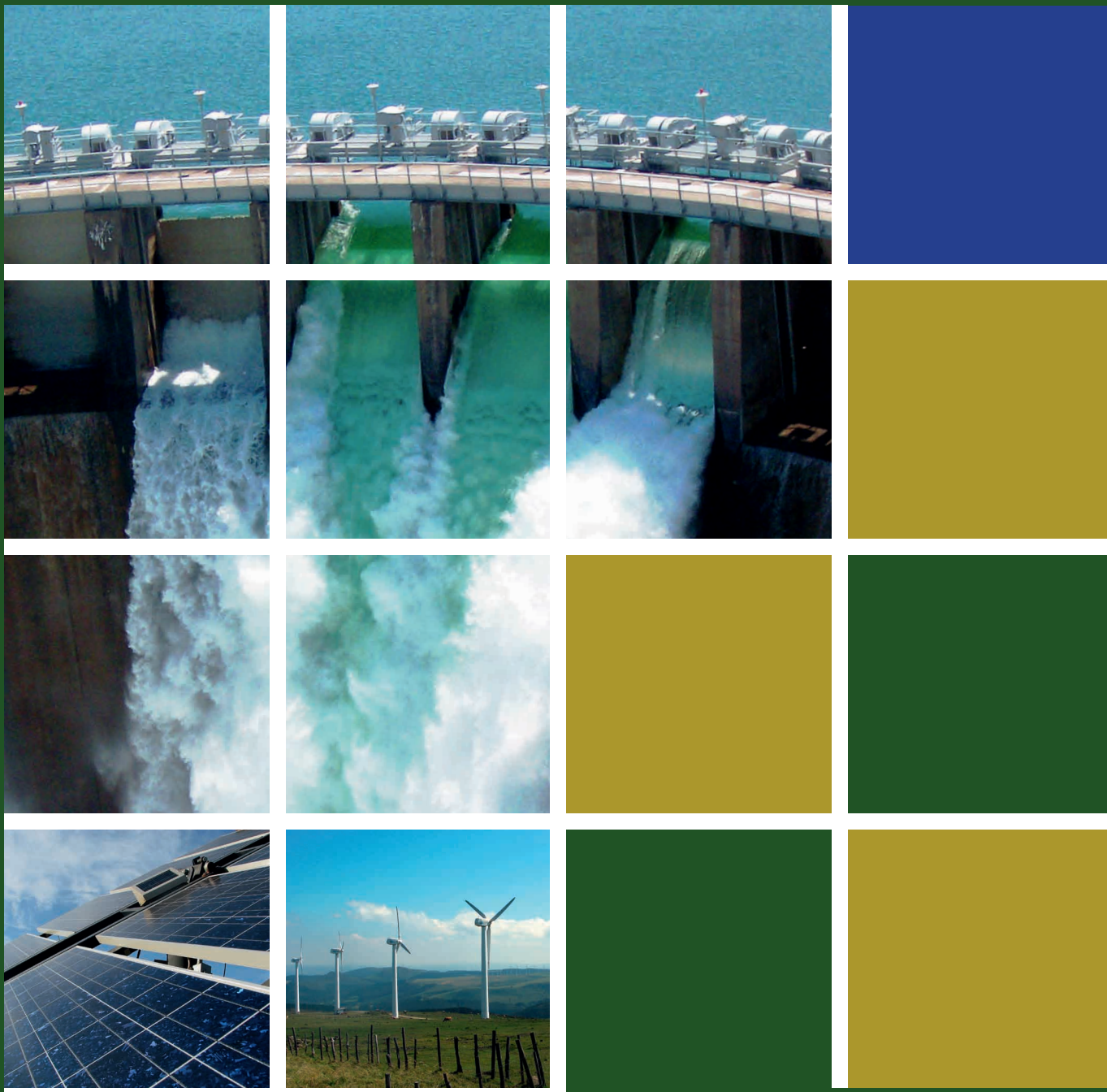




CLIMATE CHANGE AND DEVELOPMENT:

TOWARDS AN ALTERNATIVE ENERGY FUTURE
FOR SOUTHERN AFRICA?

institute for



global dialogue

**FRIEDRICH
EBERT
STIFTUNG**

PROCEEDINGS OF THE IGD/FES
CONFERENCE HELD IN
TSHWANE/PRETORIA
SOUTH AFRICA
ON 17–18 AUGUST 2009

Climate change and development: Towards an alternative energy future for southern Africa?

Proceedings of the IGD/FES Conference
held in Tshwane/Pretoria
South Africa
on 17–18 August 2009

institute for



global dialogue

**FRIEDRICH
EBERT 
STIFTUNG**

Published in December 2009 by the

Institute for Global Dialogue
IGD House, Thornhill Office Park
Bekker Street, Vorna Valley
Midrand, South Africa
P O Box 32571, Braamfontein 2017
Tel +27 11 315-1299
Fax +27 11 315-2149
Info@igd.org.za
www.igd.org.za

Friedrich-Ebert-Stiftung
SA Office
34, Bompas Road
Dunkeld West
Johannesburg
Tel: +27-11-341 0270
Fax: +27-11-341 0271
e-mail: fes@fes.org.za

All rights reserved. The material in this publication may not be reproduced, stored, or transmitted without the prior permission of the publisher. Short extracts may be quoted, provided the source is fully acknowledged.

ISBN 978-1-920216-26-9

Produced by Karen Graphics, Centurion
Tel: +27-12-663 9605
Fax: +27-12-663 9603

Contents

About the contributors	4
Acronyms and abbreviations	5
Preface	9
Introduction	11
Opening address: Climate change and development: Towards an alternative energy future for southern Africa <i>Nelisiwe Magubane, Department of Energy</i> <i>Presented by David Mahuma</i>	15
Part 1: South Africa and the political economy of renewable energy <i>Nomawethu Qase, Department of Energy</i>	21
Part 2: A renewable energy 'revolution' for southern Africa <i>Amanda Luxande, Renewable Energy and Energy Efficiency Partnership</i> <i>Sipha Ndawonde, Frost & Sullivan</i>	28 34
Part 3: Prospects for a regional approach to renewable energy <i>Johnson Maviya, Southern African Power Pool</i>	47
Part 4: Renewable energy, gender and the rural–urban divide <i>Dorah Lebelo, Citizens United for Renewable Energy and Sustainability</i> <i>Nthabiseng Mohlakoana, Gender and Energy Network of South Africa/HSRC</i>	58 65
Part 5: The market as a driver or constraint in the move towards renewable energy in southern Africa <i>Anthony Turton and David Gadd-Claxton, Touchstone Resources</i> <i>Rod Crompton, National Energy Regulator South Africa</i>	72 90

About the contributors

David Mahuma is the acting Chief Director of Clean Energy for the Department of Energy.

Nomawethu Qase is the Director of New and Renewable Energy for the Department of Energy.

Amanda Luxande is Manager of the Renewable Energy and Energy Efficiency Partnership (REEEP) Southern Africa Regional Secretariat.

Sipha Ndawonde is an Energy Analyst for Frost & Sullivan International.

Johnson Maviya is an Environmental Officer for the Southern Africa Power Pool (SAPP).

Dorah Lebelo is the southern African Coordinator for Citizens United for Renewable Energy and Sustainability (CURES).

Nthabiseng Mohlakoana is a Chief Researcher at the Human Sciences Research Council (HSRC) and part of the Gender and Energy Network of South Africa (GENSA).

Dr. Rod Crompton currently serves as a full-time Regulator Member of the National Energy Regulator of South Africa (NERSA), primarily responsible for petroleum pipelines regulation.

Prof. Anthony Turton and **David Gadd-Claxton** are Directors of Touchstone Resources (Pty) Ltd.

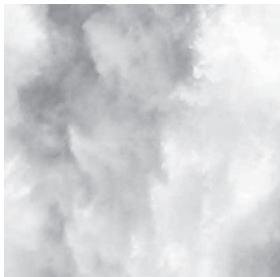
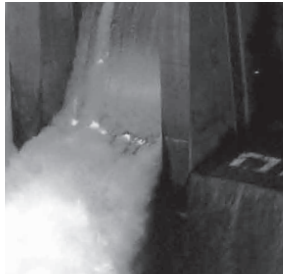
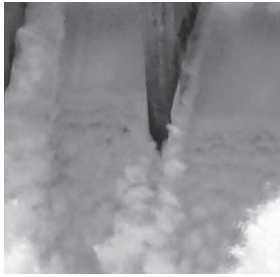
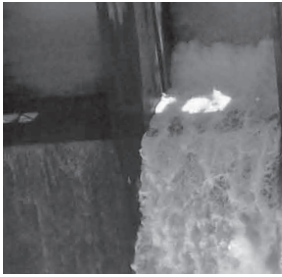
Acronyms and abbreviations

ABOM	Agreement between Operating Members
AFUR	African Forum for Utility Regulators
AMD	Acid mine drainage
AU	African Union
BBEE	Broad-based Black Economic Empowerment
BEE	Black Economic Empowerment
BPC	Botswana Power Corporation
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CEF	Central Energy Fund
CER	Certified Emission Reduction
CFL	compact fluorescent lamps
CHP	combined heat and power
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar Power
CURES	Citizens United for Renewable Energy and Sustainability
DBSA	Development Bank of Southern Africa
DE	Department of Energy
DME	Department of Minerals and Energy
DNA	Designated National Authority
DSM	Demand-side Management
EDA	Energy Development Agency
EDM	Electricidade de Mozambique
ENE	Empresa Nacional de Electricidade
ESCOM	Electricity Supply Commission of Malawi
ESI	Electricity Supply Industry
Eskom	Electricity Supply Commission of South Africa
EU	European Union
EU ETS	European Union Emission Trading Scheme
EWURA	Energy and Water Utilities Regulatory Authority
FBAE	Free Basic Alternative Energy
FES	Friedrich Ebert Stiftung

■ Acronyms and abbreviations

GDP	gross domestic product
GEF	Global Environment Facility
GENSA	Gender and Energy Network of South Africa
GGP	gross geographic product
GHG	greenhouse gas
GVEP	Global Village Enterprise Programme
GWh	Gigawatt hour
IBT	inter-basin transfer
IDC	Industrial Development Corporation
IEA	International Energy Agency
IGD	Institute for Global Dialogue
IGMOU	Inter-governmental Memorandum of Understanding
Inter-SEDE	International Security, Economic Development and Environment
IPP	Independent Power Producer
ISES	International Association of Solar Energy
ITC	Independent Transmission Company
IUMOU	Inter-utility Memorandum of Understanding
KWh	Kilowatt hour
KZN	KwaZulu-Natal
LEA	Lesotho Electricity Authority
LEC	Lesotho Electricity Corporation
LPG	Liquefied Petroleum Gas
LTMS	Long-term Mitigation Scenarios
MAP	mean annual precipitation
MAR	mean annual runoff
MERA	Malawi Energy Regulatory Authority
NEEA	National Energy Efficiency Agency
NEPAD	New Partnership for Africa's Development
NERSA	National Energy Regulator of South Africa
NGO	Non-governmental Organisation
OG	operating guidelines
OPEC	Organisation of Petroleum Exporting Countries
PCP	Power Conservation Programmes
PPA	Power Purchase Agreement
PV	photovoltaic
RE	renewable energy
REEEP	Renewable Energy and Energy Efficiency Partnership

REFIT	Renewable Energy Feed-in Tariff
REFSO	Renewable Energy Financing and Subsidy Office
REMT	Renewable Energy Market Transformation
RERA	Regional Energy Regulatory Association
RET	Renewable Energy Technology
RPS	renewable portfolio standards
SADC	Southern African Development Community
SANEDI	South African National Energy Development Institute
SANERI	South African National Energy Research Institute
SANTRECT	South African National Tradable Renewable Energy Certificate Team
SAPP	Southern African Power Pool
SAWEP	South African Wind Energy Programme
SEB	Swaziland Electricity Supply Board
SEC	Swaziland Electricity Company
SHS	Solar heating system
SNEL	Société National d'Electricité
SOE	State-owned Enterprise
SWH	Solar water heater
TANESCO	Tanzania Electricity Supply Company
TRECS	Tradable Renewable Energy Certificates
TWO	Transboundary water opportunity
UCT	University of Cape Town
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax
VER	Verified Emission Reduction
WESTCOR	Western Power Corridor
WMA	Water Management Area
ZERC	Zimbabwe Electricity Regulatory Authority
ZESA	Zimbabwe Electricity Supply Authority



Preface

"Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons."

Garret Hardin, *The Tragedy of the Commons*, 1968

When considered against the backdrop of the current effects of global warming and the rising pathologies associated with climate change, Hardin's words are indeed apocalyptic. It is a foreboding of what is to come if, as overlapping 'communities of fate', the common heritage of the planet is not preserved by mankind. It is precisely at the interface between man's seeming insatiable appetite for fossil fuels and the environmental costs that major challenges have been emerging over the last two decades. Demand for energy sources is predicted to increase by 50 per cent by 2025, and most of this demand will be fossil fuel-based. There are over 1,6 billion people who have no access to electricity, and a further 2,4 billion who rely on plant material, vegetation, or agricultural waste for their energy and heating sources. This has direct implications for maintaining the equilibrium in the world's ecological systems and biodiversity networks.

In the face of this, the earth's glaciers are receding, carbon dioxide concentrations in the atmosphere have nearly doubled, and world temperatures over the last five years have been the hottest recorded since 1861. This brings into stark relief the political and economic challenges for energy sustainability since the future of fossil fuels is highly uncertain; based on current growth and consumption trajectories, there might only be enough fossil fuels for another generation or two. This could possibly signal the demise of the current energy system and hence, there are compelling reasons to limit the use of fossil fuels and search for alternate sources before extant fossil fuel energy sources are exhausted.

This helps to explain the logic of promoting alternate energy sources and highlights the need to generate energy policies that take into account the strengthening of existing matrices of renewable energy technologies. A critical normative consideration behind renewable energy development is the displacement of polluting energy sources, in this case fossil fuels. Innovative energy policies thus include a range of options such as carbon off-setting and carbon funds that are aimed at mitigation and adaptation such that there is more judicious management of the effects of climate change but crucially, the overarching goal is to reduce greenhouse gas emissions from energy production to ensure a sustainable future. This will require serious

commitments from the international community, paradoxically in a world where cleavages of wealth, power, and resources persist.

However, in terms of where the greatest energy stresses are being experienced, Africa and its regions provide the crucible that will test the efficacy of these renewable interventions from hydro and wind power to biofuels and geothermals. For it is here that global warming is playing itself out with devastating effects and where cyclical drought, erratic weather patterns, freshwater scarcity and growing food shortages manifest themselves with growing severity. This publication represents a joint initiative of the Institute for Global Dialogue in conjunction with the Johannesburg office of the Friedrich Ebert Stiftung to provide a forum for discussion focused on how renewable energy sources could be at the forefront of climate change mitigation in southern Africa. The forum also casts an important spotlight on critical themes that inform the debate in securing an alternate energy future. It is hoped, even in a modest way, that this publication puts the realities of the challenges into a clearer perspective, mindful of Hardin's injunction.

Dr Garth le Pere

Executive Director

Institute for Global Dialogue

Introduction

More than any other continent, Africa needs an energy revolution and independence from the international fossil fuel economy; a change to RE and energy autonomy is paramount for survival.

– Preben Maegaard, Chairman WCRE

Renewable energy (RE) has been touted not only as a means of mitigating carbon emissions in addressing climate change, but also as an instrument in improving energy security and contributing to socio-economic development. Internationally, this has seen the burgeoning of RE within the energy market which, despite the global financial crisis has increased by up to 16 per cent, reaching \$120 billion during 2007.¹ However, a growing gap is emerging between states in terms of access to and the implementation of RE technologies. This is particularly evident in southern Africa, where a reliance on expensive technology and subsidised fossil fuel has resulted in RE being largely confined to the periphery of policy making. This has underscored the Southern African Development Community's (SADC) dependence on fossil fuel as a primary source of energy, contributing to wider energy insecurity while also increasing the region's exposure to economic shocks (as a result of price volatility), and impacting negatively on human health and the natural environment. In contrast, the industrialised countries of the North, and the more developed emerging powers such as India, China and Brazil, have moved towards the integration of RE into mainstream infrastructure, reducing carbon emissions as well as their dependence on fossil fuels.

As the largest contributor of greenhouse gas (GHG) within the region, South Africa faces the challenge of reconciling development and climate change objectives. In its efforts to address this challenge, Government has recognised the potential of RE in stimulating economic development as well as reducing carbon emissions. However, while there has been agreement on the need to incorporate RE into the national energy mix, production has been on a small scale and implementation has remained fragmented. Although Government has professed a renewed focus on establishing a thriving RE sector to stimulate economic development, and contribute to job creation as well as economic competitiveness, the country continues to face a dearth in capacity. In addition, vested economic interests and international constraints on investment and technology transfer raise concerns over the ability of the state to play a central role, both domestically and within the region, in supporting RE production.

1 Renewables Global Status Report: Energy Transformation Continues Despite Economic Slowdown. 13 May 2009, Paris. <http://www.ren21.net/globalstatusreport/g2009.asp> (accessed 12 June 2009).

In southern Africa the bulk of investment in energy infrastructure continues to be dominated by hydrocarbon rather than renewable energy technologies. This only adds to the growing gap between SADC countries and developed states in securing energy diversity. The lack of infrastructure and regulatory frameworks, the low profile of RE technologies, and the perceived investment risk have also encouraged foreign investors to bypass the region in favour of the more developed emerging states. Yet southern Africa has a significant, and largely untapped, RE potential which includes hydro, solar, biogas, geothermal and wind power. According to the Africa Commission '[t]hese can become the backbone of a reliable, affordable and climate friendly energy system. ... There are, thus, market opportunities for small and medium sized enterprises both as energy producers and energy consumers, be it in agriculture, agro-industries, tourism or commerce'.² Nevertheless, to encourage the development of Independent Power Producers (IPPs), there needs to be a focus on developing a favourable investment climate, clear policy frameworks, coherent and coordinated planning across the energy sector, effective regulatory oversight, and competitive bidding practices. In other words, governments within the region need to move beyond a focus on the technical details of RE technology, to considering its application, financing and integration into mainstream policy.

Energy remains a cornerstone of socio-economic development, with demand only expected to increase as the region develops. The integration of RE into the mainstream energy mix thus not only presents an opportunity to reduce GHG emissions, it also adds to energy security and socio-economic development. As individual states, the market remains fairly small; however, as a region there are sufficient economies of scale for the development of a viable RE market in southern Africa.

It is against this background that the Institute for Global Dialogue (IGD), in partnership with the Friedrich Ebert Stiftung (FES), hosted a two-day conference on 'Climate change and development: Driving an alternative energy future for southern Africa', on 17 and 18 August 2009 at the Burgers Park Hotel in Pretoria/Tshwane. The meeting was attended by over 60 participants representing diverse interests, including government officials, regional energy organisations, civil society groups, practitioners and scholars. Organised four months before the UN Climate Change Conference in Copenhagen (December 2009), this conference provided a platform for critical debate and reflection on RE within the region, from a cross-cutting political economy perspective. It sought to consider

- ◆ first, the challenges of fossil fuel dependency and the integration of RE into the energy mix in southern Africa; and
- ◆ second, issues of RE governance, including the role of inter-governmental organisations, political and economic (market) barriers to the inclusion of RE, as well as the potential commodification of RE and its impact on socio-economic development.

² Africa Commission. Access to sustainable energy. <http://www.africacommission.um.dk/en/menu/Report/Initiatives/SustainableEnergy/>

This report, which is a compilation of the papers presented during the conference, is intended to encourage further discussion on the role and value of RE regionally, as well as prospects for the development of an appropriate response and policies for the integration of RE into energy policy. The conference focused on six key issue areas:

1. Climate change and development: Driving an alternative energy future for southern Africa?

The first session provided an important frame of reference from which to start the subsequent discussions, focusing on the development of RE within southern Africa and its importance in driving economic growth and social development in an environmentally conscious manner. This included a brief overview of the current energy mix in the region, the problems of continued dependence on fossil fuel, the rapid growth of the RE market, and the potential challenges facing southern Africa in the move towards the inclusion of RE as part of the energy mix.

2. South Africa and the political economy of RE

The second session focused on the challenges facing South Africa (as the leading contributor to GHG emissions in the region) with regard to capacity building and the implementation of the RE policy in meeting greater climate change commitments. This includes problems of demand and supply, low electricity prices, subsidies and vested economic interests. This, in turn, provided the basis for furthering the discussion on South Africa's potential in driving the move towards integrating RE regionally.

3. An RE 'revolution' for southern Africa: Importance, opportunities and constraints

The third session focused on the future of RE within southern Africa – particularly its importance in driving economic growth and social development. This gave consideration to broad changes in energy demand across the region, and the importance of RE in mitigating carbon emissions, as well as meeting regional economic growth and social development targets. Industry trends within the region as well as market opportunities/constraints were given consideration, as were the political and economic barriers to RE as part of the region's energy mix.

4. Prospects for a regional approach to RE

This session focused on the role of regional energy cooperation and regional markets in promoting the development and integration of RE. Here the discussion considered the benefits of RE and the role of organisations such as the Southern African Power Pool (SAPP) in providing a coordinated regional approach to RE. The discussion also highlighted the political and economic challenges facing organisations as they seek to develop a competitive energy market in the southern African region.

5. RE, gender and the rural–urban divide

Session five set out to assess the impact of RE on social development. Energy has been treated as a commodity, and there is growing concern that this may be

extended to renewable forms of energy, as this has the potential to create a situation where the poor once again find themselves on the energy periphery. Here the presenters identified the challenges facing the poor in terms of meeting their energy requirements; they assessed the role of RE in reducing energy poverty and stimulating socio-economic development (where gender impacts are greatest); identified perceptions of RE in low-income and rural households; and assessed the importance of RE provision in rural areas as an element of development.

6. The market as a driver or constraint in the move towards RE in southern Africa

In the final session the focus of the conference turned to the role of the market as a driver or constraint in the move towards the integration of RE into mainstream energy policies. Internationally, RE occupies a growing share of the energy market; however, it is primarily the developed countries (and the more developed emerging economies) that account for the largest percentage of the RE market. The presentations highlighted the market penetration of RE – particularly in the South African context – and the intrinsic link between water and energy policies.

Conclusions

Among the key concerns raised in the presentations was the number of barriers to the integration of RE into the mainstream energy mix. These include problems of cost, governance, limited information and participation, as well as issues of national sovereignty and energy security. In conclusion, however, there was an indication that the current RE target is generally accepted as being economically viable within South Africa – provided there is Government financial support, external private sector investment and international donor funding. Similar requirements were mapped out at the regional level, including the creation of a favourable investment climate; the development of a clear policy framework; clear, consistent and fair regulatory oversight; and coherent power sector planning. These considerations should not, however, be separated from their social development context. Energy poverty continues to impact negatively on vulnerable groups in both rural and urban areas within the region, where access to energy is often limited and costly. Yet RE not only offers a means of providing electricity to those without grid access, it also affords the opportunity for countries to reduce their dependence on hydrocarbon energy sources. Indeed, as Copenhagen approaches, the proceedings from this conference demonstrate the move towards adopting a more pragmatic approach to RE from within the region.³

³ At the time of going to print, the papers presented on Eskom and RERA were not yet available.

Opening address: Climate change and development: Towards an alternative energy future for southern Africa

Hosted by The Institute for Global Dialogue (IGD)
Friedrich Ebert Foundation (FES)
Pretoria, City of Tshwane

Presented by Mr David Mahuma, Acting Chief Director: Department of Energy

Clean energy

The Programme Director
Representatives of African and international governments amongst us
Members of the Diplomatic Corps
Representatives of the Institute for Global Dialogue
Representatives of the Friedrich Ebert Foundation
Distinguished guests
Ladies and gentlemen, good morning

I am standing here today, representing the Acting Director-General of the newly established Department of Energy, Ms Nelisiwe Magubane, who could not be with us due to other equally pressing commitments of Government. She sends her sincerest apologies.

I am greatly honoured to be associated with the Friedrich Ebert Foundation and the Institute for Global Dialogue as organisations that have assisted us as a country and other emerging democracies across the world in spirit and in deeds, from the painful grips of our colonial and apartheid past through to the fledgling democracies most of us have come to be associated with. We continue to have diplomatic ties with the Federal Republic of Germany on matters of energy efficiency, renewable energy (RE) and climate change.

While the socio-political, governance, economic and international relations are moving in the right direction, there is a need to look further at other enabling sub-systems, such as the energy and the environmental sector interplay as instruments of cementing and giving meaning to the democratic order, and thereby strengthening our political resolve to be a truly democratic state.

Programme Director ...

The year is 2083 (another set of 74 years after the founding of FES) and mankind is faced with a number of challenges that the intellectuals of this decade have aptly modelled and predicted. The mortal remains of most of us in this room are at an early stage of fossilisation.

The world has continuously failed to agree on climate change mitigation and adaptation measures as the developing countries are still aspiring to develop their economies and deal with the ravages of abject hunger, poverty and energy poverty among their citizens. Kyoto, Copenhagen and other such climate change conventions have come and gone, without much progress in sight.

Many small island states are commencing to sink, as sea levels rise as a result of an increase in global temperatures and the melting polar ice caps.

Floods and hurricanes ravage the North and West as coastal towns and states are in a perpetual state of reconstruction. More national and regional financial resources are used to address national crises, leaving little or nothing by way of aid or donations to the developing and hunger-stricken countries – as has been the case over the past decades.

The global demand for goods and services is on the increase, while the coal, oil and gas industries are declining, as mankind licks the wounds of the energy policy decisions of its forebears.

The atmosphere is getting thicker with greenhouse gases as developing countries, in partnership with international partners, become bases for beneficiation of their well-endowed natural resources, on the back of extremely investor-friendly policies and stringent, but hardly implemented, environmental regimes – the reason being that comparatively speaking, their per capita emission levels are low compared to those of developed countries, therefore they can afford to emit a little more than their counterparts in developed countries.

On the other end, the economic blocks of developed countries are gravitating towards services as new manufacturing capacity is earmarked for stable and friendly developing countries who are much in need of foreign direct investment, who have an abundance of cheap labour and resources, and where, possibly, labour movements are not nearly as vocal and strong.

In the meantime, the political landscape in developing countries is a minefield of civil unrests, as citizens feel let down by their political leadership. Cross-border wars are commonplace, as cross-border natural resources like fresh water, oil and gas become the big-

gest bones of contention, and neighbours become foes. Like the United Nations Framework Convention on Climate Change (UNFCCC), regional and continental integration and cooperation are undermined, as investment in cross-border infrastructure for fresh water, rail, oil and gas and electricity becomes risky and almost impossible to regulate.

