-CARBON ECONOMY ROADMAP

The Living Planet Unit is committed to promoting a just transition to a low-carbon, climate-resilient society. To develop detailed substance and analysis of what this will mean for South Africa we have commissioned a research study to develop a Low-Carbon Economy Road Map, for which a scoping phase has been completed. We would like to hear from people interested in participating in stakeholder consulttions once a draft report is available.

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WWF participants from China, Brazil, Mexico, India, Nepal and South Africa during a climate and energy Emerging Economies Workshop held in South Africa, in 2010

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This publication builds on the report: *Cheaper Electricity with Renewable Energy*, published by WWF-SA in February 2009. We now present a scenario demonstrating how 50% of South Africa's electricity could be generated with renewable energy technologies in 2030, consistent with our national development objectives.

The information and options offered here, while of relevance to all South Africans requiring electricity, are intended primarily to empower stakeholders engaging with energy planning and climate change policy processes taking place in 2010 and 2011. In this time decisions will be taken that will affect the affordability and sustainability of electricity supply beyond 2050.

Issues covered in the publication include:

Climate Solutions 2 – How much of a challenge is it to transform to a low carbon society? What are the solutions and potential opportunities for Low-carbon Re-industrialisation?

Carbon Budget – Just how much greenhouse gas can humanity afford to emit between now and 2050? What share of a global carbon budget could South Africa reasonably lay claim to?

Cheaper electricity with renewable energy – What effect will a renewable energy target of 15% by 2020 have on the electricity price? Can this be ramped up to 50% by 2030?

Stop Kusile – Does South Africa need another huge coal-fired power station (after Medupi, which is benefiting from a World Bank loan) or can we keep the lights on by other means?

The Sustainable National Accessible Power Planning (SNAPP) tool – Introducing a tool, freely available by internet, that allows stakeholders to interrogate and compare proposals for South Africa's new electricity generation build plan, including fully transparent input data sets for cost analysis, environmental impacts and indicators of the reliability of the supply system.

We also consider how to address challenges such as financing and the perceptions, peddled by vested interests, that human progress or development, or even meeting baseload power demand, is contingent upon continued use of fossil and nuclear fuels.

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Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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