Continental cooperation has become a talk-shop as member states put national sovereignty ahead of regional and continental cooperation. Several attempts to consolidate regional block and continental structures have staggered and stalled.

In sub-Saharan countries, crop and livestock failure has hit the countryside hard due to drought and acid rain, emanating from climate change and the high concentration of greenhouse gases in the atmosphere.

Rural poverty and hunger would fuel urban migration, and force political and economic refugees to flee their motherlands in search of greener pastures across political borders. Urban infrastructure also takes strain.

In South Africa, local governments have given up on providing universal access to basic services as the demand outstrips the supply of housing, water, sanitation and electricity, and other energy services at set targets start to recede in urban areas, while rural areas have idle basic infrastructure as migrant workers and job seekers spend most of their time in urban areas – there is nothing to come home to.

Programme Director ...

The above scenario is certainly not a future state we do envisage for South Africa as a country in particular, the South African Development Community (SADC), sub-Saharan Africa as a region, or Africa as a continent.

However, research has also shown that climate change is a reality confronting the global community. The consequences will be dire for generations to come if we do not take necessary and sufficient action, as part of the global community, to mitigate the impacts.

It is generally accepted that RE can and should play a significant role as part of a repertoire of solutions. Of course we will need to look at cleaner methods of using available fossil fuels. As a country, we have also started work on Carbon Capture and Storage (CCS) with the Central Energy Fund (CEF).

But what characterises African countries and what are the common flaws in the African energy sector?

I guess from the research undertaken by the IGD, a more academic and appropriate characterisation has already been done.

But to quote the IGD, the following puts the African energy sector into perspective:

Despite its rich endowment of natural resources, Africa remains one of the poorest continents in the world. Many African countries experience the ‘double trap of resource-based nations’, namely that a continued reliance on the export of finite and diminishing natural resources also results in continued environmental degradation. Women, and particularly rural women, often bear the brunt of this unsustainable economic model.

But for the purposes of this conference, in individual African states, as regards the energy sector, investment in RE projects remains fairly small. There is potential for a regional approach to improve the economies of scale for the development of a viable RE market.

These states are also characterised by underinvestment, antiquated systems, poor governance and disparate technical standards, and a general dependence on imported capital goods and services.

This conference aims to consider the value of RE as part of southern Africa’s energy mix, as well as to address a number of regulatory barriers and economic distortions impacting on the integration and coordination of a RE policy within the region.

Africa is endowed with an abundance of renewable natural resources, such as solar energy; wind; micro, mini and macro hydro and biomass. The challenge has always been

- ◆ the funding models for sustainable implementation;
- ◆ ownership and governance;
- ◆ sustainable harvesting of these resources in the most cost-effective manner; and
- ◆ the dispersion and evacuation of generated energy through grid and hybrid systems and networks that will ensure sustainable economic development where there is demand.

From the South African side, there are a number of initiatives underway to facilitate the introduction of RE, energy efficiency and climate change mitigation into the energy sector.

You will recall that South Africa is a signatory to the UNFCCC. At the recent Climate Change and Renewable Energy Summit, South Africa reaffirmed its commitment to playing a pivotal role in the fight against climate change and global warming. In order to enable its mandate, the following legislative and other enablers have been put in place:

National legislation

- ◆ Constitution (Supreme law of the country)
- ◆ Energy Act
- ◆ Electricity Regulation Act
- ◆ National Environment Management Act

National policies

- ◆ *White Paper on Energy Policy* – revision in progress
- ◆ *White Paper on Renewable Energy Policy* – revision in progress
- ◆ Strategy on Energy Efficiency Policy
- ◆ Petroleum Liquid Fuels Charter

Frameworks

- ◆ Long-term Mitigation Scenarios (LTMS)
- ◆ Climate Change Strategy, as pertaining to the energy sector – currently under development

National Renewable Energy Institutes

- ◆ South African National Energy Research Institute (SANERI)
- ◆ National Energy Efficiency Agency (NEEA)
- ◆ South African Wind Energy Programme (SAWEP)
- ◆ Renewable Energy Market Transformation (REMT)

National funding and other enablers

- ◆ REFSO (Renewable Energy Financing and Subsidy Office)
- ◆ REFIT (Renewable Energy Feed-in Tariff)
- ◆ SAWEP (South African Wind Energy Programme)
- ◆ REMT (Renewable Energy Market Transformation)
- ◆ CEF/SANERI/NEEA within the context of the Energy Act
- ◆ Development Bank of Southern Africa (DBSA)
- ◆ Industrial Development Corporation (IDC), etc.

Regional collaborations and structures

- ◆ African Union (AU) (Energy Commission), with the following structures, inter alia:
 - NEPAD
 - SADC, with the following structures:
 - Southern African Power Pool (SAPP)
 - Western Power Corridor (WESTCOR)
 - Regional Energy Regulatory Association (RERA)
 - African Forum for Utility Regulators (AFUR)
 - Regulatory frameworks
 - Technical standards

Regional programmes and initiatives

- ◆ Regional Power Pool for regional electricity trading through the interconnected grid system;
- ◆ SADC Biofuels initiative adopted at the SADC Energy Ministers' meeting in Maputo last term.
 - SADC compact fluorescent lamp (CFL) roll-out initiative adopted at the SADC Energy Ministers' meeting in Maputo last term
 - With Phillips Manufacturing in Lesotho.

I have noted that between the Foundation and the Institute, there is a southern African programme aimed at analysing and promoting an understanding of factors that advance or hinder regional cooperation, sustainable development, and security in southern Africa.

It will be interesting to note the proposals emanating from today's dialogue on the governance, financing, planning, institutionalisation and implementation of cross-border projects within the context of the prevailing geo-political and sovereignty landscape, especially where the economies concerned cannot individually finance the segment in their part of the border.

Having said that, we do recognise that there are several barriers facing the RE sector today. These include the high initial costs of RE technologies, which are exacerbated by high dependence on imports and low electricity tariffs. This picture is rapidly changing, though, as NERSA has been approving beyond inflation electricity tariff increases, the most recent being the 31.3 per cent, to be followed by something more post-September 2009.

Programme Director, it will be imperative for the conference to consider the other dimensions necessary to enable RE participation and make the picture complete and sustainable. These are:

- ◆ Local production;
- ◆ Gender;
- ◆ Financing options;
- ◆ Capacity building;
- ◆ Training for installation, maintenance and operation;
- ◆ Governance and ownership models.

Programme Director, in conclusion let me take this opportunity to thank you for the opportunity to address this gathering, and wish you well on your deliberations.

We are certainly looking forward to the outcomes of this conference as an input to our policy processes.

We eagerly await the FES and IGD publications.
Thank you.

Part 1: South Africa and the political economy of renewable energy

Nomawethu Qase

The South African Government's key foundation for renewable energy (RE) is the *White Paper on Renewable Energy Policy*, published in November 2003. This sets a target of 10 000 GWh or 4 per cent RE contribution to final energy consumption by 2013. Interpreted differently, this target is the equivalent of replacing two of Eskom's 660 MW-capacity coal-fired power stations, or replacing 1 100 million litres of diesel (14 per cent of one year) with biodiesel. RE is to be primarily utilised for power generation and non-electric technologies such as solar water heating and biofuels, with the target to be produced mainly from biomass, wind, solar and small-scale hydro.

Government recognises the diverse potential of RE technologies to contribute to the range of policy imperatives that are the main drivers for RE development within South Africa. Driving the Renewable Energy Policy Framework has been Government's desire to diversify the energy supply mix; improve energy security; meet South Africa's contribution towards reducing greenhouse gas (GHG) emissions; bring about job creation; and ensure rural economic development through new RE initiatives.

The diversification of energy supply and improved energy security are interrelated, and apply to both the liquid fuels and power sectors. With regards to the power sector, Government has identified two roles for RE, namely encouraging the use of RE technologies to generate power, and reducing demand by diverting consumption away from electrically powered hot-water geysers and into solar geysers. For power generation, a RE framework was developed in 2008 which split the 2013 RE target into 60 per cent electricity and 40 per cent non-electrical services. Both Eskom and Independent Power Producers (IPPs) are expected to assist Government in meeting the target. However, more weight is given to IPPs.

As regards solar water heaters (SWHs), a national roll-out strategy is being developed that will bring together all the activities currently being undertaken by the private sector, Eskom, municipalities and the Central Energy Fund (CEF) for easy monitoring, reporting and accountability. This draft strategy will be made available for public comment in October 2009.

As regards the liquid fuels sector, Government has spent a number of years building national consensus on the need for a biofuels industrial strategy for South Africa. Based on a process of consensus in decision-making, the final Biofuels Industrial Strategy of South Africa was approved in December 2007, with a modest target of a 2 per cent contribution to final liquid fuels consumption by 2013, or the equivalent of 400 million litres per year. The strategy's primary focus is on ethanol and biodiesel production and their use. The key objectives of the strategy are to

- ◆ address the issues of poverty and economic development in rural areas;
- ◆ enable job creation and contribute towards Broad-based Black Economic Empowerment (BBEE);
- ◆ aid in promoting farming in underutilised areas;
- ◆ encourage energy security;
- ◆ help contribute to the RE target; and
- ◆ aid in mitigating GHG emissions and encouraging sustainable development.

Summary of key decisions or principles informing the biofuels strategy

Government has adopted a cautious approach towards biofuels, so as to minimise the negative effects on food prices. This includes the use of proven crops as feedstock. Sugar cane and sugar beet have been identified for the production of ethanol, while canola, sunflower and soya may be used in the production of biodiesel. The strategy excludes biodiesel production from *Jatropha* (pending further research) and maize which, as a South African staple, raises food security concerns. A further prerequisite is that the feedstock must be locally available, or there must be the agricultural potential to produce it locally. The strategy also supports proven technologies and seeks to enable only sustainable investment. Furthermore, the strategy targets under-utilised areas and supports farmers in these regions.

Government will play a role in driving transformation and upliftment through State-owned Enterprise (SOE) investments in biofuel plants, coupled with land reform and agricultural support for growing feedstock. This is aimed at supplementing private-sector investments and enabling SOEs to assume a leading role in the development of the RE sector. The Department of Energy (the former Department of Minerals and Energy), will monitor the industry through its licensing process. When the minimum of 2 per cent is reached, this will be reviewed before giving support to new investments (plants/litres).

Production from second-generation technologies will be excluded to minimise the risk in the early stages of the development of this industry. Moreover, under the Biofuels Strategy, Government will focus on the need to establish the local biofuels industry before integrating it into the Southern African Development Community (SADC). Currently, the financing mechanism is still being finalised, but the approved strategy indicated

- ◆ a 50 per cent fuel levy exemption for biodiesel (effective from April 2009);
- ◆ a 100 per cent exemption on ethanol (in other words, no changes);
- ◆ a reasonable return on investment proportional to the risk;
- ◆ that agricultural support is to be linked to current initiatives within the Department of Agriculture; and
- ◆ that support is to be calculated in South African cents per litre and linked to a pegged price for the given oil price and exchange rate, based on the most efficient producers.

There is no mandatory off-take, but the Minister of Energy has powers under the Petroleum Products Amendment Act to enforce this. So far, three licences (two in the Eastern Cape and one in KwaZulu-Natal) have been issued by the Office of the Petroleum Controller.

Financing mechanisms and other Government support aimed at promoting RE development

Government is looking at various options to promote RE technologies, which include subsidies, grants, tax exemptions, etc. For example, in 2005 the then Department of Minerals and Energy (DME) established a subsidy office within the department to provide financial assistance to RE project developers. In addition, the Renewable Energy Feed-in Tariff (REFIT), Phase 1, was announced in March 2009 by the National Energy Regulator of South Africa (NERSA).

Furthermore, the Department of Energy is currently working on formalising Tradable Renewable Energy Certificates (TREC's). At this point this market is operating on a voluntary basis, however, the department expects to institute an official issuing body for South Africa by 2010.

With funding from the Global Environmental Facility/World Bank, 2008 saw the development of the Renewable Energy Market Transformation (REMT) Programme, with the implementation unit located at the Development Bank of Southern Africa (DBSA). This initiative is supplementary to the South African Wind Energy Programme (SAWEP), which is primarily focused on promoting the commercialisation of wind energy technology in South Africa.

Renewable Energy Financing and Subsidy Office (REFSO)

The budget allocated and spent in the 2008/9 financial year was R5.4 million. This has increased to R10 million for the period 2009/10, of which R6 million has already been committed. REFSO offers once-off capital subsidies to qualifying projects, which must be located within the borders of South Africa and must make use of commercially viable RE technologies. Moreover, the projects must have an installed capacity of at least 1 MW (electricity), 914 KL/year (biodiesel) or 1 495 KL/year (bio-ethanol) or equivalents, and meet the 25 per cent Black Economic Empowerment (BEE) ownership requirement, in line with relevant legislation. Applications are open throughout the year for all RE projects; however, to date only power generation projects have successfully been awarded subsidies. Some projects which are supported by REFSO have also qualified for Clean Development Mechanism (CDM) support.

Table 1 below provides a summary of projects that have been subsidised to date.

Table 1: REFSO-subsidised projects

Project name	Capacity (MW)	Location	Technology	Jobs created	Capital costs	PPA	Subsidy
Clanwilliam	1.5	Clanwilliam, W Cape	Hydro	4 permanent 20 temporary	R8 600 000	Clanwilliam Municipality	R750 000
Methacap	4.2	Mossel Bay, W Cape	Biogas	2 permanent 20 temporary	R24 000 000	PetroSA	R2 000 000
Bethlehem	7	Bethlehem, Free State	Hydro	6 permanent 110 temporary	R72 000 000	Dithabeng Municipality	R3 500 000
Darling	5.2	Darling, W Cape	Wind	1 permanent 29 temporary	R74 000 000	City of Cape Town	R2 600 000
Durban landfill gas	6	Durban, KZN	Landfill	4 permanent 100 temporary	R60 000 000	eThekweni Municipality	R6 000 000
Total	24MW			17 permanent 279 temporary	R240 600 000		R14 650 000

Renewable Energy Feed-in Tariff (REFIT)

As indicated above, NERSA announced the introduction of a REFIT regime at the end of March 2009. The main objectives for the introduction of REFIT include

- ◆ creating an enabling environment for RE generation, including levelling the playing field with conventional electricity;
- ◆ creating a critical mass of RE investment and supporting the establishment of a self-sustaining environment; and
- ◆ providing access to the grid and an obligation to purchase power.

While public consultation for the second phase has been initiated, the first phase of REFIT focused on four technologies:

- ◆ Landfill gas = R0.90 (unit cost in Rand per kilowatt hour (R/kWh));
- ◆ Small scale hydro = R0.94;
- ◆ Wind = R1.25; and
- ◆ Concentrated solar = R2.10.

Renewable Energy Market Transformation (REMT)

REMT is a Global Environment Facility (GEF)-funded project, with the World Bank acting as the executing agent and the DBSA as the implementing agent. The available budget is US\$6 million, and it is expected to leverage an additional US\$9 million. The primary focus is on grid-based RE power generation and solar water heating, with the aim of establishing policy and regulatory frameworks, and building institutional capacity for RE development. For instance, the implementation support unit is driving the development of the national roll-out strategy for SWHs.

REMT also aims to assist RE developers through matching grants for power generation projects, with primary support being the provision of funds to projects at pre-feasibility stages. This programme will also make provision for performance grants to SWH ventures. Guidelines for both matching and performance grants are available on the DBSA website.

Tradable Renewable Energy Certificates (TRECs)

The development of the TREC system provides the opportunity to trade these 'green' certificates both nationally and internationally, which creates a potential 'revenue stream' for RE projects. Most importantly, TRECs will facilitate the monitoring and verification of RE-based support mechanisms such as the REFIT. TRECs can be described as electronic records that verify the origin of energy from registered RE facilities. Their benefits include their use as a mechanism for the accreditation, verification and monitoring of CDM projects. The record of transfer between market participants' accounts and their redemption is retained by the issuing body, which will be responsible for registering, issuing, transferring and redeeming certificates. These certificates are redeemed

- ◆ when they are no longer available to be traded;
- ◆ prior to green labelling in voluntary markets;
- ◆ in claiming production-based support;
- ◆ upon proof of compliance with purchase/supply obligations; and
- ◆ upon international export.

The constitution for the issuing body has been approved, with the issuing body having been established as a non-profit organisation. Consultants have been appointed to develop the official domain protocol for South Africa, as well as a business plan for the issuing body. Both processes are set to be completed before the end of the 2009 calendar year.

The South African Wind Energy Project (SAWEP)

SAWEP is a GEF-funded project, with the United Nations Development Programme (UNDP) acting as the executing agent. Its aim is to reduce GHG emissions generated by thermal power generation in the national inter-connected system. The objective is to install and operate up to 5.2 MW at Darling Wind Farm and prepare the development of 45 MW combined wind farms.

Components include:

- ◆ Increased public sector incremental cost funding;
- ◆ Green power funding initialised, support provided to the City of Cape Town for the off-take of green power generated from the Darling Wind Farm;
- ◆ Long-term policy and implementation of a framework for wind energy development provided support for the REFIT process and the unit is in the process of undertaking a pre-feasibility study for the development of a wind industrial strategy for South Africa;
- ◆ Wind resource assessment – consortium managed by SANERI, including RISO (Denmark), the Council for Scientific and Industrial Research (CSIR), the University of Cape Town (UCT) and the South African Weather Service, has started working on an updated wind atlas for South Africa;
- ◆ Commercial wind energy development – being promoted;
- ◆ Build capacity and strengthen institutions – focus on South African Wind Energy Association plus research institutions in South Africa.

Conclusion

The current RE target is generally accepted to be economically viable, provided there is Government financial support, external private sector investment and international donor funding. Government's view, based on the macro-economic study undertaken in 2004, is that achieving the target can mean

- ◆ the addition of about 1667 MW of new RE capacity compared to coal-fired power stations;
- ◆ a net impact on GDP of as high as R1 071 million per year;
- ◆ additional Government revenue of R299 million;
- ◆ additional income would flow to low-income households – as much as R128 million;
- ◆ just over 20 000 new jobs would be created;
- ◆ water savings of 16.5 million kilolitres, which translates into a potential saving of R26.6 million;
- ◆ contributing to ensuring energy security; and
- ◆ a reduction in GHG emissions.

Unlike in 2004, the environment is now ripe for wind and Concentrated Solar Power (CSP) technology to be deployed on a scale that could increase the total RE contribution, going forward. The review of the 2003 *White paper* will highlight new targets for the period beyond 2013.

Part 2: A renewable energy 'revolution' for southern Africa

Importance, opportunities and constraints

Amanda Luxande

Introduction

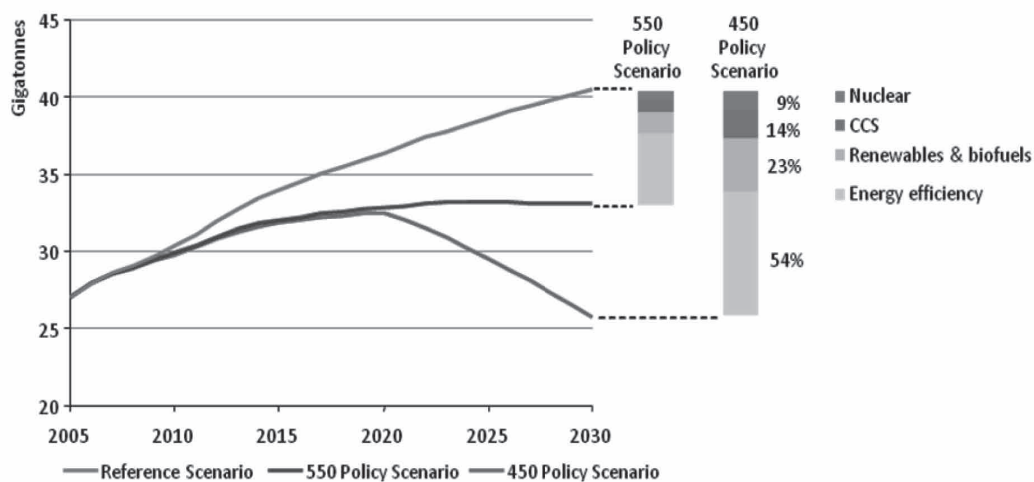
Modern energy services are key components in the economic and social development of southern Africa. With an estimated 60 per cent of the southern African population still relying on basic energy sources, it is becoming more important to recognise that increasing access to modern energy is a key component in delivering services, improving health, providing sanitation and reducing poverty.

Since its inception in 2003, the Renewable Energy and Energy Efficiency Partnership (REEEP) has acted as a market facilitator by reducing market barriers for renewable energy (RE) and energy efficiency systems, with its particular focus on emerging economies, such as the southern African region. REEEP accelerates RE market development in addressing the following key aspects:

- ◆ Policy/regulation development and improvement;
- ◆ Finance and business models.

REEEP is committed to efforts aimed at improving access to sustainable, clean energy – particularly for the poor. These aspirations are driven by the belief that RE and energy efficiency could potentially account for nearly 80 per cent of emission reductions, provided that stronger green policy interventions are adopted.

Figure 1: Renewable energy and energy efficiency could potentially account for nearly 80 per cent of emission reductions



Source: World Energy Outlook 2008, IEA

While there is strong emphasis on this assertion in theory, practical implementation on the ground is still fraught with a certain degree of difficulty. However, through organisations such as REEEP there are continuous efforts to develop good practices in the sustainable energy sector.

Why support RE?

The case for RE has been made and is supported by a wide range of actors globally. To reiterate these assertions, it remains important to acknowledge that RE offers the following benefits:

- ◆ It can help bring about security as regards supply, particularly in parts of the world like southern Africa where there is a supply crisis. In such instances the deployment of RE would provide clean and more reliable sources of energy;
- ◆ Small-scale RE projects can contribute to a government's social development agenda, i.e. increase access to energy, particularly in rural areas, where the potential for local economic development is traditionally under-utilised;
- ◆ The development of the RE sector can create jobs and enhance technical expertise within industry;
- ◆ RE adoption also offers additional local, regional and global environmental benefits by decreasing the reliance on coal as a primary energy source in southern Africa, which will, in turn, assist in addressing the global climate change challenge.

In parts of the world where poverty is rife, such as southern Africa, the most compelling argument for the acceleration of the implementation of RE arguably remains its potential to reduce poverty. While such assertions stand RE deployment in good stead, many factors contribute to the fairly slow uptake of RE. The lack of mass implementation of RE systems can be summarised as follows:

- ◆ RE technologies are relatively new within southern Africa, and therefore have to compete with more established conventional technologies;
- ◆ There is no 'level playing field' in the treatment of RE technologies vis-à-vis conventional methods. For example, oil is heavily subsidised by some governments, therefore the costs of RE systems seem that much higher and more expensive than conventional energy sources;
- ◆ The operating characteristics of RE technologies differ from those of conventional technologies. For example, the intermittency of wind can conflict with a more predictable output, particularly as regards the integration of green power into national grids.

In essence, the financial risks associated with RE systems are still perceived to be fairly high, especially in the absence of legislated support mechanisms such as feed-in tariffs (to be discussed in subsequent sections of this paper), as investors have a limited guarantee on returns. However, as best demonstrated by countries such as the United States of America, global trends indicate that more countries are opting for low-carbon economic growth.

It is widely recognised that the deployment of RE is necessary to prevent irreversible climate change. The *Stern Report* of 2009 estimates that acting now in accelerating the deployment of RE, would cost approximately 1–2 per cent of global gross domestic product (GDP). However, the cost is likely to rise to approximately 15–20 per cent of GDP over the next decades. Therefore, RE and energy efficiency ought to play an important role in creating economies on which a sustainable future can be built.

Status of RE in southern Africa

There has been considerable progress with regard to the development of appropriate policies to accelerate the uptake of RE in southern Africa. Most southern African countries have developed policies and, to some extent, set targets for RE programmes. Implementation remains a huge challenge with regards to the deployment of RE. This is largely due to the following factors:

- ◆ Poor levels of regional coordination limit the extent to which countries in the SADC region can share lessons and experiences with regard to their own efforts to accelerate the uptake of RE;
- ◆ Poor quality of long-term energy planning;

- ◆ Insufficient financing and investment to support long-term energy planning;
- ◆ Poor infrastructure, skills and capacity to implement RE programmes in many parts of southern Africa.

The culmination of the above-mentioned factors has, in turn, resulted in the following state of affairs in southern Africa:

- ◆ Barriers to the implementation of RE are well identified, but markets for RE (in its intrinsic right) are fairly poorly understood;
- ◆ Patchy and uneven market development for RE systems across southern Africa;
- ◆ Southern Africa characteristically demonstrates low levels of access to modern energy services, as most countries rely on basic energy services;
- ◆ The region's energy intensity and carbon footprint are high because of its reliance on coal;
- ◆ The electricity supply crisis is a reality.

All in all, the major challenge for the southern African region has been increasing access to energy, while mitigating against the economic costs of a supply crisis, amongst the many factors identified above. That said, the potential to develop RE markets in southern Africa is huge. Public and private sector investments in energy infrastructure in 2008 alone were estimated at ZAR 360 billion. Furthermore, load-shedding has provided a major catalyst in raising the profile of alternative solutions and innovative ways of combating climate change. At present, a scale-up in investments, through securing international partnerships in energy infrastructure, is necessary to ensure that southern Africa maximises its potential to roll out the mass implementation of RE systems.

RE options for southern Africa

Many options are available to governments in southern Africa, in terms of developing markets for RE. There could be efforts to legislate support mechanisms such as feed-in tariffs, Certified Emission Reductions (CERs), Verified Emission Reductions (VERs) and so forth. These efforts would aid in providing long-term stability and confidence in RE investments. It is also important that energy service decisions be integrated into the planning of all line ministries – not only those concerned with energy services.

Increased Government funding for RE research and development is imperative to ensure that there is a regional skills base for the production of RE, RE installations, operations and management, as well as general energy service administrations. Therefore, skills development for and by Government is a critical aspect of the increased deployment of RE in southern Africa.

In sub-Saharan Africa, the following policy mechanisms are currently being explored and/or used by various governments:

- ◆ Establishing standard Power Purchase Agreements (PPAs) for RE;
- ◆ Issuing long-term electricity generation licences and PPAs;
- ◆ Developing favourable tariff setting and adjustment formulae;
- ◆ Setting explicit targets for the sharing of RE in the electricity generation mix;
- ◆ Enacting explicit legislation to encourage local private participation in RE development, i.e. incentives for industry;
- ◆ Providing subsidies to RE-based power systems – especially those located in rural areas.

In developed countries, the following policy mechanisms are being utilised:

- ◆ Feed-in tariffs (Germany) – guaranteed price for output or a premium rate on the market price of RE produced;
- ◆ Quota mechanisms (United Kingdom) – also known as Renewable Portfolio Standards (RPSs). (Obligation for electricity suppliers to take a certain amount of sustainable power or for customers to source a proportion of their power from RE sources);
- ◆ Tender schemes (Ireland) – under a tendering scheme, competitive bids are put forward to government for individual RE projects following governments' calls for tenders;
- ◆ Voluntary mechanisms, such as green certificates (the Netherlands) – green certificates can be used to support renewable-based generation. Such certificates can be traded to consumers who are willing to pay the additional cost to support sustainable energies;
- ◆ Various hybrid schemes that may involve two or more mechanisms.

It is important to note that the abovementioned mechanisms are traditionally used in conventional electricity systems, however, they can also be used to drive capacity increases for electricity from RE. Moreover, the choice of mechanisms will largely depend on the peculiarities of individual countries. In other words, the deployment of individual mechanisms will vary, per country, due to differences in RE markets, energy systems and political intentions. Each RE mechanism has its own strengths and weaknesses, and will likely encourage sustainable energy development in a particular manner.

Conclusion

In sum, the deployment of policy mechanisms for the uptake of RE is a relatively new exercise for most southern African governments, and as such, evidence of performance is not definitive. It is, therefore, of the utmost importance for countries within SADC to assess their individual capacity (nature of RE markets, skills and governance) prior to selecting appropriate policy mechanisms for their environments. The extent to which a weakness in a mechanism can become a defect primarily depends on the interaction between the mechanism deployed and other policy efforts, such as the availability of finance for RE (capital grants or loans) and broader measures affecting changes to energy planning within a country. The failure of a particular policy mechanism in one country does not mean that the mechanism itself is defective, or is not a viable means of promoting sustainable energy practice. There is a need to create awareness amongst legislators, policy-makers and decision-makers within southern Africa of the different support mechanisms available to aid in the increased uptake of RE systems.

Governments ultimately play a crucial role in setting the legal, policy, and trade and finance conditions necessary to encourage the uptake of RE in southern Africa. However, international commitments are required to support RE deployment in emerging economies in the region. In addition, well coordinated plans and an integrated approach and actions on the part of relevant stakeholders in the RE sector would facilitate efforts to accelerate the uptake of RE in the region.

Of the utmost importance in these efforts is the need to create regional markets for RE. A regional outlook on RE is currently lacking in southern Africa, and as such, the benefits of regional integration are not maximised. Moreover, this limits the extent to which countries in southern African can exchange experiences and lessons learnt in developing markets for RE. Regional coordination, therefore, remains a critical element in building a solid and sustainable future for the southern African region. Regional coordination is vital for the successful uptake of RE in terms of

- ◆ common policy development and modes of implementation (including legislation);
- ◆ common regulatory approaches and frameworks;
- ◆ common regional trading mechanisms for physical power and RE support mechanisms;
- ◆ commitment to regional cooperation from key institutional stakeholders to support initiatives for RE in southern Africa;
- ◆ setting common targets for RE for the region.

To reiterate the main sentiments echoed throughout this think piece, RE not only provides energy and climate change security, but ultimately offers great opportunities for social and economic development.

Part 2: A renewable energy 'revolution' for southern Africa

A market perspective on the growth potential and opportunities within renewable energy

Sipha Ndawonde

The aim of this presentation is to address developments in the renewable energy (RE) market in southern Africa, from a market perspective. Often the gap between well thought out policies and a favourable market response is dependent on an understanding of the key market forces influencing the decisions of industry stakeholders.

Market participants such as investors, project developers and original equipment manufacturers respond to the incentives and guidelines established by policy makers. The role of the policy maker is to align the goal of the private sector with the broader macro-economic goals of achieving increased employment opportunities and sustainable economic growth.

It is the role of analysts to highlight industry challenges, market drivers and market restraints, and in doing so, help to bridge the gap between the objectives of the policy makers and the private sector.

The geographic scope of this presentation includes South Africa, Namibia and Botswana. The technology scope includes solar photovoltaic (PV) energy, solar water heaters (SWHs), small wind turbine technology and large wind farm technology.

This presentation is divided into four sections:

- ◆ Section one provides a broad overview of developments in South Africa, Namibia and Botswana;
- ◆ Section two analyses the feedstock availability for power generation in sub-Saharan Africa, and gives an indication of the future of renewable energies in the region;
- ◆ Section three provides a balanced overview of the solar PV, SWH and small wind turbine market in South Africa, Namibia and Botswana;
- ◆ Section four analyses developments within the large wind turbine market in South Africa and discusses its growth potential.

General overview

The backdrop to the RE energy sector in southern Africa is as follows: historically, the low price of electricity generation from traditional feedstocks, such as coal and natural gas, has lessened interest in RE power generation. Over the past five years, higher-than-anticipated economic growth in African states has led to a rapid increase in electricity demand and renewed interest in alternative forms of power generation.

The power sector in many African countries is still regulated by monopolistic control. Thus, the onus of meeting electricity demands has been placed solely on the utilities. However, aging infrastructure, over-reliance on single feedstocks for power generation and the lack of capital for electrical infrastructure refurbishment, have resulted in many countries failing to meet rising electricity demands.

Country overview

South Africa

The announcement of the Renewable Energy Feed-in Tariff (REFIT) in March 2009 marked a turning point in the growth of the South African RE equipment market. The feed-in tariff supports concentrated solar technology and small-scale hydro, landfill gas, as well as wind power projects. This announcement has been followed by declarations of interest in large-scale wind energy projects with a generating capacity of more than 700 MW. The proposed inclusion of grid-connected and small-scale solar PV technologies in the second round of the REFIT would be a major boost to the solar power industry in South Africa and the southern African region.

Botswana

Strong government support in favour of RE projects in Botswana is a key driver for the development of the market. The use of biomass feedstock and solar energy represent the key investment opportunities in the country. Government support for RE is expected to continue driving investments in future. Government will also need to form strategic partnerships with the private sector, so as to determine how best to achieve sustainable growth in the market.

With a stable economic and political environment and an abundance of natural resources, significant investment returns can be attained by investing in renewable energies in Botswana.

Namibia

Namibia has a well-developed solar energy regime. Although the scale of planned RE projects is smaller than those in South Africa, Namibia has an advanced policy framework to stimulate the wide-scale use of RE in off-grid applications. Investments in solar projects in the country are typically for off-grid solar applications. Key to the success of companies entering the industry is achieving Government buy-in and public support.

Southern Africa

To date, the use of RE technologies has mainly been limited to off-grid applications in southern Africa. Policy makers in South Africa have not succeeded in addressing the underlying causes hampering the growth potential of the RE market. Namibia and Botswana have been more successful in making use of the strong solar energy regime. Farmers, and increasingly, rural communities, are using solar PV technology as a clean alternative to diesel power and biomass feedstocks. Associations such as the Desert Research Foundation of Namibia play an important role in highlighting the economic and social benefits of switching from traditional sources of power generation to RE technologies.

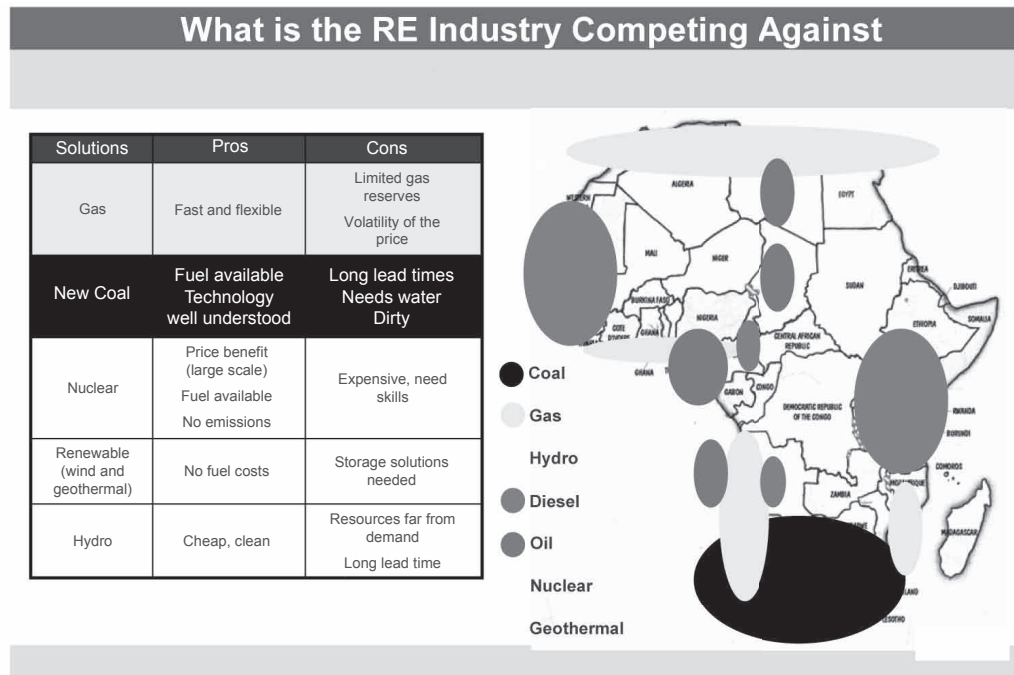
It is important to stress that the growth of the RE market in southern Africa is not solely affected by the effectiveness of government policies. The southern African region lacks adequate capacity to manufacture key components required for solar PV systems and SWHs. As a result, the majority of the components are imported, which exposes the region not only to fluctuations in the exchange rate, but also to solar PV demand and supply imbalances on the global markets.

A major positive for the African solar power industry is the global trend of falling prices of solar panels. The worldwide trend of decreasing the costs of solar PV power will assist importers of such panels, but will also create an opportunity for the domestic manufacture of solar panels.

Feedstock overview

Southern Africa has abundant solar energy resources. However, the availability of cheap coal as a feedstock for primary energy generation has reduced the potential to exploit the vast solar resources that the region is endowed with. The use of solar and wind for base load power is unlikely, due to new discoveries of natural gas reserves for power generation, nuclear energy and advances in coal technology. Nonetheless, RE has an important role to play in diversifying the energy mix, providing peak power, creating employment and meeting climate change objectives.

Figure 1: Power generation feedstock options in Africa



Source: Frost and Sullivan

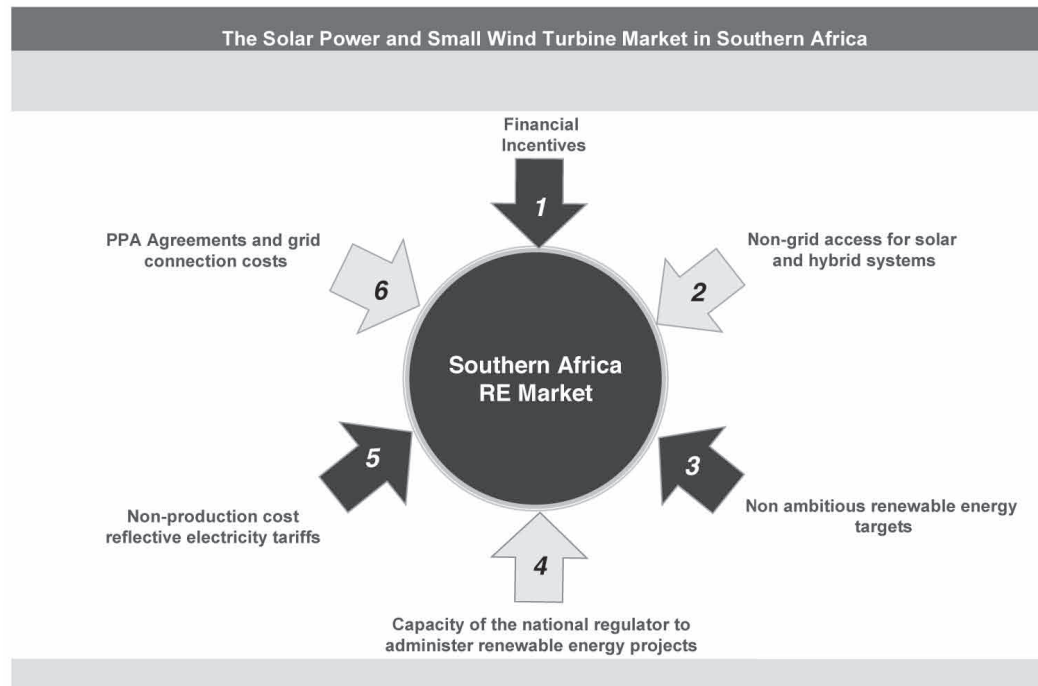
Solar technology and the small wind turbine market: Industry challenges

The following section identifies three key challenges affecting the RE industry in southern Africa.

Untapped opportunities for the international trading of carbon credits

- ◆ Until the end of 2012, the Clean Development Mechanism (CDM) will provide a revenue stream for both RE and energy-efficient interventions;
- ◆ A host of factors must be taken into consideration when applying for carbon credit benefits, including obtaining Designated National Authority (DNA) and environmental law approvals, as well as possible rejection of the project by the CDM executive board;
- ◆ The economic feasibility of many RE projects is dependent on the ability to generate Carbon Emission Reduction (CER) revenues.

Figure 2: Key industry challenges



Source: Frost and Sullivan

Cumbersome application process for the development of new projects

- ◆ In order to reduce the lead time on RE projects, certain organisational barriers must be overcome;
- ◆ Government must facilitate streamlined processes for environmental impact assessments;
- ◆ This can be achieved by undertaking and publishing generic assessments of technology impacts, mitigation options and sensitivity analyses within high-resource areas.

Non-ambitious RE targets

- ◆ Setting an ambitious RE target sends a clear policy signal to investors of governments' support for the RE energy industry;
- ◆ This helps to encourage investment and stimulates the development of local RE industries;
- ◆ The RE targets in South Africa, Botswana and Namibia could be revised by their governments, in order to attract further investment to the market.

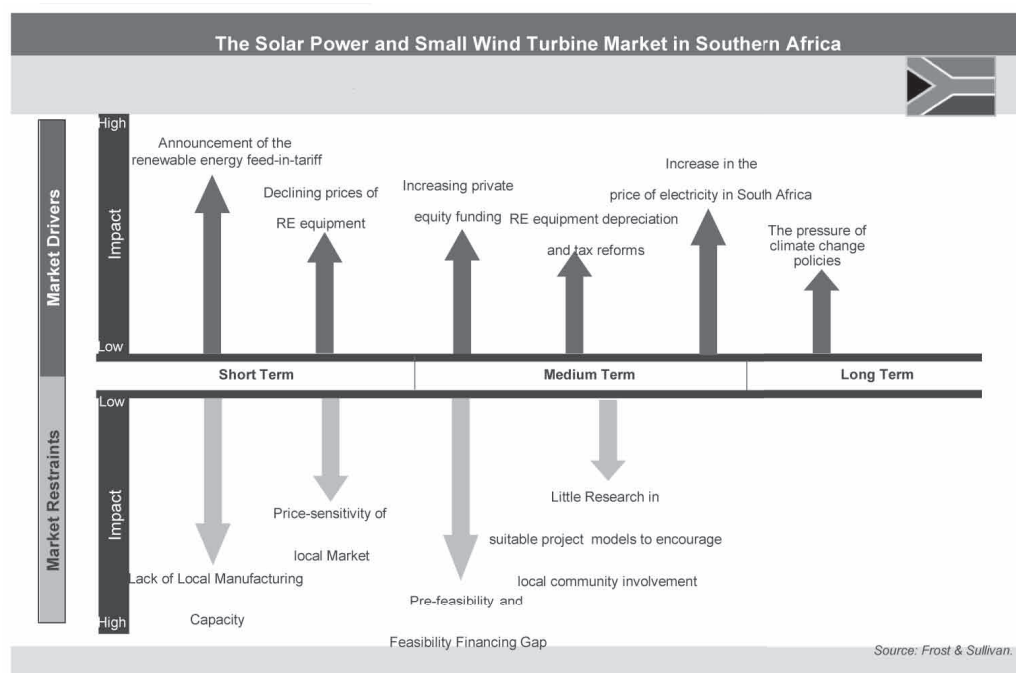
Market forces analysis

The following section identifies the key market drivers and restraints in the South African RE market.

South Africa

The key market drivers in the South African solar PV and small wind turbine market are revealed in the diagramme below. The key market drivers to be discussed are (i) the announcement of the REFIT, (ii) the declining price of RE equipment, and (iii) climate change policies and the drive to reduce the carbon footprint. The key market restraints to be discussed are (i) the lack of local manufacturing capacity, (ii) the price-sensitive South African market, and (iii) investor risk aversion.

Figure 3: Key market drivers and restraints in South Africa



Source: Frost and Sullivan

Key market drivers

Announcement of the Renewable Energy Feed-in-Tariff (REFIT)

- ◆ The REFIT announcement has attracted interest from international RE project developers, equipment suppliers and investors;

- ◆ The most important contribution of the REFIT announcement is the clear signal it sends to the international community of strong Government support for RE projects in South Africa;
- ◆ Furthermore, the announced tariff levels are sufficient to encourage immediate participation in the industry.

Declining price of RE equipment

- ◆ The combination of excessive solar PV manufacturing capacity and the global economic downturn is expected to drive down the prices of solar PV panels;
- ◆ In southern Africa, this will help reduce the pressure on the cash flow of companies importing solar PV panels.

Climate change policies and the drive to reduce the carbon footprint

- ◆ South Africa, which is the largest CO₂ emitter in Africa, is ranked 13th in the world in terms of annual carbon dioxide emissions;
- ◆ For this reason, high and low carbon-intensive companies are under pressure to purchase 'green' energy and engage in CDM/RE projects in South Africa.

Key market restraints

Lack of local manufacturing capacity

- ◆ Without local manufacturing capacity, local firms need to import components and entire solar PV or wind turbine systems;
- ◆ The solar PV Paarl manufacturing facility will certainly help to reduce the costs of importing PV panels for the South African RE market;
- ◆ The establishment of local assembly facilities for large wind turbines is an opportunity to stimulate job creation and reduce the cost of constructing wind farms.

Price-sensitive South African market

- ◆ The South African market is price sensitive with regards to the early adoption of RE technologies;
- ◆ This is evident from the slow uptake of SWH units in the country;
- ◆ In order to develop the market, consumer awareness programmes and subsidies must be introduced, for the adoption of SWH units and other RE technologies to take place.

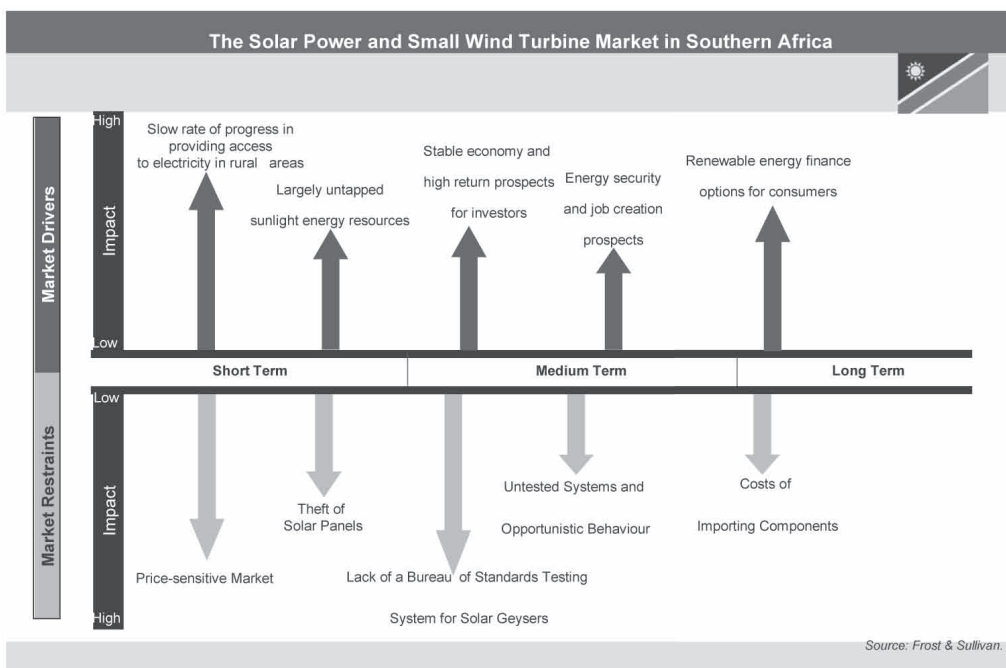
Investor risk aversion

- ◆ Although RE projects represent attractive profit margins for investment companies, the global economic downturn has increased the level of investor risk aversion globally;
- ◆ Despite this, investment companies are still expected to fund RE projects, however, they will be more cautious in selecting which projects to invest in.

Namibia

The following section identifies the key market drivers and restraints in Namibia. The key market drivers in the Namibian solar PV and SWH markets are revealed in the diagramme below. The key market drivers under discussion are (i) the slow rate of progress in providing access to electricity in rural areas, (ii) the abundant, largely untapped sunlight energy resources, and (iii) the stable economy and high return prospects for investors. The key market restraints to be discussed are (i) the theft of solar panels, (ii) exchange rate fluctuations, which increase the costs of importing components, and (iii) the price-sensitive market for SWHs.

Figure 4: Key market drivers and restraints in Namibia



Source: Frost and Sullivan

Key market drivers

Slow rate of progress in providing access to electricity in rural areas

- ◆ The Namibian Government has been unable to provide grid electrification to households in rural areas at the rate that was initially envisaged;
- ◆ The use of RE technologies is viewed as one way in which to accelerate the speed at which these rural electrification projects are implemented.

Abundant, largely untapped sunlight energy resources

- ◆ According to the International Association of Solar Energy (ISES), Namibia has a better solar radiation than countries like Spain and Portugal;

- ◆ Unlike in Spain and Portugal, Namibia has not succeeded in harvesting this significant RE potential by developing a flourishing solar power industry.

Stable economy and high-return prospects for investors

- ◆ A stable political environment and positive economic growth rate are two key factors that are crucial for attracting investments into a country;
- ◆ The Namibian economy has both good economic growth and a sound political environment.

Key market restraints

Theft of solar panels

- ◆ Remotely based solar panels erected on telecommunications infrastructure, farms and lodges, are targeted – they are stolen and resold on illegal markets;
- ◆ The vandalism of solar panels can be just as detrimental as the theft of the panels;
- ◆ The Namibian Government has recently introduced a solar panel database to circumvent the reselling of solar panels.

Exchange rate fluctuations increase the costs of importing components

- ◆ The limited manufacturing capacity in Namibia implies that most solar PV panels and geysers must be imported;
- ◆ This exposes the market to exchange rate fluctuations and impacts on the competitiveness of RE technologies.

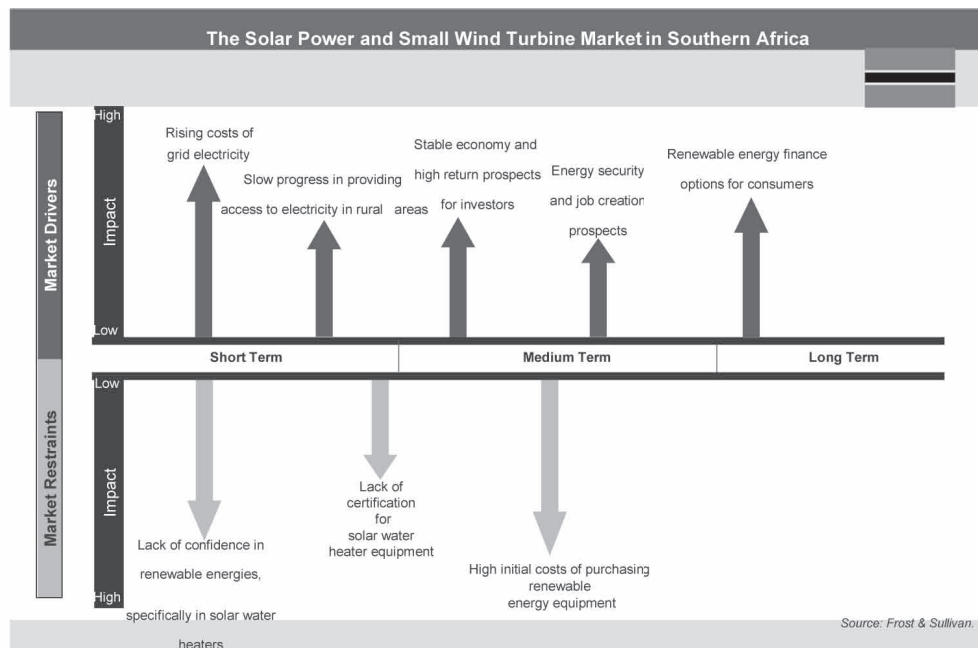
Price-sensitive market for SWHs

- ◆ The price of SWHs is a barrier to their wide-scale adoption by low- to middle income households;
- ◆ Without government subsidies for SWHs, market penetration will be limited to middle- to high-income consumers.

Botswana

The following section identifies the key market drivers and restraints in the Botswana market. The key market drivers in the Botswana solar PV and SWH market are shown in the diagramme below. The market drivers in Botswana are similar to those in Namibia. The key market driver that will be discussed in this section is the slow progress in providing access to electricity in rural areas. The key market restraints to be discussed are (i) the theft of solar panels, (ii) exchange rate fluctuations which increase the costs of importing components, and (iii) the price-sensitive market for SWHs.

Figure 5: Key market drivers in Botswana



Source: Frost and Sullivan

Key market drivers

Slow progress in providing access to electricity in rural areas

- ◆ Over 45 per cent of the Botswana population live in rural areas and only 42 per cent of this rural population have access to electricity;
- ◆ The Botswana Government has not achieved its targeted grid electrification rates, mainly due to a lack of capital;
- ◆ The use of RE offers a cost-effective solution to the rural electrification problem in Botswana.

Key market restraints

Lack of certification of SWH equipment

- ◆ Market confidence in the quality of solar geyser systems has declined in the country, owing to the installation of inferior-quality SWH systems;
- ◆ The introduction of a quality control board is expected to be announced in 2009 or 2010.

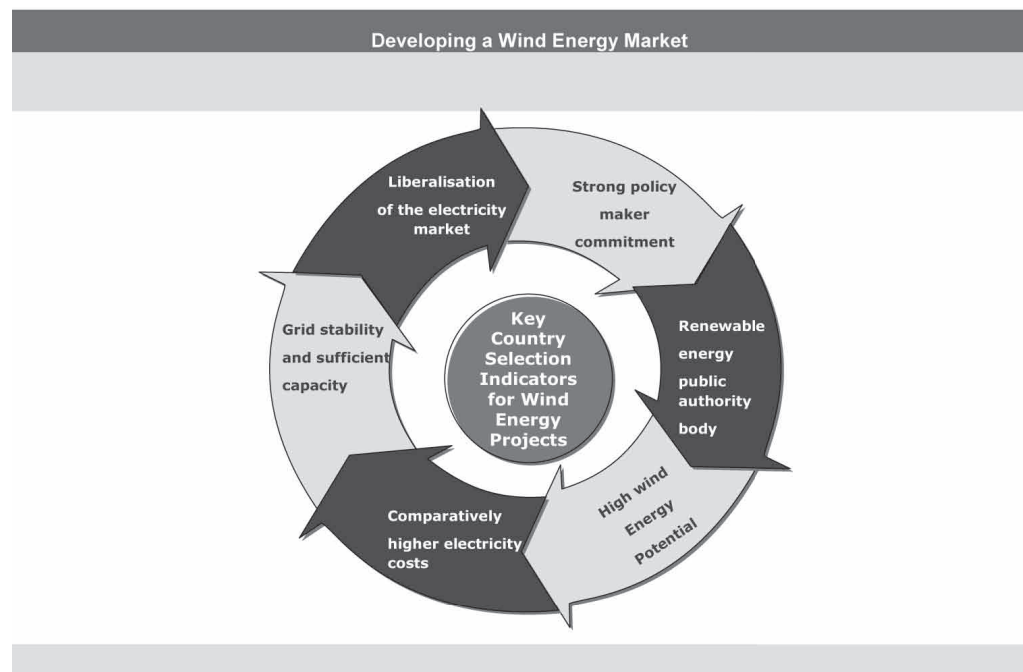
Lack of confidence in renewable energies, specifically in SWHs

- ◆ Without a certified standard for RE equipment, SWH suppliers are unable to indicate the quality of the system to the market;
- ◆ In the same way, buyers will opt to use brands with an international reputation, rather than locally manufactured products;
- ◆ This deters the establishment of manufacturing capacity in the country and reduces the competitiveness of SWH technology.

Large wind turbine market

Constantly changing regulations and RE support schemes increase the risk for investors. This leads to higher financing costs, which translates into either the need for higher rates of return on investments, or the rejection of a project. There are high costs involved for project developers who seek to develop projects in developing countries with little or no wind energy experience. Project developers, in general, prefer to wait until the initial regulatory imperfections in a developing country's technical environment have been resolved, before investigating projects. As high costs are associated with once-off wind energy projects in a country, project developers prefer to invest in long-term projects in a region. This preference is a key reason for the failure of the tendering process that has been used extensively worldwide.

Figure 6: International best practice for suitable wind energy sites



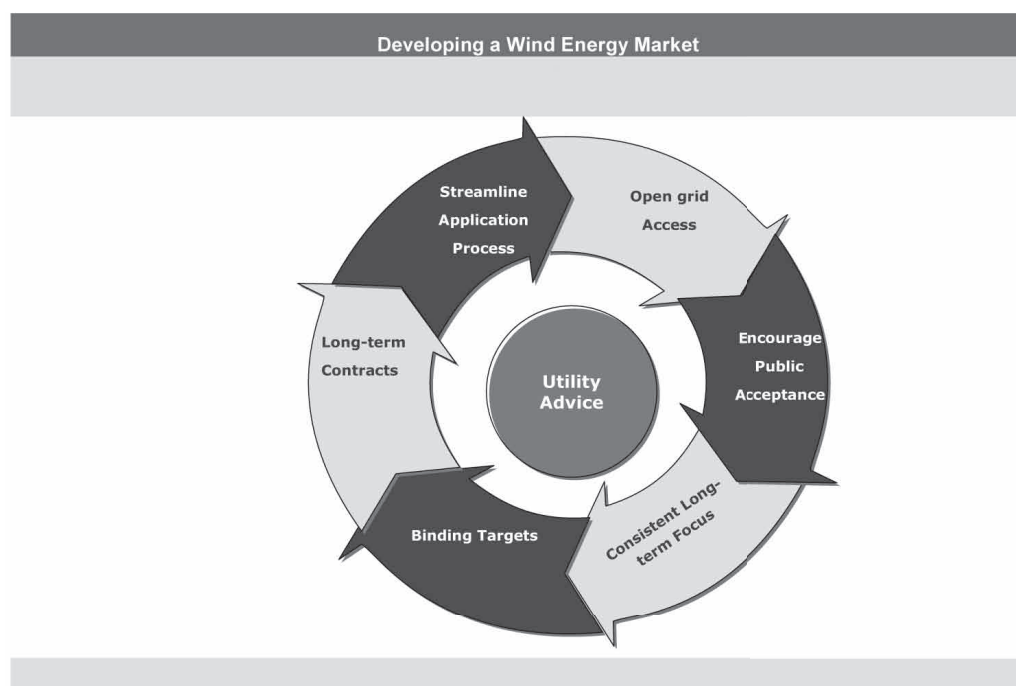
Source: Frost and Sullivan

International best practice for suitable wind energy sites

In order to attract wind energy projects to the country, wind energy policies must

- ◆ allow for stable and open grid access rules;
- ◆ encourage public buy-in and support for wind energy projects;
- ◆ have a long-term focus and be consistent;
- ◆ enforce legally binding targets and obligations;
- ◆ offer wind energy project developers long-term contracts with a fair rate of return;
- ◆ encourage good governance and streamlined procedures.

Figure 7: Utility advice



Source: Frost and Sullivan

The role of the CDM in large wind power projects

The use of the CDM is one way in which project developers can bring additional revenues to wind energy projects. Income derived from CERs can make a substantial contribution to a project's profitability. However, the administrative burden of using the CDM means that few projects have been successfully financed by this programme, and therefore the CDM has had a limited impact on developing countries in Africa.

China and India are the two countries that have benefited most from the Kyoto Protocol's CDM. In Africa, only two countries, namely Egypt (three) and Morocco (two) have wind projects that are registered for CDM revenues.

The expansion and improvement of the CDM process has been proposed, and this is likely to be implemented. Until then, in developing countries it is important that wind projects are backed by other government policies and incentive-based instruments.

Table 1: Wind projects registered for CDM revenues

Country	No. of projects	MW
India	27	5 047
China	314	16 977
Mexico	12	1 272
Brazil	11	687
South Korera	11	317
Cyprus	4	207
Dominican Republic	3	173
Egypt	3	285
Phillipines	2	73
Morocco	2	70
Costa Rica	2	69
Nicaragua	2	60
Panama	1	81
Mongolia	1	50
Jamaica	1	21
Colombia	1	20
Israel	1	12
Argentina	1	11
Chile	3	73
Vietnam	1	30
Ecuador	1	2
Total	647	25 560

The outlook for large wind power projects in southern Africa

Power sector liberalisation is required to attract Independent Power Producers (IPPs) to the electricity sector. Unlike South Africa, Namibia and Botswana do not have REFITs to support the development of the RE sector. Utilities must develop the necessary in-house technical know-how and expertise before RE can be connected to the electricity grid.

Aided by increasing levels of Government support, the southern African RE equipment market is poised to grow exponentially in the next five years.

Part 3: Prospects for a regional approach to renewable energy

Johnson Maviya

Introduction

There are two major factors that have generated interest in renewable energy (RE) in the Southern African Power Pool (SAPP). These are

- i) the scientific, political and societal consensus around the fact of global warming, its human causes and potentially catastrophic negative impacts;
- ii) the tightening supply, surging demand and subsequent soaring prices of coal and concerns about the security of power supply.

These two factors have actually motivated the SAPP region to venture into utilising alternative sources of fuel, such as RE. The generation mix within SAPP, with 70 per cent of the region's power being coal fired (see chart below) has raised concerns about the region's efforts to reduce greenhouse gas (GHG) emissions. These external as well as country- and industry-specific factors have led the region to investigate opportunities for the adoption of RE.

Definition of renewable energy (RE)

RE can be defined as *'the term used to describe energy flows that occur naturally and continuously in the environment, generated from unlimited or rapidly replenishing sources that renew on a timescale such that humans can utilize them indefinitely'* (Department for Business Enterprise and Regulatory Reform, 2007). Examples of RE include wind turbines, photovoltaic (PV), solar thermal, combined heat and power (CHP), biomass, biogas from anaerobic digestion, geothermal and small hydropower. Large hydropower is not considered here because it is well understood, and has often already been exploited. Sources of RE are considered inexhaustible, but are generally flow-limited, as regards the amount of energy or power (capacity) that can be delivered per unit of time.

What is the Southern Africa Power Pool (SAPP)?

The SAPP is a regional body that was formed in 1995 through a SADC treaty to optimise the use of available energy resources in the region, and for countries to support one another during emergencies. The SAPP, whose coordination centre is in Harare, Zimbabwe, comprises twelve SADC member countries represented by their respective electric power utilities. There are four legal documents covering the rights and obligations of SAPP members. These are:

- i) The Inter-governmental Memorandum of Understanding (IGMOU), which grants permission to utilities to participate in the SAPP, and to enter into contracts and guarantee the financial and technical performance of the power utilities;
- ii) The Inter-utility Memorandum of Understanding (IUMOU) between parties, defining ownership of assets and other rights, e.g. provision for a change in status from participating to operating member;
- iii) An Agreement between Operating Members (ABOM), which determines the interaction between the utilities with respect to operating responsibilities under normal or emergency conditions;
- iv) Operating guidelines (OGs), which define the sharing of costs and functional responsibility for plant operation and maintenance, including safety rules.

Southern African Power Pool - vision and objectives

Vision

- ◆ Facilitating the development of a competitive electricity market in the SADC region;
- ◆ Giving the end user a choice of electricity supplier;
- ◆ Ensuring that southern Africa is the region of choice for investment by intensive energy users;
- ◆ Ensuring sustainable energy developments through sound economic, environmental and social practices.

Objectives

- ◆ Providing a forum for the development of a world-class, robust, safe, efficient, reliable and stable interconnected electricity system in the southern African region;
- ◆ Coordinating and enforcing common regional standards of quality of supply, measurement and monitoring of systems performance;
- ◆ Harmonising the relationship between member utilities;
- ◆ Facilitating the development of regional expertise through training programmes and research;
- ◆ Increasing power accessibility in rural communities;
- ◆ Implementing strategies in support of sustainable development priorities.

Membership

The SAPP comprises twelve member utilities of which nine are inter-connected. The twelve are the Botswana Power Corporation (BPC), Electricidade de Mozambique (EDM), Electricity Supply Commission of Malawi (ESCOM), Empresa Nacional de Electricidade (ENE – Angola), Eskom, Lesotho Power Corporation (LEC), NamPower, Société Nationale d'Electricité (SNEL – DRC), Swaziland Electricity Company (SEC), Tanzania Electricity Supply Company Ltd (TANESCO), ZESCO Limited – Zambia, and Zimbabwe Electricity Supply Authority (ZESA). Of these, the following are non-operating members: ENE, ESCOM and TANESCO.

Table 1: SAPP membership

No	Full name of utility	Status	Abbreviation	Country
1	Botswana Power Corporation	OP	BPC	Botswana
2	Electricidade de Mocambique	OP	EDM	Mozambique
3	Electricity Supply Corporation of Malawi	NP	ESCOM	Malawi
4	Empresa Nacional de Electricidade	NP	ENE	Angola
5	ESKOM	OP	Eskom	South Africa
6	Lesotho Electricity Corporation	OP	LEC	Lesotho
7	NAMPPOWER	OP	Nam Power	Namibia
8	Societe Nationale d'Electricite	OP	SNEL	DRC
9	Swaziland Electricity Board	OP	SEB	Swaziland
10	Tanzania Electricity Supply Company Ltd	NP	TANESCO	Tanzania
11	ZESCO Limited	OP	ZESCO	Zambia
12	Zimbabwe Electricity Supply Authority	OP	ZESA	Zimbabwe
OP = Operating member NP = Non-operating member				

The status of power supply in the SAPP

The total installed capacity in countries included in SAPP is about 53 000 MW, but the available capacity is only 45 000 MW due to technical limitations. The dependable capacity is further reduced to 41 000 MW, as the available hydro capacity varies, depending on the season and other constraints. The peak demand in 2006 was 42 000 MW, resulting in load shedding in rather extensive parts of the region. Bearing in mind that there is a need for continuous reserves of above 4 000 MW, not included in these figures, it goes without saying that the regional deficit situation is becoming a severe challenge for utilities.

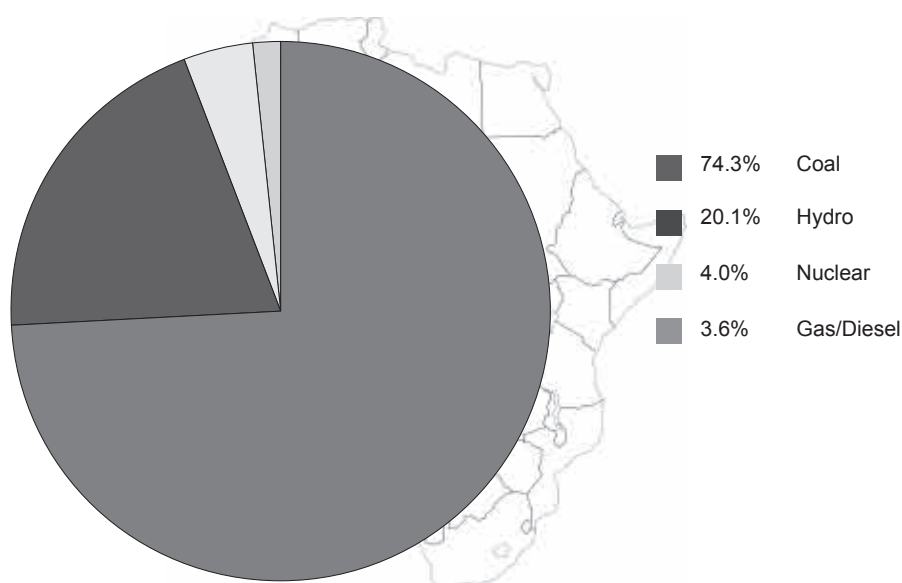
Table 2: SAPP power status: Installed and available capacity

No	Country	Utility	Installed capacity (MW)	Available capacity (MW)
1	Angola	ENE	742	590
2	Botswana	BPC	132	120
3	DRC	SNEL	2,442	1,170
4	Lesotho	LEC	72	70
5	Malawi	ESCOM	305	253
6	Mozambique	EDM	233	137
7		HCB	2,250	2,075
8	Namibia	NamPower	393	390
9	South Africa	Eskom	42,011	36,398
10	Swaziland	SEC	51	50
11	Tanzania	TANESCO	591	480
12	Zambia	ZESCO	1,632	1,630
13	Zimbabwe	ZESA	1,990	1,825
	Interconnected SAPP		51,206	43,865
	Total SAPP		52,844	44,998

Generation mix in the SAPP

Coal-fired power plants contribute the greatest percentage of the Power Pool's electricity, namely 73.3 per cent. The rest of the electricity is hydro (20.1%), nuclear (4%) and gas/diesel (91.6%). Nuclear's 4 per cent contribution is wholly in South Africa (see Figure 1).

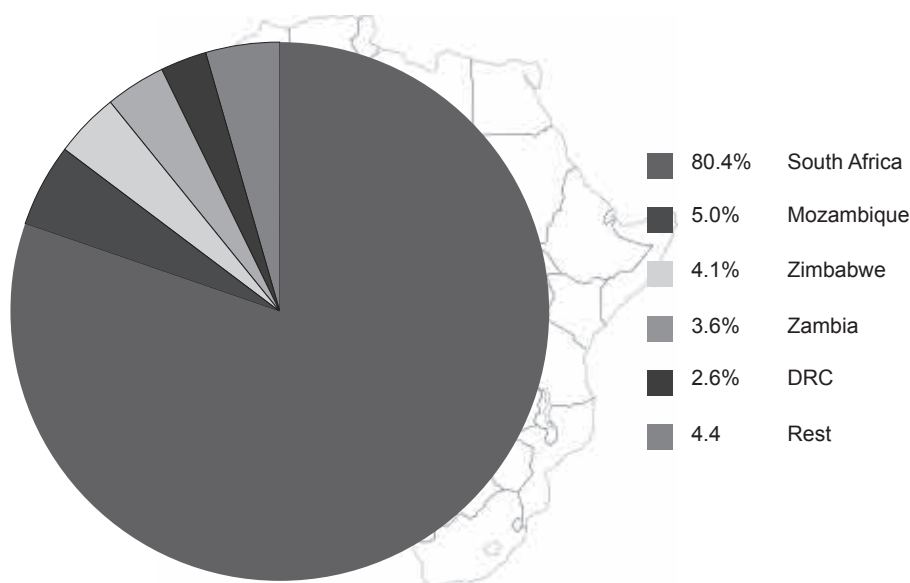
Figure 1: Generation mix in the SAPP, 2007



Country contribution generation capacity

South Africa contributes 80.4 per cent of the SAPP's generation capacity. Mozambique's 5 per cent contribution comes second, with Zimbabwe (4.1 %) and Zambia (3.6%) third and fourth respectively. The DRC contributes 2.6 per cent of the Power Pool's generation capacity, while the remaining 4.4 per cent comes from the others SAPP countries (see Figure 2).

Figure 2: Distribution per country, 2007



The achievements of the SAPP

The period between 2004 and 2007 saw tremendous strides in terms of an increase in generation capacity within the SAPP. A total of 2 235 MW was commissioned at different power stations within the SAPP countries from new, rehabilitated as well as upgraded plants (see Table 3).

Table 3: SAPP's new generation projects

Country	Plant	Capacity (MW)	Total capacity (MW)	Commissioning date	Comment
Angola	Capanda 1	2 x 130	260	2004	New
Tanzania	Ubongo	2 x 40	80	2005	New
Zambia	Kariba North	2 x 30	60	2004	Rehabilitation
South Africa	Camden	2 x 190	380	2005	De-mothballed
Zambia	Kariba North	30	30	2005	Rehabilitation
South Africa	Camden	190	190	2006	De-mothballed
South Africa	Arnot	6 x 20	120	2005–2006	Upgrade
Swaziland	Maguga	20	20	2007	New
Zambia	Kariba North	30	30	2006	Rehabilitation
Zambia	Kafue Gorge	15	15	2006	Rehabilitation
South Africa	OCGT (IPP)	1050	1050	2007	New OCGT
Total			2235		

Challenges in the SAPP

The SAPP faced a number of challenges in its operations. Key among these was the diminishing generation of surplus capacity. Economic growth of more than 5 per cent in most SADC member countries resulted in an unprecedented growth in electricity consumption and demand. Again, the Power Pool has the task of implementing a competitive service at a time when the region is unable to generate reserve surplus capacity.

The Central Corridor created a bottleneck in the transmission of power from the North (the DRC and Zambia) to the South (South Africa and Botswana), due to limited transmission capacity. Some of the transmission lines responsible for these bottlenecks are:

- ◆ The DRC – Zambia's 220 kV line limits trading with the DRC;
- ◆ Central Corridor in Zimbabwe: Alaska – Sherwood 330 kV;
- ◆ Bulawayo-Insukamini – Botswana – RSA 400 kV;
- ◆ RSA – Namibia 765 kV & 400 kV, overloaded to supply Cape Town at times.

There is no regulatory body to effect cost-reflective tariffs which could be attractive to investors. While the Power Pool has opened its doors to private sector participation, some countries do not allow private companies to engage in trading without going through government utilities. This scenario tends to limit participation by Independent Power Producers (IPPs) and Independent Transmission Companies (ITCs). One of the problems posed by electricity trading is the handling of transmission losses in a competitive market. Mechanisms have to be put in place to deal with these eventualities.

Addressing SAPP challenges

To address the challenges facing the SAPP, the region needs to do the following:

- ◆ Create an enabling environment for investors to invest in generation and transmission infrastructure;
- ◆ Embrace the principles of cost-reflective tariffs;
- ◆ Upgrade transmission lines to enable the evacuation of power from generation sources to load centres;
- ◆ Connect non-operating members to the SAPP grid – ENE, TANESCO and ESCOM.

Demand-side Management (DSM) and Power Conservation Programmes (PCP)

The Power Pool must create mechanisms to provide financial support for the development and implementation of DSM in the SADC sector and develop local manufacturing capacity to support DSM initiatives. The region must come up with a policy for the efficient use of electrical energy, such as the implementation of compact fluorescent lamps (CFLs). Minimum energy-efficient standards for new connections must be put in place.

Supply-side measures

The region must ensure the maximisation of all installed supply options and the recapitalisation of power utilities. All planned short- and medium-term generation projects must be well packaged for funding and implementation. An enabling environment must be created for further research into RE, as well as the implementation of RE projects to ensure the diversified security of supply.

Provision of investment incentives

Policy issues relating to legal and regulatory frameworks must be revisited to allow for Value Added Tax (VAT) and tax exemptions for the importing of power equipment during a defined period. The important issue of the implementation of cost-reflective and time-of-use tariffs must be addressed as a matter of urgency.

RE initiatives in the SAPP

Benefits of RE in the SAPP

RE has always been viewed as key for an alternative source of energy in the SAPP. Addressing a wind energy seminar in April 2009, the South African Minister of Minerals and Energy, Buyelwa Sonjica, said: “*Wind is the fastest growing energy source with an average annual growth of 29% over the last 10 years. The industry provides more jobs per capita than conventional power generation.*”

The benefits of RE within the SAPP include

- ◆ increased fuel diversity and security in a region that is already experiencing diminishing generation surplus capacity;
- ◆ a real option value from the modular nature of smaller investments, which can be timed more closely with increased demand;
- ◆ a reduced risk of environmental and regulatory costs and burdens from the emissions and other externalities associated with conventional technologies;
- ◆ adoption, which can improve relations with government, Non-governmental Organisations (NGOs), investors and other stakeholders;
- ◆ the creation of domestic or community employment opportunities.

Global warming and RE in the SAPP

Although GHG emissions within the SAPP are not at significant levels, compared to those of Europe and the USA, considerable amounts of GHGs are currently being emitted into the atmosphere from coal-fired power stations. Table 4 below gives a summary of the emissions from a number of coal- and gas-fired power stations in the region.

Table 4: The SAPP emission factors, 2008

Country	Plant name	Fuel type	Installed capacity	CO ₂ , Kgs/GJ	NO _x , Kgs/GJ
Namibia	Van Eck	Coal	120 MW	88	0.5
RSA	Kendal	Coal	3 804 MW	96.3	0.44
	Lethabo	Coal	3 558 MW	99.6	0.583
	Arnot	Coal	3 450 MW	95.3	0.28
Tanzania	Kiwira	Coal	6 MW	73	0.125
				73.9	
Zimbabwe	Bulawayo	Coal	120 MW	97.5	0.07
	Harare	Coal	135 MW	97.3	2.48
	Hwange	Coal	920 MW	97.1	0.29
Botswana	Morupule	Coal	132 MW	103	0.32
Mozambique	Massingir	Diesel		74.2	
Namibia	Paratus	Diesel		74.8	
Zambia	Kaoma	Diesel		74.4	

The most common GHG is carbon dioxide (CO₂), which accounts for about 74 per cent of the total GHG emissions resulting from human activities. Global warming has (and will continue to have) significant adverse effects on global systems and, as a result, on human wellbeing.

RE can play a significant role in the movement to abate GHG emissions, because it offers an opportunity to de-couple energy use from GHG emissions by providing energy from zero-carbon, low-carbon or carbon-neutral renewable sources.

The Kyoto Protocol, which aims to control GHG emissions, can reduce the cost to the overall economy of emission reduction by allowing flexibility in abatement through the buying and selling of permissions to emit. Kyoto also allows for emission reduction 'credits' to be generated in developing countries, by reducing the GHGs associated with projects such as the displacement of fossil fuel-based electricity by renewable electricity capacity. The credits, called Certified Emission Reductions (CERs), are saleable within the European Union Emission Trading Scheme (EU ETS). This therefore provides developing countries (including SADC countries) with an incentive to consider RE projects.

RE initiatives in the SAPP

The SAPP is implementing the following forms of RE:

- ◆ Run-of-river hydroelectricity;
- ◆ Biomass;
- ◆ Wind power;
- ◆ Solar power.

Run-of-river hydroelectricity (mini-hydro)

This paper considers only hydroelectricity of up to 100 MW. Large-scale hydroelectric schemes of above 100 MW are not considered, because they are well understood and have often already been exploited.

Mini-hydroelectricity has been planned in the following SAPP countries:

Table 5: Mini hydroelectric projects in the SAPP

Country	Scheme	Capacity	Status
Namibia	Orange River	40–100 MW	Feasibility studies completed
	Ruacana river	80 MW	Work to finish in 2010
Malawi	Kachipira Phase 2	64 MW	Feasibility studies completed
	Tedzani Phase1 & 2	40 MW	Feasibility studies completed
Mozambique	Massingir	27 MW	Pre-feasibility studies completed
	Lucio	80 MW	Pre-feasibility studies completed
	Alto Malema	50MW	Pre-feasibility studies completed

Lesotho	Ox-bow	80 MW	Feasibility studies completed
	Muela Phase 2	100 MW	Feasibility studies completed
Swaziland	Maguga	20 MW	Project completed in 2008
Zambia	Kabwelume	62 MW	Feasibility studies completed
	Kundabbwika	100 MW	Feasibility studies completed
	West Lunga	2.5 MW	Feasibility studies completed
	Kabompo Gorge	34 MW	Feasibility studies completed
Tanzania	Chikata Falls	3.5 MW	Feasibility studies completed
	Ubongo	100MW	Trial testing going on
	Tegeta	45 MW	Feasibility studies completed
Zimbabwe	Gairezi	30 MW	Feasibility studies completed
DRC	Nseke	62 MW	Feasibility studies completed
	Koni	42 MW	Feasibility studies completed
	Mwadingusha	12 MW	Feasibility studies completed
	Zongo	75 MW	Feasibility studies completed
	Nzilo	27 MW	Feasibility studies completed
	Sanga	8 MW	Feasibility studies completed

Biomass

The SAPP is implementing a number of biomass projects. Currently, a demonstration plant of 0.5 MW exists in Namibia. There are several biomass plants in South Africa, but they are not utility-owned. In Zimbabwe, a 500 kVA wood waste plant exists in Chimanimani. Triangle (biogas) produces 45 MVA, while Hippo Valley (biogas) produces 35 MVA.

Wind

Studies done in most SAPP countries have revealed the following scenarios:

- ◆ 100 MW (10 MW x 10 farms) can be generated by wind resources along the Mozambique coast;
- ◆ The Polytechnic of Namibia is planning to do a countrywide project on wind resource assessment;
- ◆ Most countries have wind farms;
- ◆ Wind generation in Mozambique – 10 MW at Chicumbane;
- ◆ RSA: Klipheuwel – 3.2 MW, Darling IPP – 5.2 MW;
- ◆ Zimbabwe – numerous small schemes exist, but are not connected to the grid.

Solar

Studies conducted by the SAPP Coordination Centre (2009) indicate that all SAPP countries have solar maps. Solar technology is basically used for remote, off-grid applications, water pumping, solar home systems, telecommunications, centralised hybrid systems, lighting, traffic lights and water heating. PV is mainly used in rural schools and hospitals. There are numerous Telkom and Sentec stations in South Africa.

Geothermal

Developed geothermal sites exist in Zambia, where a 200 kVA pilot plant is awaiting connection to load. A 2 MW potential exists at Kapisya, where investigations have

been done. A further 2 MW potential exists at Chinyunyu, where further investigations have been done.

Challenges to the implementation of renewable energy in the SAPP

While the countries in the SAPP have made considerable strides towards the implementation of RE in the region, several challenges exist which limit the full implementation of this technology, amongst which are:

- ◆ Low tariffs discourage investment in the sector by IPPs, unless grants are extended to investors;
- ◆ Solar and wind technologies have higher variability of electricity generation and lower dispatchability relative to conventional generation, while biomass technologies can have adverse environmental and social impacts, if not carefully managed;
- ◆ In the absence of subsidies, RE generation currently often costs more than conventional generation;
- ◆ Price uncertainty in GHG emissions markets makes the valuation of RE investment challenging – the region has not benefited from CDM;
- ◆ There is limited experience and personnel expertise around the procurement, engineering and development of RE projects.

Conclusion

Given the environmental and economic challenges related to RE, it would be advisable for governments within the SAPP to greatly encourage funding for the training and education of engineering operatives to work in this sector. In addition, funding must also be focused on developing cost-effective, large-scale energy storage technology. It is clear that if the dream of renewables is truly to be realised, the problems of economic competitiveness, development factors, supply concerns and public policy issues have to be resolved.

References

- DALE, A.P. 2005. Energy sector overview of Zambezi Basin Developments. In T. Matiza, Crafter, S., & Dale, T., eds, *Water Resource use in Zambezi basin*. Available at: [databases.sardc.net/books/ZamBasin 2000/view.php](http://databases.sardc.net/books/ZamBasin%2000/view.php)
- SOUTHERN AFRICAN POWER POOL (SAPP). 2008. *Annual Report*. Harare, Zimbabwe.
- NEWMAN, N. 2009. Counting the costs of going green. In *Engineering Technology*, 26 July to 8 August.

Part 4: Renewable energy, gender and the rural–urban divide

Dorah Lebelo

Energy poverty and its gender impacts

Energy poverty can be defined as the lack of adequate modern energy to meet the basic needs of cooking, warmth and lighting, and essential energy services for schools and health centres, as well as for income generation. Many poor communities in southern Africa live in rural and peri-urban areas, where access to modern energy services is lowest and its improvement most costly. For example, in South Africa, approximately 2.5 million households lack access to electricity, over four million households do not cook with electricity, two million households rely on candles for lighting, while over 50 per cent of households rely, to some extent, on wood fuel. Women, who remain a huge part of these rural poor, are heading households in communities where gender inequality is more or less pervasive.

Of the approximately 1.3 billion people living in poverty globally, it is estimated that 70 per cent are women, many of whom live in female-headed households (FHHs) in rural areas. Approximately 41 per cent of households in South Africa are female-headed, likely to be extremely poor, and rely heavily on biomass. There seems to be little dispute over the fact that FHHs are usually disadvantaged in terms of access to land, livestock, other assets, credit, education, health care and extension services (IFAD).¹ Households which rely on farming and do not have any income through remittance are particularly severely affected (IFAD). Women's labour and time are often considered less valuable than that of men, who make many of the important decisions about household energy choices and how women should utilise their time.

Energy poverty cuts across all aspects of the lives of the poor – they lack energy for both household and productive use. The former affects women and children (particularly girls) the most, as they bear the burden of collecting firewood, cooking with 'dirty' fuels and living with poor-quality lighting. However, energy is also needed for productive purposes; it is hard to produce a surplus in a society where cheap energy in the form of fossil fuels has been available to others in a disproportionate way. Access to cheap oil and coal has created a society where labour is devalued, as a day's labour is equivalent in value to 35c of fuel (40 grams of oil) purchased from

¹ IFAD. For more on poverty among female-headed households in Africa, see <http://www.ifad.org/gender/learning/challenges/women/60.htm>

the pump at a service station. The poor are largely excluded from this massive bonus of cheap energy that modern society has gained from fossil fuels. The continued marginalisation of the poor from these benefits will mean continued poverty on all levels and, in all likelihood, greater poverty in the future.

Challenges in meeting the energy needs of the poor

Most poor households in southern Africa cannot afford an electricity connection, and even if they get a connection they can only afford to use electricity predominantly to power lighting, televisions and radios. Affordability interventions often focus on tariffs and thus ignore the non-connected issue which is still being faced by many rural and urban poor. The poorest often pay more for their energy through candles or batteries, or through the use of their time (travelling long distances to buy paraffin or fuel wood).² In rural southern Africa, many women travel long distances every day to collect fuel wood. The opportunity cost of this time can be measured by time that could have been spent on income-generating activities, child care or education.

Energy access is frequently perceived as simply a technical problem, which poses a challenge for the poor. This narrow view often results in the failure of various initiatives aimed at expanding energy access to the poor. Energy access cannot be addressed simply as mere technical and economic issues: it is important to take a people-centred approach in looking at how energy affects peoples' lives directly. Hence, there is a need for a participatory approach, where people's sensitivities to cultural, social and economic factors are taken into consideration in the choice of energy technologies.

Renewable energy (RE) resources available on the continent have not been actively developed to meet people's energy needs. There are various obstacles to the development of local and RE sources, amongst which are financial barriers, a shortage of local expertise, a lack of locally produced equipment and components, institutional and regulatory barriers (including a non-incentive fiscal framework).

There is a challenge of limited access to appropriate financing schemes that can allow the poor to overcome the high up-front costs of RE technologies and appliances. There is a large funding gap in providing access to RE for the poor, which has not been seriously addressed by existing financial mechanisms and institutions. The political will and governments' commitment are also urgently needed to prioritise investment in RE as critical for the development of the poorest sectors.

Energy access is not without cost, and the initial expenditure on connections (electricity) or better technologies can be high. Even though the energy needs of the poor are limited, many of them cannot afford to pay even the small amounts that can

2 Consumers International. 2006. Energy: Sustainable access for all. World Consumer Rights Day, 15 March 2006.

make a significant difference to their lives. The majority of the poor have very low incomes that are not sufficient for procuring energy services to meet basic needs such as cooking, provide affordable transport, power pumps for drinking water, heat spaces or serve productive purposes.

Inequality in women's energy access

Not all energy-poor people live in rural areas. Energy access differs across the urban–rural divide, with rural areas being relatively worse off than urban areas. Many low-income people in urban and peri-urban areas suffer from a lack of access to energy services, and their numbers are likely to increase. The difference in the level of access to resources means that development outcomes still vary considerably between rural and urban centers. However, due to the large volume of rural–urban migration, the proportion of the poor in rural areas is declining.

Lack of opportunities in rural areas due to energy poverty is a major factor driving increased migration from rural to urban areas. Without energy, there are few jobs in rural areas other than farming, and workers tend to move to the cities in search of employment. Women who are left behind in the villages, struggle to provide for themselves and their children. The absence of energy services is a key barrier to development and growth opportunities in rural areas, and impacts women in distinct ways.

Role of RE in addressing energy poverty

Renewable sources of energy could play an important role at the local level – particularly within informal settlements in urban and rural areas. RE technologies such as solar photovoltaic (PV) systems offer prospects for meeting the lighting, telecommunications, refrigeration and other power needs of the poor in a cost-effective and efficient manner, also in areas that are far removed from national electricity grids. They also have the potential to stimulate local economic development by introducing community-based solar enterprises that can be set up with training in installation and maintenance skills. This could be coupled with innovative and flexible financing systems for consumers to support the entrepreneurs.

The use of energy-efficient appliances and the substitution of cost-effective RE technologies for fossil fuels, such as solar water heaters (SWHs) and other space-heating and cooling devices, offer opportunities to reduce the cost of energy services, while at the same time conserving resources. This could be true particularly where community-based RE enterprises are developed to meet the energy needs of the poor in rural and urban areas with no access to the grid. The ideal is for a partnership with the private sector which is driven by community members, to build on existing local

institutions and support the growth of new institutions that can manage and provide energy services for the community in the long term.

However, to improve the access of the poor – including women – to RE resources, it is necessary to provide them with credit, technical information and knowledge.

Barriers in accessing RE

An important challenge facing the poor – particularly women – is a lack of information about RE options that could be appropriate for their own situations. Public awareness about the use of RE sources, their costs, benefits and reliability, is very limited. Consequently, entrepreneurs are not motivated to venture into investing in unknown technologies with uncertain market potential. It is essential to heighten public awareness of the benefits and applicability of RE as a means to achieve sustainable development goals, including social and economic betterment through improved access to energy services. Already a number of cases of innovation and successful RE projects involving women, entrepreneurs and end-users are available across the developing countries – these can be distributed to the poor to replicate and scale up.

The lack of financial resources at both individual and government level is another constraint to the propagation of technologies. The transition from traditional fuels that are often regarded as ‘free’ (such as wood) to RE technology (such as SWHs or energy-efficient wood stoves) requires an initial capital investment on the part of the individual user, which is beyond the reach of the urban and rural poor. As a result, partnerships with donors can be developed for investing in the local production of RE components; setting up supplier networks; and the training and accreditation of people with installation, marketing and maintenance skills.

The attitude of key policy-makers towards RE technologies ranges from caution to scepticism, thus RE is not given high priority in national energy planning. It is crucial that RE be taken up at the national and regional levels to generate much-needed political support aimed at levelling the playing field and creating a favourable climate for RE. Each country needs to develop clear overall goals and targets for advancing the use of RE, which will help to create an environment that is conducive to long-term investment and provides planning certainty for industrial stakeholders and consumers. This will then eventually help to overcome high initial costs.

RE is a better choice

Shifting to RE could bring multiple benefits to the poor. It has the potential to

- ◆ **promote gender equity:** traditional energy sources – particularly traditional biomass – place a disproportionate burden on women. Because of women's traditional role in fuel collection and use, there is a huge opportunity cost in terms of time that could be more productively spent, as well as an enormous waste of human energy that could be curtailed;
- ◆ **improve indoor air quality:** air pollution is associated with traditional biomass use in inefficient cook-stoves and heating – this is a major cause of disease and mortality in developing countries, particularly among women and children;
- ◆ **bring about economic self reliance:** poor people often spend a disproportionately large share of their income on kerosene, batteries and candles in order to meet their energy needs; RE sources – particularly non-electrical options – can dramatically reduce the cost of 'imported' sources;
- ◆ **advance empowerment:** community control and the management of local resources for energy can empower communities, rather than creating new dependencies on materials/equipment and 'fuel' provided from 'outside'.

To improve the access of women to RE resources, a number of interventions need to be made, including providing them with credit, and supplying them with technical information and knowledge. It is also critical to come up with awareness-raising campaigns aimed at policy makers – this, to ensure that there is no resistance to gender and gender issues. Designing, formulating and implementing more gender-sensitive policies that take into consideration men and women's needs, is vital.³

It is important to increase efforts to raise awareness amongst women at large about RE technologies and opportunities; to establish a network on women and energy so as to facilitate advocacy and knowledge sharing; to include women in the design, planning, implementation and monitoring of projects; to do a gender evaluation of energy programmes and interventions; and to support women in establishing micro-enterprise income-generating projects that involve RE – especially when they face barriers related to gender issues and concerns; and also to appoint women decision-makers and gender-sensitive men in the energy sector.

Finally, it is important to realise that gender equality and the empowerment of women requires a holistic approach, not just an approach with a particular solution for access to and control over energy. Such a holistic approach requires that all forms of gender inequalities and vulnerabilities be addressed.

3 United Nations Economic and Social Commission for Western Asia. 2006. Gender and renewable energy ESCWA Centre for Women Newsletter, December 2006, Vol. 1 Issue 2.

The role of Independent Power Producers (IPPs) in addressing energy poverty

Communities need to be provided with adequate assistance to develop local energy resources to meet their energy requirements. Possible solutions include, amongst others, stand-alone power supplies and mini-grid distribution systems powered by mini and small-scale PV, wind power, community biogas generation and distribution. In order to promote RE commercialisation, Government should adopt a regulatory framework to encourage both private individuals and companies to invest in RE projects.

There are plenty of opportunities for IPPs to get involved in the energy sector, and capitalise on both the strong demand and plentiful natural resources like solar and wind energy. This will also demonstrate that RE can present a viable alternative to grid-based fossil fuel power (which often fails to meet the energy needs of the poor), through a mix of energy options which are linked to the local economy and livelihood generation projects such as biomass cogeneration plants and wind farms, for on-grid applications, off-grid electrification and energy efficiency.

IPPs may also be privately held facilities (such as rural solar or wind energy producers) and non-energy industrial concerns generating electric power for on-site use (and which may also be capable of feeding excess energy into the distribution or transmission grid system). IPPs could play a major role in providing RE equipment, training local people, and offering maintenance and equipment repair, i.e. job creation. For this reason, an active partnership between the public and private sectors is required. The private sector should be encouraged to invest in the RE market, in order to provide RE equipment and services, including maintenance and repair, and offering training to local people.

Households and local entrepreneurs could be assisted to become involved in solar PV, either by taking advantage of government subsidy programmes or by deciding to pay the extra cost themselves; ‘net metering’ that allows ‘stored’ kilowatt hours (KWhs) over the utility connection and power sales at retail-tariff levels.

The importance of micro-financing in facilitating access to RE by those most disadvantaged

RE equipment is expensive for local people, therefore financial support will play a crucial role. Over the past three decades micro-financing has helped to alleviate poverty and it could help to make RE a source of income for a new class of business – RE microenterprises. As a result, microfinance institutions could offer personal consumption ‘energy loans’, and help finance the energy poor to leverage RE sources like solar, wind and biogas not only for personal use in their homes, but also to create businesses.

Microfinance has the potential to provide sustainable financial services for sustained economic security and growth for the poor. It provides credit for investment in small-scale activities for energy access systems and self-employment (chosen by the poor themselves) empowers the poor through a personal transformation of being able to produce their own energy and potentially earn some income out of it.⁴

Microfinance institutions could support programmes in solar energy, biogas and improved cook-stoves, which include training and capacity building for entrepreneurs who promote the systems, as well as financial products tailored for RE uptake. For example, entrepreneurs will be financed to install solar systems and sell power to those in the community who cannot yet afford to invest in their own systems.

Nevertheless, the success of micro-financing is dependent on several factors, such as infrastructure, the availability of information, the education of users, the availability of maintenance services, and the creation of opportunities for income-generating activities.⁵ It is important for the poor to be able to choose from a number of energy options those which are the most appropriate technologies. They need reliable and accessible information in their own languages, in order to be able to make informed choices about the technologies they want to use. Furthermore, available micro-financing mechanisms need to be explained, along with their advantages and disadvantages.

4 <http://www.microfinancegateway.org>

5 CORE International, Inc. Role of micro-financing in promoting renewable energy technologies (RETs) in rural areas, for sustainable development and poverty alleviation. www.drumindia.org

Part 4: Renewable energy, gender and the rural–urban divide

Nthabiseng Mohlakoana

Introduction

In 2006, the Department of Minerals and Energy (DME) formulated the Free Basic Alternative Energy Policy to ensure that households without grid electricity have access to subsidised energy services (DME, 2006). These services include part payment by the local municipality towards a fee-for-service for the solar heating system (SHS), to the service provider, on behalf of the household. Unfortunately, not all rural municipalities with households that have SHSs manage to make such payments and subsidies, and often households cannot afford to pay the full fee-for-service, which frequently leads to disconnections or households not even bothering to apply for SHSs at all.

In the rural areas of South Africa, where households have been provided with SHSs through the government's electrification programme, these systems are mainly used for lighting. Households in both KwaZulu-Natal (KZN) and the Eastern Cape have indicated that these systems provide them with a much-needed service, namely basic lighting. The standard systems that are installed in these households are 50 Wp and can provide a rural household with electrical power for four low-energy-consuming lights, a small black-and-white television, a small radio and the ability to charge a cell phone battery. Households can have access to this electrical power for four to six hours a day, depending on whether there is sufficient power stored in the battery.

Perceptions of renewable energy (RE) in urban low-income households

Households in low-income rural and urban areas do not have much information about RE. Most of the technologies available to them, such as SHSs and solar water heaters (SWHs), are only introduced through government-subsidised and donor-funded programmes (Annecke and Mohlakoana, 2006). Most of these programmes do not provide much information to the households, and to a certain extent the households do not have much choice but to accept the technology, as it is often free or highly subsidised.

Households that were interviewed for various studies in the rural areas of KZN and the Eastern Cape considered SHSs as 'inferior electricity'. Their main concern was

that they could not cook and satisfy other thermal needs, such as heating, with their SHSs. A lack of information to these households and high expectations of such technologies have created a stigma in the low-income rural areas, which has resulted in some households opting to ‘wait’ for grid electricity.

Households in low-income rural and urban areas continue to use paraffin, regardless of its costs – paraffin has become the most expensive fuel used by low-income impoverished households, with prices more than tripling in the past five years (Truran, 2009:3). One of the reasons for the continued use of paraffin is that it is still the most accessible fuel for low-income communities, as it is sold in small quantities and people can easily access it from informal shops. Buying paraffin at informal shops instead of petrol stations, for instance, increases the costs for these households, as prices at this level are not regulated and informal shops can price the commodity as they wish. Use of paraffin by these households is not only costly, but also dangerous. The paraffin appliances that these households use are of low quality, and although most paraffin stoves have been taken off the market as they do not meet South African regulatory standards, households in low-income communities still manage to purchase these on the black market that has been created due to the high demand for such appliances.

Even when RE technologies (RETs) are available through government subsidies for low-income urban and rural households, these households often cannot afford the capital costs, such as installation fees required by the service providers. Fees paid for the monthly service of the RETs also become too expensive for these households, which often face being disconnected from the system.

Challenges

The cost of SHSs for rural households in impoverished areas is often too high and therefore unaffordable. These households do not earn large amounts of money – if their members are employed at all – and often have to rely on the government’s social grants. Without access to reliable energy sources such as RETs, they have to depend heavily on wood, candles and paraffin to meet their household energy needs. Buying SHSs and SWHs is also not an option for these households, as they are too expensive. In South Africa there are currently no micro-financing schemes for households, contrary to other developing nations such as Brazil, India and some African countries. South African households only have the option of a monthly fee-for-service, of which – if they are fortunate – their local municipality will pay a portion on their behalf. It should also be noted that these payments do not translate into ownership of the SHSs, as households have to pay this fee for as long as the SHSs are in their possession.

Some rural and urban households do not qualify for these solar systems because they are located close to the electricity grid, and according to the stipulations of the

DME, only households situated 5–10 kilometres from the national grid may qualify for RETs such as SHSs.

Theft of the SHSs in the rural areas of KZN was a big challenge for both households and the service providers. Some households opted to return their SHSs as they were afraid of putting their families in danger. Some SHSs were literally removed from households' rooftops, and if members of the household protested, they were often threatened, sometimes by gun-wielding criminals (Annecke and Mohlakoana, 2006).

As mentioned above, while some rural municipalities have been able to implement the Free Basic Alternative Energy Policy by providing subsidies to households with solar systems, this has been a challenge. Most rural municipalities do not have the capacity to implement this policy, thereby putting rural low-income households at a further disadvantage as they do not have reliable and clean energy supplies to meet their own needs. This also means that women and girl children have to collect wood to supply the household's energy needs, and in so doing they miss out on an education and economic development activities.

There is still a lack of integration of energy services for both low-income urban and rural households. Households in the low-income sector use a diverse range of energy services and fuels rather than depending on any single source (unlike high-income households that rely mainly on electricity for all their energy needs). When these households are only provided with one source of energy, they have to find ways and means to supplement their energy needs, hence they continue using wood and other 'dirty' fuels. If households are provided with a reliable, accessible and affordable energy mix that satisfies their energy needs, there will be no need to provide them with grid electricity, as there are many RETs that can be combined to achieve this goal. SHSs can provide lighting, TV and radio power; SWHs can provide households with hot water; solar stoves, hot-boxes and efficient wood and coal stoves can provide households with cooking energy; and sufficient insulation of the homes can provide households with much-needed heating energy. This 'energisation' approach can ensure that even low-income households have better energy services and do not need to depend on grid electricity.

Where RETs are introduced, there is often a lack of technical capacity in communities. People are introduced to these technologies, but are not given the technical support and expertise to manage them if anything goes wrong. RETs have great potential to provide much-needed employment in low-income areas, and will guarantee technical support if a few people are trained to work with problems arising when households use their RETs. Lack of technical support also leads to the RETs being vandalised, as communities lose faith in the technologies and see them as useless when they do not function properly. This heightens the stigma that communities associate with RETs and makes acceptance difficult.

Opportunities

With Free Basic Alternative Energy (FBAE) subsidies, households have an opportunity to use RETs in an affordable way, and this will also do away with the culture of non-payment that many service providers have to deal with. Other RETs can be introduced to ensure the integration of energy services for poor and impoverished households, thus contributing to the changing realisation that there is more than just lighting services to using RETs. There is also the potential for small business development in low-income areas through the use of RETs. Some communities, for instance, have benefited from making hot-boxes and selling them to other community members.

Cell phone battery charging is another business opportunity that rural people with SHSs have taken advantage of. Most people in the rural areas own cell phones, as this provides a reliable source of communication with the outside world, but unless they have electricity to power the batteries, their cell phones become useless. Often, household members have to make a special trip into town to charge their cell phones, but this becomes very costly as they have to pay not only for transport, but also for charging their phones. Some RETs have been used to power computers and sewing machines, and this has enabled people in the rural areas to gain skills in using modern technology which, in turn, enhances their chances of employment in the urban areas.¹

The rising costs of electricity, paraffin and liquefied petroleum gas (LPG) should be seen as an opportunity to promote RETs – especially to households in low-income areas. If RETs are affordable and easily accessible, households will not need to use other energy sources.

Low-cost housing schemes in South Africa do not provide occupants with water-heating appliances such as geysers, therefore these households have to find other means of accessing hot water. This often means they have to heat water on the stove top, using electricity, LPG or paraffin. If households cannot afford these fuels, they have to use wood to meet this energy need. RETs such as SWHs can fulfil this need and ensure that these households have adequate water-heating capacity. The Nelson Mandela Bay Municipality in Port Elizabeth, in the Eastern Cape, has proved up

to 1 200 low-cost homes with SWHs as part of Eskom's Demand-side Management (DSM) programme. In Cape Town, Kuyasa location in Khayelitsha is also projected to receive 2 300 SWHs by August 2010, thanks to a project registered through the Clean Development Mechanism (CDM) under the Kyoto Protocol – the first of its kind in Africa. Sales of carbon credits through this project will go towards setting up a fund to ensure employment for local people, who will work as SWH technicians to provide sustainable long-term maintenance on these systems.

1 Restio Energy, a company based in Cape Town, has installed a few solar systems in containers in the rural areas of northern KwaZulu-Natal, where they are used for income generation purposes by local communities. www.restio.co.za

Importance of RE provision in rural areas as an element of rural development

The provision of modern technological services in the rural areas creates a sense of equality between rural and urban communities. If the energy service that people receive is good, of high standard and reliable, they will not be concerned about what type of technology it is. If the now renamed Department of Energy (DE) is to provide all South African households with electricity by 2012, as is its target, low-income households that currently do not have grid electricity and are using SHSs would have gained much-needed experience in using electrical appliances by the time they receive grid electrification in their communities.

RETs, which have the potential to alleviate poverty in low-income rural and urban areas, can also improve the health services in these areas, as clinics can use refrigerators to store medication. The provision of lighting through these technologies will also improve people's ability to study at night, and eliminate the need to study by candlelight.

What are the gender impacts of RE provision (or a lack thereof)?

The provision of lighting and the ability to use entertainment-related appliances, such as radio and TV, benefit the whole family, whether the members be male or female. In rural low-income areas, most families see this as a luxury, as they are not able to afford the connection and fee-for-service for the SHSs, and they are not yet connected to the grid. Unfortunately, most rural women and girl children continue collecting wood and plant residues to ensure energy supply in their homes, when the time taken to collect such fuels could be used for productive and income-generating activities. Girls often miss out on school days or do not attend school at all, because their chores (such as collecting wood) take hours every day. Moreover, wood-collecting activities are dangerous for women and girl children: they risk long-term health effects such as back pain, but also might be attacked by animals or criminals, as they have to walk long distances looking for fuel-wood.

In urban areas, female-headed households are most vulnerable as these girls or women do not always have secure or permanent jobs. They do not have land tenure either, which means that they are always at the mercy of landlords, or live in areas that are not recognised by local authorities, and therefore are not provided with services.

The more sustainable and stable income that women depend on is in the form of social grants, but often these are not enough to take care of big families and in this case, modern energy services do not become a priority. In many instances, women in low-income communities are also responsible for taking care of the aged and the

sick. In Imizamo Yethu, a township in Cape Town, a group of women who volunteered their time and services as palliative care workers by visiting the homes of the sick and the aged, said that it was very difficult to provide proper care to such people without sufficient energy in the household (Energy Research Centre, 2008). Sick people require heat and hot water to bath (for hygienic reasons), and this task becomes impossible if there is no appropriate energy service to satisfy this need. Food also needs to be prepared so that the sick can follow a balanced diet, to speed their recovery and restore good health. The women reported that this was most challenging, because even though food was donated to the sick and needy, it had little impact if they did not have the means to cook it.

Political and economic barriers to the development of RE sources in rural areas

Although the RE policy has been published and some of its goals implemented, the link between policy, institutions and financing is still very weak. Financing RETs in rural areas still depends on the donors and not on the needs of the people. If there are funds available, Government usually goes ahead with implementation without assessing the 'real' energy needs of rural communities, hence not all the communities' energy needs are satisfied.

There is also a need to integrate energy services with other basic services being delivered to the poor: water supply, telecommunications and road construction can benefit and complement the provision of energy services to rural areas. If these services are delivered in an integrated way, local municipalities can save on resources, which may result in better service delivery.

Power relations within government and community structures need to be strengthened to ensure that there is buy-in of RETs in the rural areas. The power that local traditional leaders have in influencing the behaviour of community members is often taken for granted by policy implementers. If these structures are involved from the outset in planning the delivery of energy services to their communities, most projects and programmes would be successful, as communities would take ownership of these initiatives.

One of the biggest problems facing rural communities, is unemployment. Often, educated rural community members leave such areas in search of better employment opportunities, or to advance their careers. This leaves these rural areas in a worse state due to the skills drain that they experience when educated people leave. Employing people in rural energy provision programmes could encourage the skilled and educated to stay in such areas, where they can utilise their much-needed skills and services.

RETs depend on reasonable funding for them to be introduced in rural communities; however, there is usually a lack of local funding. Local financial institutions need to take the initiative and fund RET services that will benefit the low-income sector, even by providing micro-finance. This will also encourage regional and international funding and financing opportunities, and lead to the sustainable provision of RETs in rural areas.

Conclusion

In order for RETs to be taken seriously and to impact on the lives of people living in low-income urban and rural areas, there needs to be better information and knowledge dissemination about these services. RETs need to be affordable for people in low-income areas and must meet their basic energy needs beyond the provision of lighting and entertainment services. Heating and cooking, which are very important energy needs, are vital to the wellbeing of any household.

The proper implementation of FBAE subsidies could provide opportunities for more rural and low-income urban households to use RETs. Nevertheless, the delivery of RETs needs to be integrated with other basic services, to ensure sustainability. As such, other Government programmes and initiatives can also benefit from the availability of energy services in rural areas. RETs can provide opportunities for small business development in both rural and urban areas, as people can expand energy service delivery using these technologies. Yet further understanding is needed on the impact that a lack of modern technology and insufficient provision of energy has, in further disadvantaging female-headed and female-managed households. Indeed, it is women and girl children who continue to carry the burden of collecting wood and walking very long distances to provide much-needed basic energy services to their homes.

References

- ANNECKE, W., & N. MOHLAKOANA. 2006. *Socio-economic characteristics and impact assessment of the KwaZulu Energy Services programme of solar home systems installation*. Cape Town: Gender and Energy Research and Training.
- DEPARTMENT OF MINERALS AND ENERGY (DME). 2006. *Free Basic Alternative Energy Policy: Household Energy Support Programme*. Pretoria: DME.
- ENERGY RESEARCH CENTRE. 2008. *Alleviation of poverty through the provision of local energy services: Establishing energy-related priorities in urban and peri-urban areas*. Cape Town: University of Cape Town.
- TRURAN, G. 2009. Household energy poverty and paraffin consumption in South Africa. *Boiling Point*, 56.

Part 5: The market as a driver or constraint in the move towards renewable energy in southern Africa

Anthony Turton and David Gadd-Claxton

Introduction

South Africa has a highly diversified economy, but the sustainability of that economic growth and prosperity is now being placed at risk by two critical natural resources: water and energy. This think piece makes the case for the link between water and energy, expanding it to the entire Southern African Development Community (SADC) region, by virtue of the highly complex linkages that exist in the strategic water and energy sectors on the supply side. A case is made for a new debate at the regional level, between national water, energy and food security policies, by virtue of these linkages. Given that the principal author is a water resource specialist and a relative newcomer to the field of energy, this paper will carry a bias that reflects this fact.

Water as a strategic natural resource

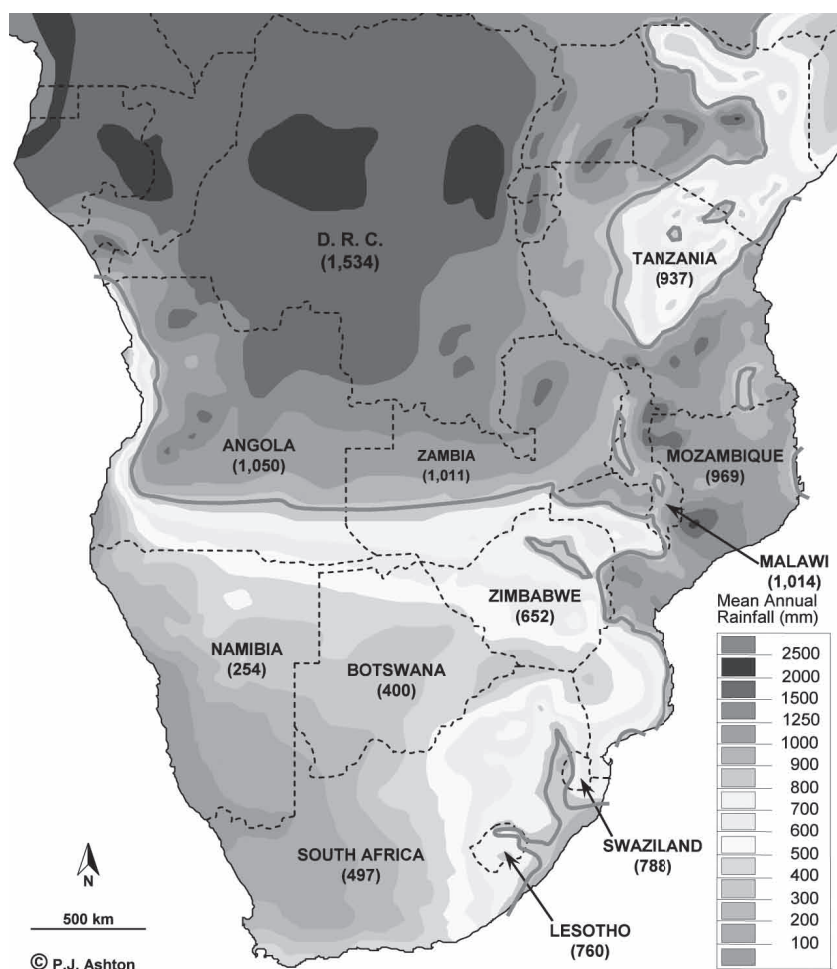
One of the most significant developmental constraints on the entire African continent is the conversion of rainfall, known technically as Mean Annual Precipitation (MAP), to water that occurs in rivers as runoff, known technically as Mean Annual Runoff (MAR) and which is thus available as an economic resource. The continental averages are: 20 per cent for Africa; 35 per cent for Europe, Australia and Oceania; 43 per cent for South America; and 45 per cent for North America and Asia (Gleick, 1993). This means that at a continental level, Africa loses a whopping 80 per cent of its rainfall as evaporation or transpiration (known as evapotranspiration) shortly after it falls. This biophysical factor is a key element in the argument presented in the rest of this paper.

The SADC region covers 14 sovereign states, two of which are islands. The 12 mainland African states are linked by 21 river basins that cross international political borders, 15 of which are considered to be the most important in terms of socio-economic development (Turton et al., 2008). The SADC region is characterised by a specific hydrological regime, made more complex by the fact that the majority of the area lies between the Inter-Tropical Convergence Zone and the Southern Ocean, each of which drives different patterns of weather and precipitation. This biophysical characteristic

is superimposed onto a set of countries, each with different developmental trajectories, political histories, legal systems that reflect former colonial legacies, and diverse natural resource endowments (Turton, 2009). The end of the Cold War resulted in an attenuation of localised theatres of political instability, which in turn has meant that the SADC region is now set to grow economically into a more integrated regional grouping, possibly along similar lines to that of the European Union (EU) (Turton et al., 2008).

The economic development potential of the SADC region is defined by the availability of water. The primary source of water is precipitation, which is highly skewed across the region, as shown in Figure 1. The precipitation patterns are characterised by steep gradients from North to South and from East to West, with what are currently the most economically diverse countries on the 'wrong side' of the global average of 860 mm/yr⁻¹. The data presented in Figure 1 reflect these precipitation-related facts in a dramatic way, with the red line representing the global average isohyet of 860 mm/yr⁻¹ and the number stated in brackets beneath the name of each country presenting the MAP for that country.

Figure 1: Mean annual precipitation (MAP) across the SADC region shows that water resource availability to three of the most economically developed countries is a limiting factor to future economic growth potential



Africa has 63 transboundary river basins that cover 61 per cent of the surface area, containing 93 per cent of the total water resources of the continent in which 77 per cent of the population lives (Phillips et al., 2006). The SADC region has a total of 21 river basins that cross international political borders, ranging from large perennial systems like the Congo and Zambezi, to small ephemeral systems like the Cuvelai. Table 1 provides a rough indication of the relative size of the 15 major transboundary basins in the SADC region in terms of their area and volumetric flow.

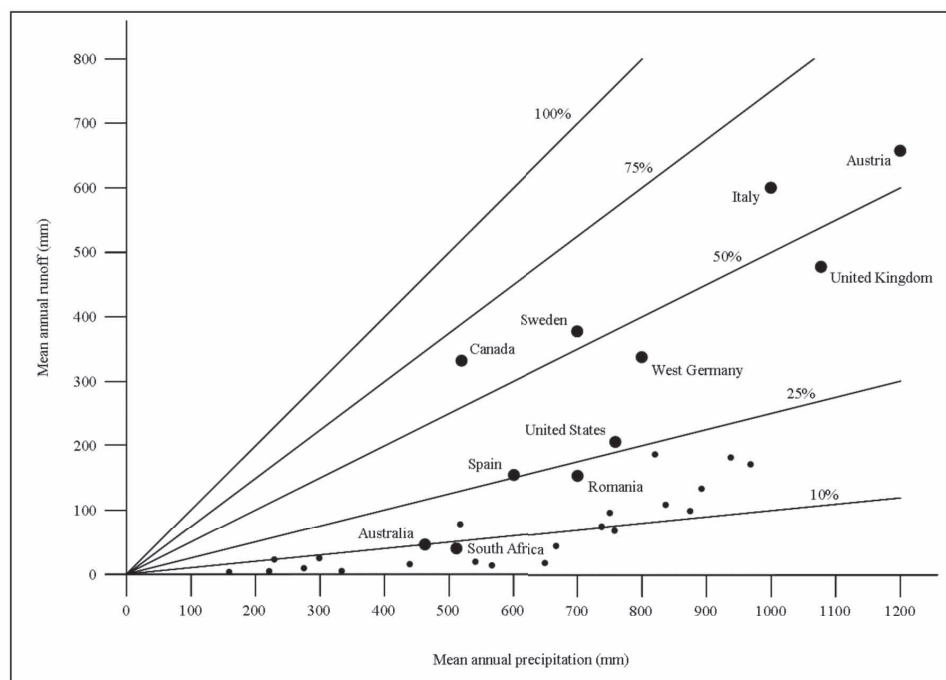
Table 1: Physical description of the major transboundary rivers in the SADC region (Turton et al., 2008)

Basin	Total basin area (km ²)			River length (km)	Mean annual runoff (Mm ³ /yr ¹)
	Pallett	UNEP	Wolf		
Buzi	31 000	-	-	250	2 500
Congo / Zaire	3 800 00	3 669 100	3 669 100	4 700	1 260 000
Cunene	106 500	110 000	-	1 050	5 500
Cuvelai	100 000	-	-	430	Ephemeral
Incomati	50 000	46 000	46 000	480	3 500
Limpopo	415 000	414 800	414 800	1 750	5 500
Maputo	32 000	30 700	30 700	380	2 500
Nile	2 800 000	3 038 100	3 038 100	6 700	86 000
Okavango / Makgadikgadi	570 000	706 900	706 900	1 100	11 000
Orange / Senqu	850 000	945 500	945 500	2 300	11 500
Pungué	32 500	-	-	300	3 000
Rovuma	155 500	151 700	151 700	800	15 000
Savé - Runde	92 500	-	-	740	7 000
Umbeluzi	5 500	10 900	10 900	200	600
Zambezi	1 400 000	1 385 300	1 385 300	2 650	94 000

Source: Columns 2, 5 & 6 – Pallett et al., 1997; Column 3 – UNEP, 2002b; Column 4 – Wolf, 2006.

Having noted that the continental conversion of MAP to MAR is 20 per cent, it becomes instructive to examine the exact situation within different transboundary river basins in the SADC region, because it is considerably worse than the continental average. Figure 2 shows the MAP:MAR conversion ratio for the 21 transboundary river basins in the SADC region. The horizontal axis represents MAP, with the vertical axis showing MAR. The small dots on the graph represent individual river basins in the SADC region, with the larger dots representing specific countries by way of comparison. It is immediately evident that while the river basins in the SADC region differ in terms of volumetric flow, they are mostly clustered along or below the 10th percentile (O’Keeffe et al., 1992). This shows that while the continental average MAP:MAR conversion is 20 per cent, the SADC conversion ratio is considerably less, being in most cases half of that (10%), often from a low precipitation base. If one gets more specific, the Orange and Limpopo River basins – both of which are extremely important to South Africa, Mozambique, Zimbabwe, Botswana, Lesotho and Namibia – have an average conversion of a paltry 5.1 per cent (Ashton et al., 2008). It is this set of factors – a combination of climatic and hydrological – that is a fundamental developmental constraint in the SADC region (Turton et al., 2008), which is not yet part of the regional energy debate.

Figure 2: The conversion ratios of MAP to MAR in the SADC region are mostly clustered around the 10th percentile (redrawn from O’Keeffe et al., 1992)



The water/energy nexus

The water/energy nexus is complex, but can be simplified as follows: the regional energy strategy is mostly based on coal combustion, with some localised exceptions driven by the availability of viable alternative resources. For example, Angola has major hydrocarbon reserves and the riparians of the Congo and Zambezi River basins have viable hydropower reserves. Note that the former is somewhat of an exception in the region, whereas the latter grouping is defined by virtue of water availability. If one drills down a bit deeper, it becomes evident that in a coal-based energy scenario there are two key factors at play: the first relates to the location of the actual coal reserves, whereas the second relates to the availability of water. As a ballpark figure it takes the combustion of one kilogram of coal and the evaporation of two kilograms of water to produce one kilowatt hour (KWh) of electricity with the coal combustion technologies currently used by Eskom, a major regional energy producer.

With this in mind it becomes instructive to assess the location of coal and water resources for this purpose. While a regional map is not readily available, two maps from South Africa serve to illustrate the point at hand. Figure 3 shows the distribution of coal in South Africa, whereas Figure 4 shows South Africa’s national water balance as it was in 2000, expressed in terms of percentage availability (or deficit). An examination of these two maps shows that in general there is a localised water scarcity where coal deposits exist, which poses a new question: does one transport the coal to the water, or the water to the coal in order to generate electricity? In the

case of South Africa, the solution to that problem has been the large-scale engineering of inter-basin transfers (IBTs) of water, all cascaded from river basins with surplus water to river basins in deficit, close to the coal sources (see Figure 5).

Figure 3: The distribution of coal in South Africa (Eskom).

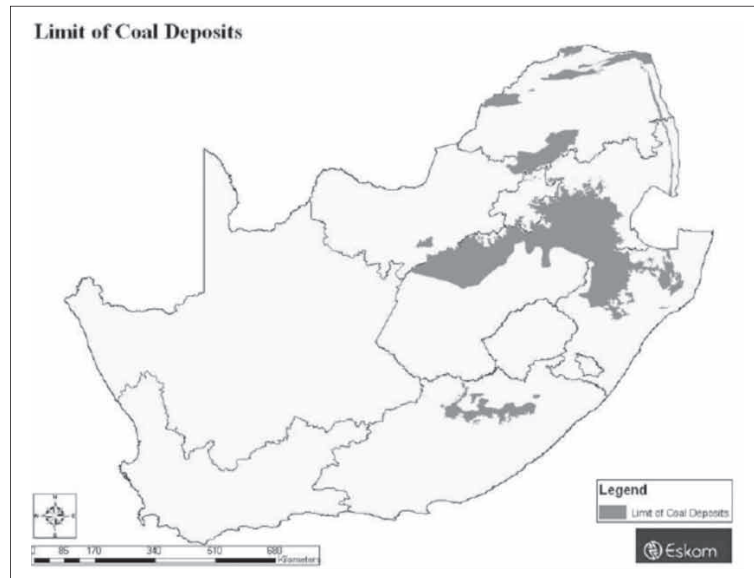
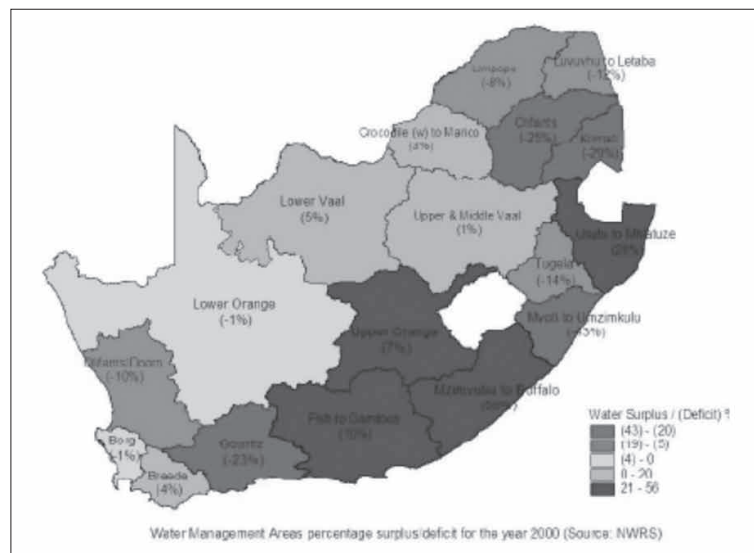


Figure 4: The water balance in specific regions of South Africa, as it was in 2000 (NWRS 2004)



The existence of massive IBTs in South Africa is a characteristic of the economic foundation of the country and needs to be understood in the context of an energy debate, for a number of reasons. Figure 5 shows the full extent of IBT development in South Africa, while Table 2 lists details of the end use. Note how much of the emphasis has been placed on cascading water into the river basins supporting energy production in the coalfields, the most notable being the Upper Vaal and Olifants Water Management Area (WMA).

Figure 5: Various river basins in South Africa expressed as a function of the respective water management areas (NWRS 2004). Note the major IBTs into the coal-producing areas of the Upper Vaal and Olifants WMA

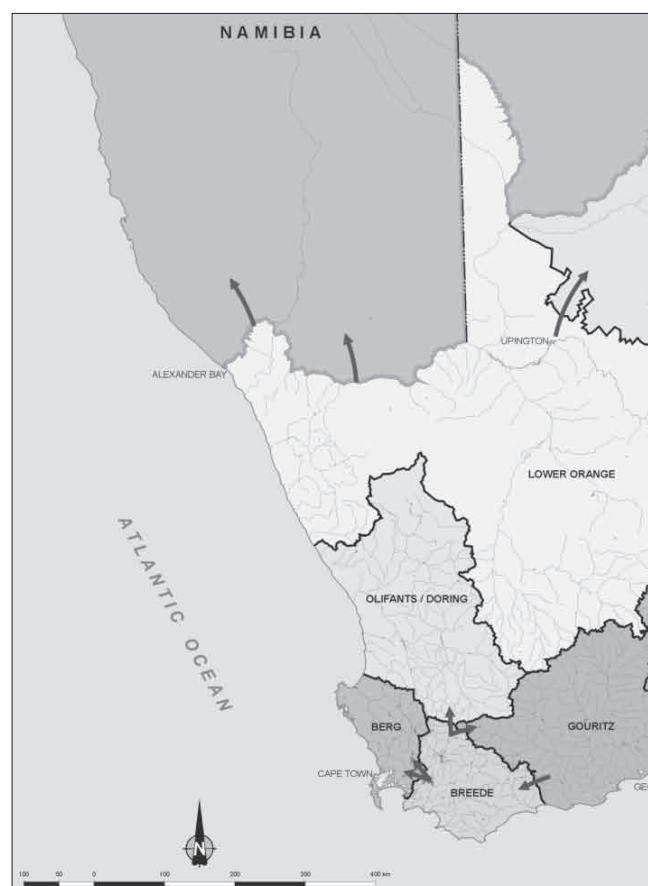


Table 2: Inter-basin transfer of water in South Africa

Name of transfer scheme	Source international basin	Recipient international basin	Average transfer (106m ³ yr ⁻¹)	Primary water use
Vaal - Crocodile	Orange	Limpopo	615	Industrial, domestic
Vaal - Olifants	Orange	Limpopo	150	Industrial (Eskom)
Olifants - Sand	Limpopo	Limpopo	30	Pietersburg
Crocodile - Limpopo	Limpopo	Limpopo	6	Gaborone
Komati - Olifants	Incomati	Limpopo	111	Industrial (Eskom)
Usuthu - Olifants	Maputo	Limpopo	81	Industrial (Eskom)
Assegaai - Vaal	Maputo	Orange	81	Industrial, domestic
Buffalo - Vaal	Non-international basin	Orange	50	Industrial, domestic
Thukela - Vaal	Non- international basin	Orange	630	Industrial, domestic
Orange - Buffels	Orange	Non- international basin	10	Industrial, domestic
Orange - Lower Vaal	Orange	Orange	52	Irrigation, domestic
Orange - Riet	Orange	Orange	189	Irrigation
Orange - Fish	Orange	Non- international basin	643	Irrigation, domestic, industrial
Fish - Sundays	Orange via Fish	Non- international basin	200	Irrigation, domestic
Caledon - Modder	Orange	Orange	40	Industrial, domestic
LHWP (1A)	Orange	Orange	574	Industrial, domestic
LHWP (1B)	Orange	Orange	297 (by year 2003)	Industrial, domestic

Source: Turton, 2003:187

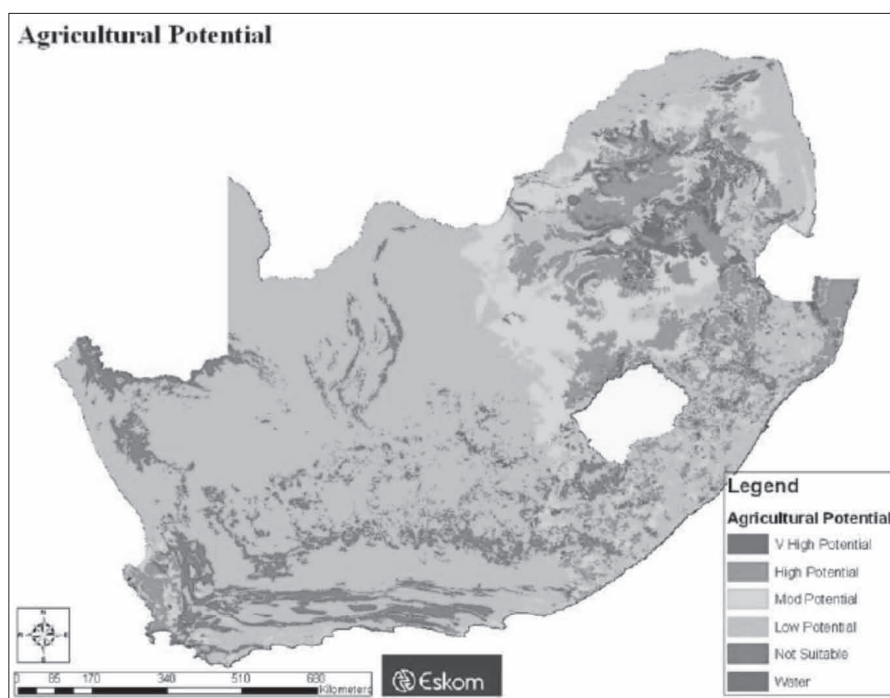
Unintended consequences

Having noted the close connection between water and energy, at least in South Africa, but used that as a proxy indicator to provide an understanding of the problem in the rest of the SADC region, it becomes instructive to dwell for a moment on some of the unintended consequences of the current energy and water policies.

- ◆ The first major negative impact has been the loss of aquatic ecosystem integrity, most notably arising from the construction of dams and the resultant loss of the natural flood pulse (Davies et al., 1993; Davies & Day, 1998; Junk et al., 1989; Puckridge et al., 1993; Snaddon et al., 1999);
- ◆ A potentially far more serious impact is the dependence that arises from such infrastructure. In South Africa's nine provinces supported by IBTs, eight are reliant on IBT for more than 50 per cent of their gross geographic product (GGP). Gauteng Province supports around 25 per cent of the total population of South Africa, generates around 10 per cent of the economic output of the entire African continent, and is 100 per cent reliant on the IBT of water (Basson et al., 1997). If that transfer were to stop for whatever reason, then that economic output would no longer be sustainable; therefore, while the hydraulic infrastructure underpins economic growth, it also creates vulnerabilities that need to be fully understood before such schemes are embarked on;
- ◆ An emerging consequence is what is known as acid mine drainage (AMD). This occurs after coal- and gold-mining operations cease and the pyrite in the rock is exposed to water, bacteria and oxygen, resulting in the production of sulphates. This has a devastating impact on all receiving bodies of water, specifically where the sulphate sterilises the water, and the heavy metals and radionuclides contaminate the sediment, rendering it potentially unfit for human use thereafter (Coetzee, 1995; Coetzee et al., 2002a, 2002b, 2005, 2006; CSIR, 2008; Hobbs & Cobbing, 2007; Hobbs et al., 2008; Oelofse, 2008a, 2008b; Paton, 1998; Wade et al., 2002);
- ◆ An as yet unquantified consequence is that arising from the liberation of aluminium in certain soil types when the pH of rain falls over time. This is associated with acid rain, which is driven by coal combustion when sulphur dioxide combines with atmospheric moisture and falls to the ground. Research has shown that in certain soil types this releases aluminium, which enters the maize plant *via* the roots and prevents the pollen tube at the end of the cob from forming properly (Ashton, personal communication, 2008; Bennet et al., 1987; Bennet & Breen, 1991a, 1991b; Giaveno et al., 2002; Kochian & Shaff, 1991; Ma et al., 2000; Rout et al., 2001). Without a properly functioning pollen tube pollination cannot occur, and as a result the crop yield is greatly reduced. The exact geographic extent of this phenomenon is unknown, but it suggests that an element of the regional energy debate should be focused on regional food security as well, because ultimately it will be a trade-off between coal combustion and food security if this information is correct.

The latter – agricultural production and consequently national food security – is an emerging issue that has, to date, received little attention in the energy debate. Figure 6 shows the somewhat limited extent of high-potential agricultural land in South Africa. If this map is compared with the data presented in Figure 1, then it becomes evident that areas of coal production coincide with areas of high-potential agricultural yield, so in essence the trade-off between energy and national food security is likely to be driven by the gradual collapse of South Africa's agricultural capacity. In this regard it is illuminating to note that the *Financial Mail* reported in 2008 that the Olifants River basin, draining an area of high energy production, has become so polluted that exports to the EU, valued at R28 billion per annum, are now at risk (Paton, 2008). This is a taste of things to come, as our appetite for energy drives coal mining in the most productive agricultural land in South Africa.

Figure 6: Agricultural land in South Africa is mostly of low potential, but the high-potential land coincides with coal deposits (see Figure 1), linking coal combustion to future food security issues across the SADC region



So where does this leave us in the context of this paper? Clearly the issue is highly complex, involving more than just a simple trade-off between water and energy. A relatively new methodology emerging from the water sector is called the Trans-boundary Water Opportunity (TWO) analysis, which sets out to determine areas in which optima can be generated in the water and energy sectors, largely by redefining the context in which those optima are reached (Phillips et al., 2008). The general principle is that optima are scale specific, so a rational optimum at a localised level might not be a rational optimum at a regional level of scale. An input into this process is what is known as the Inter-SEDE (International Security, Economic Development and Environment) methodology (Phillips et al., 2006).

Given that space precludes a more detailed explanation in this paper, Table 3 summarises the economics-related indicators for SADC member states, as generated for a recent United Nations Economic Commission for Africa (UNECA) report by the principal author and a team of specialists at the Council for Scientific and Industrial Research (CSIR), using the Inter-SEDE methodology (Turton et al., 2008).

Table 3: Economics-related indicators data for the 14 SADC countries

Country	Poverty-related indicators				Development potential				
	GDP per capita (PPP, US\$) 2007 est.	% Pop below pov line (US\$2/day)	Life exp (M/F years) 2008 est.	Infant mortality rate deaths / 1000 live births 2008 est.	Literacy rate (M/F %) 2001 est.	Energy use per capita (KWh/per capita/year)	Agric as % of GDP 2007 est.	Indust as % of GDP 2007 est.	Water avail/ use (m3 per capita / year) Total actual per capita
Angola	7,800	70 (2003)	36.99/38.9	182.31	82.9/ 54.2	175.6	9.5	65.8	23311
Botswana	14,300	30 (2003)	51.28/49.02	44.01	80.4/ 81.8	1412.3	1.6	51.5	1610
DRC	300	50	52.22/55.8	83.11	80.9/ 54.1	79.3	55	11	25183
Lesotho	1,400	49 (1999)	40.97/39.34	78.59	74.5/ 94.5	159.1	15.2	45	2910
Madagascar	900	50 (2004)	60.58/64.51	55.59	75.5/ 62.5	48.6	26.8	15.8	46139
Malawi	800	53 (2004)	43.74/43.15	90.55	76.1/ 49.8	93.2	37.8	18.1	3613
Mauritius	11,300	8 (2006)	70.28/77.4	12.56	88.4/ 88.4 (2000)	1623.0	4.8	25	3229
Mozambique	800	70 (2001)	41.62/40.44	107.84	63.5/ 32.7 (2003)	450.5	23	30.1	5145
Namibia	5,200	56 (2005)	50.39/49.38	45.64	86.8/ 83.5	1370.8	10.6	35.4	3032
South Africa	9,700	50 (2000)	49.63/48.15	45.11	87/ 85.7	4948.5	3.2	31.3	989
Swaziland	4,700	69 (2006)	31.69/32.3	69.59	82.6/ 80.8	1063.1	11.8	45.7	2429
Tanzania	1,300	36	50.06/52.88	70.46	77.5/ 62.2 (2002)	29.8	42.5	18.9	2591
Zambia	1,400	86 (1993)	38.49/38.7	100.96	86.8/ 74.8 (2003)	741.7	17.4	26.1	22751
Zimbabwe	200	68 (2004)	45.08/43.46	33.86	94.2/ 87.2 (2003)	1081.0	18.1	22.6	1088

Source: Columns 1–5, 7–8: *CIA World Factbook*

From this analysis it is evident that two of the most water-constrained countries (South Africa and Botswana) are also amongst the biggest energy users in the SADC region. Space prevents a more detailed analysis here. The TWO Analytical Framework consists of a matrix with four key factors of development opportunities and two key categories of sources of water to realise those opportunities. In addition, the framework allows for context-specific analysis, which affords the possibility to add other factors and categories for creative analysis, and to realise change. It would be useful to commission a regional study using the TWO methodology in order to gain a more nuanced assessment of the water/energy nexus. It would also be very useful to commission a regional study that seeks to map out and quantify the linkages between coal combustion and regional food security, in order to inform a future decision about trade-offs between these two critical elements.

Potential market drivers of a new energy policy

The regional energy policy, which is based largely on coal combustion, is likely to become unsustainable in the near future, manifesting as a number of specific drivers that will probably trigger the need for a new regional energy policy. Briefly, these drivers are the following:

- ◆ The price of electricity is set to increase dramatically. This will send market signals that a change in policy is needed;
- ◆ Given that a major element of electricity use in the region involves the pumping of water, specifically in areas of great economic diversification (such as those found in South Africa), the initial market signals are likely to emerge from that location simply because the cost of water will escalate – partly due to its increasing scarcity, but also partly due to the rising cost of energy needed to sustain IBTs on the scale currently seen in that country. Attention is drawn to the fact that the SADC region is unique in the sense that major cities (and thus areas of concentrated economic activity) are not located on rivers, lakes or the seashore, but rather on watershed divides. This means that water has to be pumped uphill in increasing volumes, as the population and economic demand grow;
- ◆ This scenario is likely to see the emergence of what can be called a ‘dual stream reticulation system’ in which water of different quality is piped to different consumers at different costs. Essentially, a high-quality high-cost water stream will be sent to domestic consumers, but over time a lower-cost lower-quality industrial water stream will be brought online. The latter will consist of treated effluent, such as that coming out of sewage treatment plants or AMD from closed mines, which will be treated to a safe but not potable standard, for onward reticulation as industrial process water. This will alleviate pressure on potable water sources and will enable the transition from an extractive (mining-based) economy to a new value-added beneficiation-based economy that is likely to emerge in the post-mine closure phase.

Geothermal energy in the context of SADC

Assuming the above logic is valid, then a new energy policy will be negotiated within the context of SADC, but it will be driven by individual member states. It is probable that the most water-constrained countries will drive this debate once their respective governments start to understand the water/energy nexus. This will open space in which alternative energies can be considered. In order to inform that process, the authors wish to introduce the concept of geothermal energy into the debate.

There are two types of geothermal energy: the first form, active geothermal energy, uses the heat from rocks to produce electricity. This is related to tectonic activities

and in the context of the SADC region, is likely to be associated with the Great Rift Valley that extends from Kenya into Mozambique and Botswana, terminating in the Okavango River Delta (Ellery & McCarthy, 1994; McCarthy & Ellery, 1993; McCarthy et al., 2000; Turton et al., 2003). There are other localised sources of hot rock, but mostly of a low energy yield. The second is a more exciting form of energy, namely passive geothermal, which uses the earth as a sink rather than a source. When electricity is used to heat and cool space, the conventional approach is to use air conditioners that remove the heat from inside a space and vent that heat outside into the air. With passive geothermal technology that process is streamlined, and the heat removed from inside space is stored in the rocks beneath the building, available for use when space heating is called for. This technology, which has been proven overseas, is said to improve the efficiency of current electricity use for heating and cooling by 50 per cent. This needs to be verified, and TouchStone Resources (Pty) Ltd is in the process of doing this. Assuming this percentage to be reasonably accurate, then two market drivers are likely to emerge:

- ◆ The recent 31 per cent escalation in electricity cost, which has just been approved by the National Energy Regulator of South Africa (NERSA), is likely to set the trend for future energy costs. This will begin to make passive geothermal technology feasible in the SADC region;
- ◆ The price of commodities – specifically foodstuffs and water – is likely to increase as resources become scarcer. This scenario is specifically linked to coal mining and combustion, which has a direct correlation with the high-potential areas of agricultural land in South Africa. This is likely to mobilise public opinion, which will drive the energy policy debate in a way that becomes linked to the food security debate.

In the field of passive geothermal energy, the trend is likely to be led by the demonstration of the technology within the next year. The cost of that installation will probably be high, given the fact that supply lines of hardware are currently non-existent, and technical staff are as yet unqualified. However, TouchStone Resources (Pty) Ltd is investing heavily in this area, with a view to building regional capacity which is designed to drive the cost down dramatically. Once the technology has been demonstrated there is likely to be a spate of new installations, specifically in places like shopping malls which cool large volumes of space. The business models of these construction sites are of such a nature that initial costs are amortised over a lifetime, which will help to make the technology more affordable through long-term energy cost savings. Once the technology has been established and the cost of installation driven down to more reasonable levels, then retrofitting is likely to take place as old air-conditioning hardware is replaced by passive geothermal units.

Global climate change as a driver

Global climate change is likely to manifest most acutely in the availability of water. Figure 7 is a representation of the SRES A2 scenario, which suggests that the SADC region is likely to become warmer and drier over time (Scholes & Biggs, 2004). Figure 8 translates this data into changes in the availability of water. It must be noted that localised water scarcities are likely to be exacerbated in areas adjacent to the coal-producing areas of South Africa, once again introducing the link between energy, water and economic development.

Figure 7: The SADC region is set to become warmer and drier by 2050, if the SRES A2 scenario, developed during the HADCM3 Climate Model Projections, is to be believed (Scholes & Biggs, 2004:4).

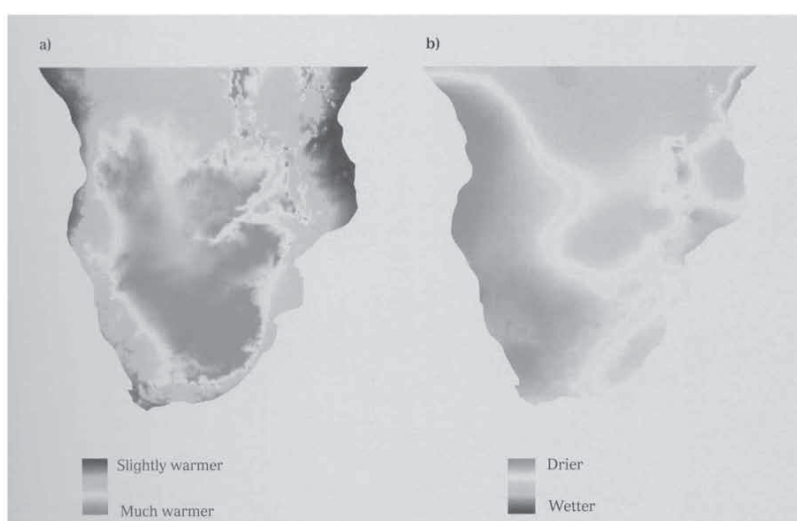
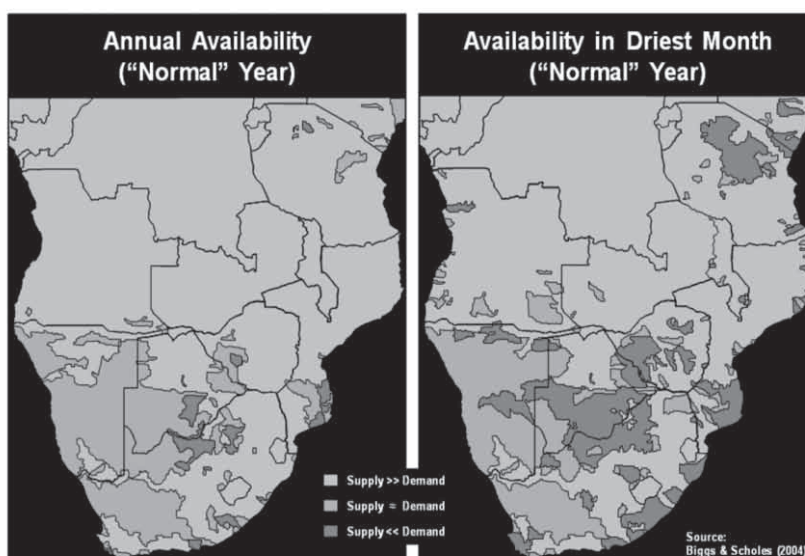


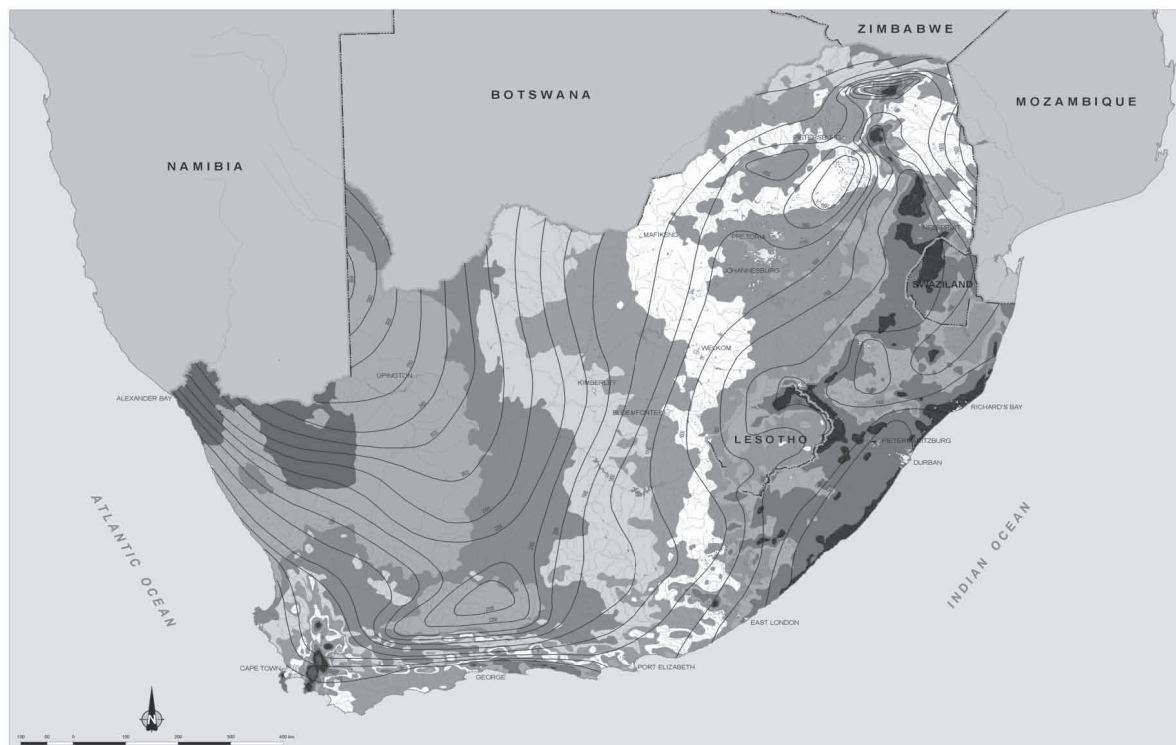
Figure 8 (below) translates this into risk associated with the availability of water during the driest months of a normal year, which will increasingly become a development constraint in areas already under stress (Peter Ashton)



If one evaluates this against the existing position with respect to precipitation and evaporative potential in South Africa, as shown in Figure 9, it becomes evident that the existing high levels of evaporative losses, shown as isopleths, are likely to be increased. One of the outcomes of this natural process will be the increased loss of water from major storage dams, which will have a number of unintended consequences:

- ◆ Increased salinity levels of rivers: when combined with the increased salt loads arising from AMD, specifically in the coal- and gold-producing areas of South Africa, this will translate into the loss of the national water resource integrity, which in turn will drive up production costs;
- ◆ The need for remediation treatment processes to reduce salinity at point source will increase the cost of production, marginalising South African products in the global market through non-competitive prices;
- ◆ Existing water resources will come under increased pressure from eutrophication, as toxic cyanobacteria proliferate along the lines of what is already being seen in South Africa (Harding & Paxton, 2001; Oberholster, 2008; Oberholster et al., 2004, 2005, 2008; Oberholster & Ashton 2008; Oberholster & Botha, 2007).

Figure 9: The distribution of rainfall in South Africa, juxtaposed against evaporative demand from the atmosphere (NWRs 2004). Climate change is likely to increase the already high evaporative losses and might even hasten the production of toxic microcystin in eutrophic impoundments



Recommendations

In order to stimulate much-needed regional energy policy reform, the following recommendations can be considered by foreign donors:

- ◆ Commission a regional study using the TWO methodology with a view to determining what interventions might be appropriate in terms of optimising water and energy use and allocation across the SADC region (i.e. assess new water and new energy potential);
- ◆ Commission a regional study using a geographic information system (GIS) and other techniques to map out the areas of coal production, coal combustion, the movement of airborne pollution plumes and their subsequent deposition as acid rain, and maize production areas, with a view to determining if there is any link between coal dependence and national or regional food security;
- ◆ Commission a regional study using GIS and other techniques to map out areas of mining, with a view to determining the geographic extent of AMD, specifically as it might impact on the loss of agricultural capacity and future economic development, if left unmanaged. A regional salts model would be most useful as a policy tool;
- ◆ Commission a regional study using GIS and other techniques to map out areas of active geothermal energy potential, with a view to determining the viability of this resource as a future component of a regional energy mix;
- ◆ Commission a regional study using GIS and other techniques to map out areas of eutrophication arising from river impoundment, with a view to determining what risk microcystin-producing cyanobacteria pose for human health and agricultural production. This has a distinct climate change component to it, because tentative evidence from South Africa suggests that there is a change in cyanobacterial population dynamics, which might show a correlation with small changes in ambient temperature.

Figures 10 and 11: Photographs of salinisation along watercourses draining the Witbank area of South Africa (courtesy of Dr. Jan Myburgh of Pretoria University). The entire Olifants WMA is highly stressed as a result of this process



Conclusion

The fact that the most economically diversified country in the SADC region is now confronted with severe water and energy constraints, is likely to trigger the emergence of a new debate in which three major policy streams start to converge – water, energy and food security. That will probably create a window of opportunity in which reform is possible. The authors are of the opinion that geothermal energy, until now not thought to be important enough to consider as a viable option, will start to enter the energy mix of the SADC region. Market drivers are likely to come from the energy sector, but increasingly also from the high cost of water and food staples as agricultural land is lost to the unintended consequences of our regional dependence on coal – salinisation arising from AMD downstream of coal-producing areas – which is already occurring in the rivers downstream of Witbank, as shown in the photographs above. A similar process is likely to occur as a result of acid deposition *via* rain onto soils that produce maize, necessitating higher input costs in the form of limestone (calcium carbonate) to counter the release of aluminium as a trace element.

Bibliography

- ASHTON, P. 2008. Discussion between the 50:50 camera crew and the author at the CSIR, Pretoria, South Africa.
- BASSON, M.S., VAN NIEKERK, P.H., & VAN ROOYEN, J.A. 1997. *Overview of water resources availability and utilization in South Africa*. Pretoria: Department of Water Affairs and Forestry.
- BENNET, R.J., BREEN, C.M., & FEY, M.V. 1987. The effects of aluminium on root cap function and root development in *Zea Mays* L. *Journal of Environmental Experimental Botany*, 27.
- BENNET, R.J., & BREEN, C.M. 1991(a). The Aluminium Signal: New dimensions to mechanisms of aluminium tolerance. *Plant Soil*, 134:153–166.
- BENNET, R.J., & BREEN, C.M. 1991(b). The recovery of the roots of *Zea Mays* L. from various aluminium treatments: Toward elucidating the regulatory processes that underlie root growth control. *Journal of Environmental Experimental Botany*, 31.
- COETZEE, H. 1995. Radioactivity and the leakage of radioactive waste associated with Witwatersrand gold and uranium mining. (In: Merkel, B.J., Hurst S., Löhnert E.P., & Struckmeier W., (eds). *Proceedings Uranium Mining and Hydrogeology 1995*, Freiberg, Germany: *Geo-Congress 1*. – 583 S.; Köln (von Loga; ISBN 3-87361-256-9)).
- COETZEE, H., VENTER, J. & NTSUME, G. 2005. *Contamination of wetlands by Witwatersrand gold mines – processes and the economic potential of gold in wetlands*. Council for Geosciences Report No. 2005-0106. Pretoria: Council for Geosciences.
- COETZEE, H., WADE, P., NTSUME, G., & JORDAAN, W. 2002(a). *Radioactivity study on sediments in a dam in the Wonderfonteinspruit Catchment*. DWAF Report. Pretoria: Department of Water Affairs and Forestry.

- COETZEE, H., WADE, P., & WINDE, F. 2002(b). Reliance on existing wetlands for pollution control around the Witwatersrand gold/uranium mines in South Africa – are they sufficient? (In: Merkel, B.J., Planer-Friederich, B., & Wolkersdorfer, C., (eds). *Uranium in the Aquatic environment*. Berlin: Springer. p. 59–65.)
- COETZEE, H., WINDE, F., & WADE, P.W. 2006. *An assessment of sources, pathways, mechanisms and risks of current and potential future pollution of water and sediments in gold-mining areas of the Wonderfonteinspruit Catchment*. WRC Report No. 1214/1/06. Pretoria: Water Research Commission.
- CSIR. 2008. *High confidence study of children potentially affected by radionuclide and heavy metal contamination arising from the legacy of mine water management practices on the far West Rand of South Africa*. Project Concept Note, dated 26/2/2008. Pretoria: Council for Scientific and Industrial Research (CSIR).
- DAVIES, B.R., & DAY, J. 1998. *Vanishing waters*. Cape Town: University of Cape Town Press.
- DAVIES, B.R., O'KEEFE, J.H., & SNADDON, C.D. 1993. *A synthesis of the ecological functioning, conservation and management of South African river ecosystems*. Water Research Commission Report No. TT 62/93. Pretoria: Water Research Commission.
- ELLERY, W.N., & MCCARTHY, T.S. 1994. Principles for the sustainable utilization of the Okavango Delta ecosystem, Botswana. *Biological Conservation*, 70(2):159–168.
- GIAVENO, C.D., BRANCO, J., & DE MIRANDA FILHO, J.B. 2002. Field comparison between selection methods at the maize seedling stage in relation to aluminium tolerance. *Scientia Agricola*, 59(2):397–401.
- GLEICK, P.H. (ed). 1993. *Water in crisis: A guide to the world's water resources*. New York: Oxford University Press.
- HARDING, W.R., & PAXTON, B.R. 2001. *Cyanobacteria in South Africa: A review*. Water Research Commission Report No. TT 153/01. Pretoria: Water Research Commission.
- HOBBS, P.J., & COBBING, J.E. 2007. A hydrogeological assessment of acid mine drainage impacts in the West Rand Basin, Gauteng Province. Report No. CSIR/NRE/WR/ER/2007/0097/C. CSIR/THRIP. Pretoria: Council for Scientific and Industrial Research (CSIR).
- HOBBS, P., OELOFSE, S.H.H., & RASCHER, J. 2008. Management of environmental impacts from coal mining in the upper Olifants River Catchment as a function of age and scale. (In: Patrick, M.J., Rascher, J., & Turton, A.R. (eds). *Reflections on water in South Africa*, special edition of *International Journal of Water Resource Development*, 24(3):417–432.
- JUNK, W.J., BAYLEY, P.B., & SPARKS, R.E. 1989. The flood pulse concept in river-floodplain systems. (In: Dodge, D.P., (ed). *Proceedings of the International Large Rivers Symposium (LARS)*, *Canadian Special Publication of Fisheries and Aquatic Sciences*, 106:110–127.)
- KOCHIAN, L.V., & SHAFF, J.E. 1991. Investigating the relationship between aluminium toxicity, root growth, and root-generated ion currents. (In: Wright, R.J., Baligar, V.C. & Murrmann, R.P., (eds). *Plant-soil interactions at low pH*. Dordrecht, The Netherlands: Kluwer Academic Publishers. p. 769–778.)
- MA, L.G., FAN, Q.S., YU, Z.Q., ZHOU, H.L., ZHANG, F.S., & SUN, D.Y. 2000. Does aluminium inhibit pollen germination via extracellular Calmodulin? *Plant and Cell Physiology*, 41(3):372–376.
- MCCARTHY, T.S., COOPER, G.R.J., TYSON, P.D., & ELLERY, W.N. 2000. Seasonal flooding in the Okavango Delta, Botswana – recent history and future prospects. *South African Journal of Science*, 96:25–33.

- MCCARTHY, T.S., & ELLERY, W.N. 1993. The Okavango Delta. *Geobulletin* 36(2):5–8.
- NWRS. 2004. *National Water Resource Strategy*. Pretoria: Department of Water Affairs and Forestry (DWAF). [Online]. Available: <http://www.dwaf.gov.za/Documents/Policies/NWRS/Default.htm>
- OBERHOLSTER, P. 2008. *Parliamentary Briefing Paper on Cyanobacteria in Water Resources of South Africa*. Annexure “A” of CSIR Report No. CSIR/NRE/WR/IR/2008/0079/C. Pretoria: Council for Scientific and Industrial Research (CSIR).
- OBERHOLSTER, P.J., & ASHTON, P.J. 2008. *State of the Nation Report: An overview of the current status of water quality and eutrophication in South African rivers and reservoirs*. Parliamentary grant deliverable. Pretoria: Council for Scientific and Industrial Research (CSIR).
- OBERHOLSTER, P.J., & BOTHA, A-M. 2007. Use of PCR-based technologies for risk assessment of a winter cyanobacterial bloom in Lake Midmar, South Africa. *African Journal of Biotechnology*, 6:14–21.
- OBERHOLSTER, P.J., BOTHA, A-M., & CLOETE, T.E. 2005. An overview of toxic freshwater cyanobacteria in South Africa with special reference to risk, impact and detection by molecular marker tools. *Biokem*, 17:57–71.
- OBERHOLSTER, P.J., BOTHA, A-M., & GROBBELAAR, J.U. 2004 *Microcystis aeruginosa*: Source of toxic microcystins in drinking water. *Africa Journal of Biotechnology* 3:159–168.
- OBERHOLSTER, P.J., CLOETE, T.E., VAN GINKEL, C., BOTHA, A-M., & ASHTON, P.J. 2008. *The use of remote sensing and molecular markers as early warning indicators of the development of cyanobacterial hyperscum crust and microcystin-producing genotypes in the hypertrophic Lake Hartbeespoort, South Africa*. Pretoria: Council for Scientific and Industrial Research (CSIR).
- OELOFSE, S.H.H. 2008(a). Protecting a vulnerable groundwater resource from the impacts of waste disposal: A South African waste governance perspective. (In: Patrick, M.J., Rascher, J., & Turton, A.R., (eds). *Reflections on water in South Africa*, special edition of *International Journal of Water Resource Development*, 24(3):477–490.)
- OELOFSE, S.H.H. 2008(b). Mine water pollution – acid mine decant, effluent and treatment: Consideration of key emerging issues that may impact the state of the environment. Pretoria: Department of Environmental Affairs and Tourism (DEAT). [Online]. Available: <http://soer.deat.gov.za/docport.aspx?m=97&d=28>
- O’KEEFFE, J., UYS, M., & BRUTON, M.N. 1992. Freshwater systems. (In: Fuggle, R.F., & Rabie, M.A., (eds). *Environmental management in South Africa*. Johannesburg: Juta & Co. p. 277–315.)
- PALLET, J., HEYNS, P.S.V., FALKENMARK, M., LUNDQVIST, J., SEELEY, M., HYDÉN, L., BETHUNE, S., DRANGERT, J., & KEMPER, K. 1997. *Sharing water in southern Africa*. Windhoek: Desert Research Foundation of Namibia (DRFN).
- PATON, C. 2008. Dam dirty. *Financial Mail* (November). p. 32–39.
- PHILLIPS, D.J.H., ALLAN, J.A., CLAASSEN, M., GRANIT, J., JÄGERSKOG, A., KISTIN, E., PATRICK, M., & TURTON, A.R. 2008. *The TWO analysis: Introducing a methodology for the Transboundary Waters Opportunity analysis*. Report No. 23. Stockholm: Stockholm International Water Institute (SIWI). [Online] Available at: http://www.siwi.org/documents/Resources/Reports/Report23_TWO_Analysis.pdf

- PHILLIPS, D.J.H., DAOUDY, M., MC CAFFREY, S., ÖJENDAL, J., & TURTON, A.R. 2006. *Trans-boundary water cooperation as a tool for conflict prevention and broader benefit-sharing*. Stockholm: Ministry for Foreign Affairs Expert Group on Development Issues (EGDI).
- PUCKRIDGE, J.T., SHELDON, F., BOULTON, A.J., & WALKER, K.F. 1993. The flood pulse concept applied to rivers with variable flow regimes. (*In: Davies et al., A synthesis of the ecological functioning, conservation and management of South African river ecosystems*. Water Research Commission Report No. TT 62/93. Pretoria: Water Research Commission.
- ROUT, G.R., SAMANTARAY, S., & DAS, P. 2001. Aluminium toxicity in plants: A review. *Agronomie*, 21:3–21.
- SCHOLES, R.J., & BIGGS, R. 2004. *Ecosystem services in southern Africa: A regional assessment*. Pretoria: CSIR.
- SNADDON, C.D., DAVIES, B.R., & WISHART, M.J. 1999. *A global overview of inter-basin water transfer schemes, with an appraisal of their ecological, socio-economic and socio-political implications, and recommendations for their management*. Water Research Commission Report No. TT120/00. Pretoria: Water Research Commission.
- TURTON, A.R. 2003. The political aspects of institutional development in the water sector: South Africa and its international river basins. Unpublished draft of a D.Phil. thesis. Department of Political Science. Pretoria: University of Pretoria.
- TURTON, A.R. 2009. *New thinking on the governance of water and river basins in Africa – lessons from the SADC region*. Johannesburg: South African Institute of International Affairs.
- TURTON, A.R., ASHTON, P.J., & CLOETE, T.E. 2003. An introduction to the hydropolitical drivers of the Okavango River Basin. (*In: Turton, A.R., Ashton, P.J., & Cloete, T.E., (eds). Transboundary rivers, sovereignty and development: Hydropolitical drivers in the Okavango River Basin*. Pretoria & Geneva: AWIRU & Green Cross International. p. 9–30.)
- TURTON, A.R., ASHTON, P.J., & JACOBS, I. 2008. *The management of shared water resources in southern Africa*. CSIR Report No. CSIR/NRE/WR/ER/2008/0400/C. IMIS Contract No. 2009UNA073263853111. Lusaka: United Nations Economic Commission for Africa – Southern Africa (UNECA-SA).
- UNEP. 2002(b). *Atlas of international freshwater agreements*. Nairobi: United Nations Environment Program; and Corvallis: Oregon State University.
- WADE, P.W., WOODBOURNE, S., MORRIS, W.M., VOS, P., & JARVIS, N.W. 2002. *Tier 1 risk assessment of selected radionuclides in sediments of the Mooi River Catchment*. WRC Project No. K5/1095. Pretoria: Water Research Commission.
- WOLF, A.T., (ed). 2006. *Hydropolitical vulnerability and resilience along international waters: Africa*. Nairobi: United Nations Environment Program (UNEP).

Part 5: The market as a driver or constraint in the move towards renewable energy in southern Africa

*Rod Crompton*¹

Introduction

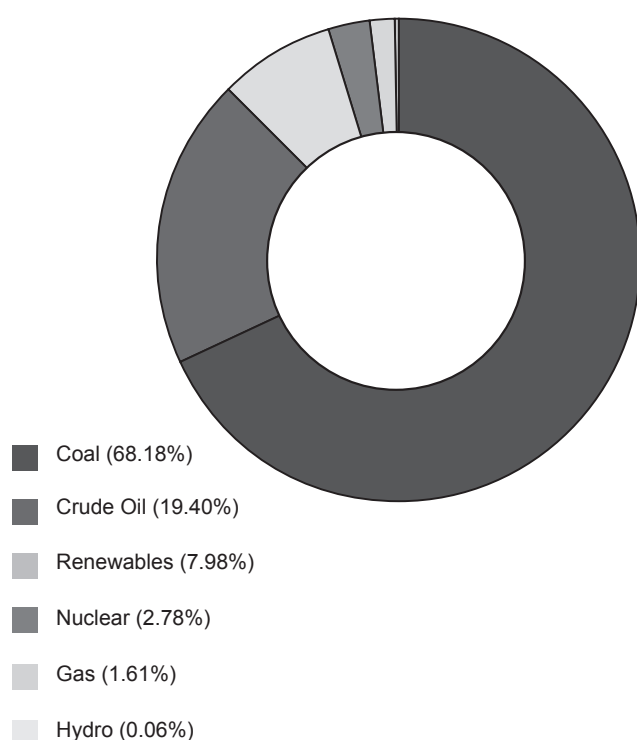
Southern Africa has a significant, largely untapped, renewable energy (RE) potential, including solar, wind, hydro, biomass and geothermal. The southern African economies are all market based, to a greater or lesser extent, and thus RE producers must, unavoidably, operate their enterprises within the paradigms of the markets in which they choose to do business. This paper explores the limiting role that markets play, as well as their enabling and even propelling role. It begins by providing an overview of RE market penetration and offers some high-level explanations for that phenomenon, before taking a more detailed look at the renewable electricity and biofuels markets.

Overview

A convenient point to begin this discussion is to try to determine the role that RE currently plays in the provision of primary energy. In South Africa it accounts for approximately 7.98 per cent of primary energy supply (see Figure 1). Nearly half of that is accounted for by domestic energy – in short, wood fuel or the like. Within the SADC region the picture is similar, except that the proportion of primary energy accounted for by biomass for domestic energy, is higher. There are exceptions, like Lesotho, where this is a limited option.

¹ These are my personal opinions.

Figure 1: Primary energy supply – South Africa (2004)



Source: *Digest of South African energy statistics 2006* (Department of Minerals and Energy)

It follows that the contribution RE makes to the commercial primary energy market is very limited – approximately 4 per cent. For the purposes of this discussion, I believe we can ignore the 0.06 per cent attributable to hydro, as this is largely accounted for by large dams that were built without climate change imperatives being part of the decisions.

The latest available data (see Figure 1) are somewhat dated. However, the number and size of the RE producers that have been added to the stock since 2004 is so limited, they may be counted on the fingers of one hand. Despite much fanfare and media coverage about RE, very little has materialised in the form of viable operations: there are only the tiny Darling wind farm (5MW); the Bethlehem Hydro (7MW), another small hydroelectric project and a Durban landfill gas project.² The size of the solar water heating market in South Africa has been approximately 7 000 to 10 000 units p.a. over this time period, which is also not a substantial contribution. In the biofuels market a few small waste cooking oil recovery projects, that re-refine the oil for use as vehicle fuel, have emerged.

Eskom supplies approximately 95 per cent of South Africa's electricity and only 1 per cent of its generation base is renewable (*Eskom Holdings Annual Report, 2007*).

2 Some may argue that landfill gas is not, strictly speaking, renewable energy.

Within the SADC region the picture is similar, although the data are less easy to come by. There are a few large hydro-electric schemes which, as in South Africa, were built without taking climate change into account. They too made commercial sense. Based on this overview of past performance we have established that commercial RE constitutes a small percentage of primary energy. The fact that RE is so poorly represented in southern Africa's primary energy mix could lead us to the conclusion that market forces have acted as a constraint to the introduction of RE. If the market were not a constraint, then surely we would have seen a higher prevalence of RE? Put another way: is the market the constraint, or is RE itself the constraint, because for the most part it is commercially uncompetitive?

Many types of RE suffer from the handicaps of lower energy density and yield only intermittent supply. For example, Eskom believes the capacity factor for wind farms in South Africa ranges between 16 and 28 per cent. Most RE sources have similar characteristics, for example, day/night, seasons, floods/droughts, and so on. Therefore, to ensure security of supply, an investment in a similar backup capacity is necessary to maintain energy supply when nature does not allow the RE technology to do so.³ And since renewable energies are more costly than conventional energy, it is possible to conclude that electricity production from RE costs more than twice what one would pay for conventionally produced electricity in South Africa. Indeed, the Renewable Energy Feed-in Tariffs (REFITs) approved by the National Energy Regulator of South Africa (NERSA) suggest that it is between 3 and 7 times higher (see Table 1). Liquid biofuels cost up to three times what one would pay for petroleum fuels (IEA 2005).

Table 1: Comparison of REFIT and Eskom tariffs

Technology	Unit	Tariff (R)
Wind	R/kWh	1.25
Small hydro	R/kWh	0.94
Landfill gas	R/kWh	0.90
Concentrated solar	R/kWh	2.10
Eskom conventional	R/kWh	0.33

There are more powerful market forces at work to limit the role RE can play in the South African market, than the simple scenario outlined above may suggest. These have to do with the structure of this developing economy. The South African economy is characterised by a minerals and energy complex (see Fine & Rustonjee). Mining and minerals beneficiation are large and intensive energy users with a low tolerance for high energy prices. For example, some estimate that an increase in the current cost of electricity from 33c/KWh to 100c/KWh will force the chrome industry to close down.

The South African economy is also characterised by a large percentage of unemployed and low-income citizens, who can ill afford high energy prices. In addition, the spatial

³ As in most such matters there is a counter view. Amory Lovins is an exponent of the view that a suitable range of renewable technologies, with appropriate grid management, can off-set the irregular nature of renewable generators. That may be true in a large economy, once there are a sufficient number of renewable producers, but it does not seem to hold in South Africa in these early years of introducing RE.

development of South Africa means that transport costs comprise a significant portion of industrial and household costs. The industrial heartland, for instance, is 600km from the port of Durban; the transport costs of shipping exports to Durban impair South Africa's competitiveness in international markets. For all these reasons, the tolerance for high liquid fuels prices – as is likely to be the case if a significant portion of the demand were to be met by biofuels – is also limited.

If the wide-scale introduction of RE is to have a significant cost-raising effect on conventional energy prices, it will lead to a fairly fundamental restructuring of the economy and will impact significantly on lower-income households' budgets. This is likely to meet strong resistance from industry as well as households. These imperatives have acted as a considerable brake on Government's ability to incentivise RE, and are likely to do so for the foreseeable future.

This is a convenient point at which to shift the focus from a higher-level overview downwards, towards a closer inspection of RE markets. In doing so we will look through two lenses, namely supply and demand (which are usually reconciled through the price mechanism) and the legal paradigm within which the market operates. The RE markets for electricity and vehicle propulsion fuels are both regulated, albeit in different ways, but apart from this they differ greatly and have very different cost drivers. Consequently, it is more convenient to consider them separately. Let us begin with the electricity market.

Electricity

Although the price of electricity has been regulated in one form or another for many years it has, to a certain extent, reflected the balance of supply and demand. The surplus of supply over demand in the decade up to 2005 was a product of earlier over-investment in generating capacity. This, together with the low cost of coal, resulted in low electricity costs. Although costs have begun to rise in recent years, electricity prices in South Africa are still among the lowest in the world. This has not only been a formidable barrier to entry for renewable electricity, but also one of the main constraints. A further barrier has been Eskom's virtual monopoly of the market.

The democratic government, conscious of these barriers, has consequently made a succession of increasingly robust interventions to alter the shape of the RE market in an enabling manner. The first was through the *White Paper on Energy Policy* (1998), which cautiously stated that Government would support RE technologies. Shortly after the 2002 World Summit on Sustainable Development, Government published the *White Paper on Renewable Energy* which set down a key milestone in the form of a target for RE – albeit a modest one: the target is 10 000 GWh (Gigawatt hour) by 2013.⁴

4 To put the target into perspective, this would be equivalent to electrifying approximately two million households with an annual electricity consumption of 5 000 KWh. Put another way, the 10 000 GWh target is equivalent to about 5 per cent of present electricity generation in South Africa. This is equivalent to replacing two (2 x 660 MW) units of Eskom's combined coal-fired power stations. <http://www.dme.gov.za/energy/renewable.stm#2> (accessed 16 August 2009).

Next, the Designated National Authority (DNA) was established to facilitate trade in carbon credits.⁵ The price of carbon credits is an important contributor to the revenue streams that RE producers can expect (Department of Environmental Affairs and Tourism, 2008:16).

Certified Emission Reductions (CERs) form part of the Clean Development Mechanism (CDM) process established in accordance with the Kyoto Protocol. What role the CDM will play after 2012 is still to be decided through international negotiation.

Government established the Renewable Energy Finance and Subsidy Office (REF-SO), which offers once-off capital subsidies for RE investments – its 2009/10 budget is R10.6 million. Since its establishment three years ago, it has dispensed R14 million to six projects respectively, all of which are designed to produce electricity.

Government also established the Energy Development Agency (EDA) within its Central Energy Fund group of companies, which has spent approximately R50 million in four years, searching for and investing in viable RE projects.

Research and development as regards renewable technologies has been boosted by the establishment and funding of the South African Energy Research Institute (SANERI)⁶ which has spent R17.7 million over three years.

Government clarified its *White Paper on Renewable Energy* by means of a Renewable Energy Framework, in which it stated that the RE target of 10 000 GWh is to be met by 60 per cent electric and 40 per cent non-electric sources. Independent Power Producers (IPPs) are expected to supply 60 per cent of the 6000 GWh electric target.

In March 2008, Government established the South African National Tradable Renewable Energy Certificate Team (SANTRECT) to facilitate and coordinate the establishment of a not-for-profit issuing body that will be responsible for registering, issuing, transferring and redeeming Tradable Renewable Energy Certificates (TRECs) in South Africa.⁷ The target date for its establishment was March 2009,⁸ but this is now likely to be March 2010.⁹

5 A regulation under Section 25 of the National Environmental Management Act, establishing the DNA, was Gazetted on 24 December 2004 by Martinus van Schalkwyk, Minister of Environmental Affairs and Tourism. The regulation established the DNA within the Department of Minerals and Energy, and provided the DNA with its legal mandate to oversee the Clean Development Mechanism in South Africa.

6 SANERI was recently incorporated into the South African National Energy Development Institute (SAN-EDI) by dint of the National Energy Act, 2008 (Act No. 34 of 2008).

7 A TREC is an electronic record that verifies the origin of energy by a registered RE entity. The TREC concept separates a certificate with value from the physical energy carrier. It provides an internationally tradeable potential revenue stream for RE producers.

8 http://www.dme.gov.za/energy/renew_TRECS.stm (accessed 16 August 2009).

9 Personal communication, Silas Mulaudzi, DME, 17 September 2008.

While the handful of RE power generators that has emerged may not have been able to get off the ground without these various support measures, the measures have not brought forth a spate of investment in RE power generation. The support Government has given to nuclear energy over the same period has also failed to generate investment, even though the level of support was at a vastly higher level.

This year, Government has taken its boldest steps yet in a way that many commentators expect will, at last, bring forth significant investment in RE power generation. A two cents/KWh levy has been introduced on electricity manufactured from hydrocarbons, with effect from 1 July 2009, and a REFIT for several RE technologies has been announced by NERSA.

Even if these measures prove successful, their impact is likely to be very limited. The rate gap between conventional energy and REFIT is between 3 and 7 times higher (see Table 1). Also, Eskom is a large and powerful actor in the electricity market, and judging by recent Government statements it is set to stay that way. Its forecast for RE as a share of its primary energy is about 2 per cent by 2026 (*Eskom Annual Report*, 2008:62). Eskom may be accused of trying to stay within its core competence (coal-fired power generation), but it does make rational calculations based on cost, stability of supply and similar factors to arrive at such a result.

Financial incentives may be necessary, but they are not sufficient to induce renewable electricity. As in much of the real world, the 'devil is in the details'. For renewable electricity producers to enter the market there are two further hurdles to cross: first they must enter into a Power Purchase Agreement (PPA) with Eskom, because Government has designated the utility as the 'single buyer'. This status means that Eskom is the sole purchaser of all electricity introduced onto the national grid. The evidence I have heard at public hearings suggests that this is a considerable obstacle to be overcome. Also, it appears that PPA negotiations can be difficult. Second, renewable electricity producers must comply with the Grid Code in order to introduce their power onto the grid. Understandably, this code was designed for a few large, mainly coal-fired power stations, and will need some adaptation in order to accommodate many small electricity producers with intermittent supply.

Electricity has limited tradability across international boundaries. In southern Africa this has meant that national markets are, to a large extent, held captive by the costs determined by their national electricity utility, notwithstanding the establishment of the SAPP. It has also meant that competition from imported electricity is limited, and this has further reduced any propensity towards competition. In contrast, the situation in the liquid fuels markets is almost the direct opposite (see below).

Southern African electricity markets, which are dominated by state-owned utilities, do not have a history of competition. It is not easy for conventional IPPs to enter the market, let alone renewable electricity IPPs which tend to have additional requirements, as discussed above. The institutional architecture and culture in the market

are less easily measurable market constraints. The nature, structure and corporate culture of institutions such as Eskom, the banks, and economic and environmental regulators suffer from inertia and a built-in wariness of new technologies and market rules. Turning now to the biofuels market, the overall picture is similar to that of the market for renewable electricity, in that despite considerable media hype, there has been even less investment.

Biofuels

Biofuels have had even less success than renewable electricity in penetrating the market. The International Energy Agency (IEA) has argued that because the benefits of biofuels are difficult to quantify, their market price is not an adequate reflection (IEA, 2005:11). Despite this, the IEA believes that the non-market benefits are significant. Such benefits include

- ◆ reduced oil demand and its accompanying foreign exchange saving, which are important for many countries;
- ◆ reductions in greenhouse gas (GHG) emissions;
- ◆ air quality improvements and waste reduction;
- ◆ agricultural benefits in the form of alternative markets for some crops.

In addition to being under-priced, biofuels face several other, more complex, market constraints. Internationally, the prices of liquid fuels are US dollar denominated. The volatility of the Rand/US\$ exchange rate increases the risks for biofuels investors, who typically need 10 to 15 years of price certainty to assuage their financiers. Furthermore, the international oil price is tracked by liquid fuels prices. In recent years, oil prices have increased in volatility, and this has been reflected in South African and SADC fuel prices. The international crude oil market is driven by a complex set of factors, including supply and demand, oligopolistic supply and strategic considerations. Local producers of biofuels have to compete with crude oil-based fuels. Unfortunately for biofuels producers, the cost drivers for biofuels and mineral petroleum are very different – not least is the difference between agricultural costs and crude oil prices, which can be influenced by unpredictable events such as local conflicts in crude oil-producing regions of the world.

Crude oil producers enjoy a cushion in their value chain, in the form of a natural resource rent. That rent can be maximised when oil prices are high, and then used to cushion the effects of low prices. Biomass producers can only enjoy something similar under special conditions, for instance, when crude oil prices are high, crop feedstock prices are low and the exchange rate is favourable. They have to juggle these three volatile factors that determine their returns. Feedstock costs typically represent about 70 per cent of biofuels' production costs, therefore, in short, the risks are much higher.

Although competition exists in the liquid fuels markets, new entrants such as biofuels producers face high barriers to entry in the manufacturing and distribution chains. In addition, the established participants are experienced and wily players, many of whom can rely on international parent companies and expertise for advice and support. Many oil companies are back-integrated into crude oil mining and see biofuels as a possible threat, if not a nuisance, to the value chain in which they operate.

Some biofuels feedstock crops such as sugar, maize, canola and soya can also be sold in their agricultural commodity markets. Consequently, when those commodity market prices are high and crude oil prices are low, producers are tempted to switch sales to the most lucrative market. This, in turn, introduces additional financial risks into biofuels production.

Finally, assuming that biofuels producers can overcome and mitigate all the risks outlined above, there is one final hurdle: marketing the product to consumers. In the SADC region, most of the service stations that service the public are ‘tied’ to the oil company whose branding they carry. They are contractually prevented from procuring fuel from parties other than their franchisor. Unless a biofuels producer can find an existing oil company willing to sacrifice some market share by accepting (a competitor’s) biofuels, the biofuels producer will have to invest in an own service station network.

Although biofuels producers face a host of market constraints, there are nevertheless several market forces that facilitate their introduction, one of which is the existence of competition. Most SADC countries are dependent on imported crude oil and/or imported liquid fuels. (Angola is a notable exception in the crude oil market.) This has meant that for many years competition has been an integral part of liquid fuels’ wholesale markets. This crack in the edifice of market constraints presents an opportunity for biofuels producers.

The legal framework that shapes the liquid fuels markets contains inducements as well as constraints. One element that is both an inducement and a constraint is the regulated prices of liquid fuels. Some pricing certainty and price smoothing is to be found in regulated prices. On the other hand, regulated prices track the volatile crude oil price.

Technical specifications for liquid fuels are regulated to quite precise limits – this is necessary for the efficient operation of internal combustion engines. Unfortunately, both biodiesel and bioethanol (a substitute for petrol) have different properties to mineral fuels. In their pure form, biofuels require engine modifications, and if they are blended into mineral diesel or petrol, then other technical and quality standard issues arise. These challenges are not insurmountable, as Brazil and other countries have shown, but they remain a barrier to entry for a fledgling southern African industry.

Possible sources of feedstock crops for biofuels are also limited by regulation. South Africa has prohibited not only the use of maize as a feedstock, but also the growing of certain crops, such as jatropha (used for biodiesel).¹⁰

Efforts by the (then) Department of Minerals and Energy to introduce biofuels into South Africa unleashed a substantial policy debate which has apparently still not been fully resolved. A host of contending policy issues have emerged, each (as is often the case) with its own associated interest groups. Briefly, these policy issues are the following:

- ◆ Biofuels and food security;
- ◆ The impact of biofuels on land use and settlement;
- ◆ Opportunities for job creation: commercial agriculture or subsistence agriculture?
- ◆ Is biofuels an energy strategy linked to security of fuel supplies or a job creation programme, or both?
- ◆ Water allocations for biofuels in a water-scarce region.
- ◆ The impact of biofuels on rural development and the ability and extent of agricultural extension services necessary to move subsistence farmers into commercial farming;
- ◆ The risks of introducing new plant species that may be invasive or threatening to the ecology;
- ◆ The import of biomass for the manufacture of biofuels has trade and import substitution policy implications. Similarly, the export of biofuels manufactured with state support and the impact on domestic targets also have policy implications.

Government has launched a number of interventions to try to shape the biofuels market, just as it has the electricity market (some of those that are common to both the electricity and the biofuels market are not repeated here, namely the two policy White Papers, the Renewable Energy Framework, the establishment of the REFSO, DNA, EDA and SANERI/SANEDI, as well as facilitating TRECs).

Several specific measures have been introduced for biofuels. In 2003, the Petroleum Products Amendment Act 2003 (Act No. 58 of 2003) placed an obligation on oil refiners and wholesalers to give preference to biofuels. In June 2006, new regulations on fuel specifications permitted the blending of biodiesel into conventional diesel.

Direct financial incentives have thus far been limited to the fuel levy. The fuel levy on biodiesel was reduced by 40 per cent in 2007 and by 50 per cent from 2008. Bioethanol is exempt from the fuel levy, but not from VAT. This incentive amounts to less than half of those applicable in some developed countries (see Table 2),

¹⁰ Criteria for licences to manufacture biofuels, [http://www.dme.gov.za/pdfs/energy/Biofuels%20Licensing%20criteria.pdf\(2\).pdf](http://www.dme.gov.za/pdfs/energy/Biofuels%20Licensing%20criteria.pdf(2).pdf) (accessed 16 August 2009).

where incentives have been successful in establishing a biofuels industry. In South Africa, half of the fuel levy on diesel amounts to 67.5 c/l.

Table 2: Incentives for biofuels

All SA c/l	USA	Germany	Spain	UK
<i>Biodiesel</i>	203	394 293 (after tax)	225	295
<i>Bioethanol</i>	116	450	300	295

In December 2007, Government released its *Biofuels Industrial Strategy*, which set a target of 2 per cent biofuels in the liquid fuels market by 2013 (Department of Minerals and Energy 2007). Since then, Government has been developing an implementation plan to give effect to this industrial strategy, which includes a financing mechanism, but it has yet to be published. Thus far, only criteria for licences to manufacture biofuels have emerged,¹¹ but these Government interventions have not yet brought forth a biofuels producer.

Conclusions

Government, in its Renewable Energy Framework, made this significant comment: ‘Government objectives will drive the market’ (p. 6). This suggests that Government has realised that market forces alone will be inadequate to deliver on the modest RE target, and that Government will have to intervene in order to achieve that. However, it also seems to suggest that setting objectives will provide the necessary propulsion for the target to be achieved. Despite this, Government has gone beyond merely setting objectives and has intervened in the market using a raft of policy measures and modest financial incentives. To date, these market interventions have yielded very little in the way of renewable primary energy for the commercial market. The REFIT and some innovative financing by the EDA in the solar water heating market hold out the promise of some improvement. Even if that improvement materialises, the market share which RE enjoys seems set to remain limited. However, in the medium term two market factors look set to work in favour of RE: as regional demand for electricity grows, new investments in power generation will be made and this will raise the cost of electricity. As the global demand for crude oil grows, its price will rise and the price of liquid fuels will follow suit. Both these market developments will increase the scope for RE.

¹¹ Biofuels manufacturers are required to be licensed under the Petroleum Products Act 1977 (Act No. 120 of 1977, as amended).

References

- DEPARTMENT OF MINERALS AND ENERGY. 2007. *Biofuels Industrial Strategy*. [Online]. Available at: www.dme.gov.za/energy/renew_bio.stm
- DEPARTMENT OF MINERALS AND ENERGY. 2007. Tradable Renewable Energy Certification System. www.dme.gov.za/energy/renew_TRECS.stm
- DEPARTMENT OF MINERALS AND ENERGY. No date. *Renewable Energy Framework*. [Online]. Available at: www.dme.gov.za
- ESKOM HOLDINGS. 2007. *Annual Report*. [Online]. Available at: www.eskom.co.za/annreport07/...
- FINE, B. & RUSTOMJEE Z., 1997. *The political economy of South Africa: From minerals-energy complex to industrialisation*. Johannesburg: Wits University Press.
- INTERNATIONAL ENERGY AGENCY. 2005. *Biofuels for transport*. OECD/IEA. [Online]. Available at: www.iea/org/...
- LOVINS, A.B. et al. 2002. *Small is profitable: The hidden economic benefits of making electrical resources the right size*. Snowmass, CO: Rocky Mountain Institute.
- NATIONAL ENVIRONMENTAL ADVISORY FORUM. 2008. *Obstacles and barriers to renewable energy in South Africa*. Pretoria: Department of Environmental Affairs and Tourism.

