State of

Renewable Energy

in South Africa

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Foreword

by Ms Tina Joemat-Pettersson - Minister of Energy

South Africa embarked on a new journey since the publication of the White Paper on Energy Policy of 1998. Critical among the priorities of Government at the time, which was characterised as a period of reconstruction and development, was the mass rollout of electrification to lend a new sense of belonging to people who were previously excluded from accessing this modern energy service. Since the national electricity utility, Eskom, had excess capacity, the renewable energy (RE) technology options were marginalised, often being left to a few demonstration or pilot projects largely driven by the international donor community. Yet, these projects contributed immensely to the demonstration of the potential of RE technologies and to some degree filled the gap in respect of provision of non-grid services to targeted rural communities between 2001 and 2010. The tipping point for RE technologies came with the REFIT process that was publicised and managed by NERSA; it galvanised the market. Catapulted to prominence by the electricity blackouts of 2008, RE technologies as options with short lead times became an attractive alternative for our country and have since delivered according to expectations. Consequently, the IRP 2010 set a target of 17,800MW (equivalent to 42%) of new electricity generation capacity to be derived from renewables, largely Solar (PV & CSP) and Wind.

South Africa has taken off on a new trajectory of sustainable growth and development; there is no turning back. Since 2011 the country has introduced a world class competitive bidding process, which to date has delivered 92 Independent Power Producers who will contribute in excess of 6,327 MW. This world-renowned programme is set to inform the design of other related programmes on the continent and across the globe. The REIPPPP programme has successfully created an enabling framework for attracting substantial private sector expertise and investment for utility scale RE. It has delivered cost effective, clean energy infrastructure to the country and contributed to security of electricity supply that is expected to bring about a virtuous circle of investment and economic growth. In a period of just less than five years, we are proud to have secured a position among the top-10 countries in the world with significant investments in RE technologies. Pioneering work by officials within Government, state-owned entities, the private sector and the international donor community, contributed immensely towards the achievement of this milestone – and for this, South Africa will always be grateful.

This report presents a consolidated and authoritative account of progress made thus far in advancing RE technologies to the economy and citizens at large. We trust that Civil Society, Parliament and the international community can use this resource as a quick reference point to hold the Department of Energy (DoE) to account and also to provide additional advice on areas that need more attention or intervention. The South African government sees renewables as having a critical role in advancing transformation of the energy sector and social equity. It will contribute towards creating green economy jobs; diversification of our energy mix and universal access to modern energy services, which is an aspiration built on the express commitment to expand the current 85% household electrification rate to 97% by 2025. Renewables are expected to contribute both to grid and off-grid electrification, transport fuels and electricity demand-side management through fuel switching, e.g. from electric geysers to solar water heaters. The report highlights the key policy and legislative framework that underpins Government activities in this field, as well as other key role players and responsible institutions across all tiers of Government. It will be produced periodically and published widely for easy access and dissemination of information.

Tina Joemat-Pettersson, MP
Minister of Energy

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List of Acronyms

Below is an alphabetical list of acronyms of bodies and terms that appear in this document, unless individually noted elsewhere:

A

ADA	Austrian Development Agency
AIJ	Activities Initiated Jointly
AQP	Assessment Quality Partner

B

BAPEPSA	Biomass Action Plan for Electricity Production
BAU	Business As Usual
BIS	Biofuels Industrial Strategy
BTT	Biofuels Task Team
BUSA	Business Unity South Africa

C

CaBREERE	Capacity Building in Energy Efficiency and Renewable Energy
CDM	Clean Development Mechanism
CED	Clean Energy Division
CEF	Central Energy Fund
CEO	Chief Executive Officer
CER	Certified Emission Reduction
CoGTA	Department of Cooperative Governance and Traditional Affairs
COP17	17th session of the Conference of the Parties
COUE	Cost of Unserved Energy
CPUT	Cape Peninsula University of Technology
CPV	Concentrator Photovoltaics
CRSES	Centre for Renewable and Sustainable Energy Studies
CSAG, UCT	Climate System Analysis Group, University of Cape Town
CSP	Concentrated Solar Power
CSIR	Council for Scientific and Industrial Research

D

DAFF	Department of Agriculture, Forestry and Fisheries
DANIDA	Danish International Development Agency
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DEA&DP	Department of Environmental Affairs and Development Planning (Western Cape Provincial Government)
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism (Eastern Cape Provincial Government)
DoE	Department of Energy
DPE	Department of Public Enterprises
DQP	Development Quality Partner
DST	Department of Science and Technology
DTI/ the dti	Department of Trade and Industry

E

EDC	Energy Development Corporation
EEDSM	Energy Efficiency and Demand Side Management Programme
EEP	Energy & Environment Partnership Programme
EIA	Environmental Impact Assessment
EL	Electroluminescence
ELIDZ	East London Industrial Development Zone
EPC	Engineering, Procurement and Construction
EPRET	Energy Policy, Research and Training Project
ERA	Electricity Regulation Act
ERC	Energy Research Centre

Eskom	South African National Electricity Utility
EU	European Union

F

FBE	Free Basic Energy
FDI	Foreign Direct Investment
FTE	Full Time Equivalent

G

GCCA	Generation Connection Capacity Assessment
GEF	Global Environment Facility
GEF-UNDP	Global Environmental Facility - United Nations Development Programme
GHG	Green House Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GRI	Gestamp Renewable Industries
GSET	Group for Solar Energy Thermodynamics
GTZ	German Technical Co-operation Organization
GW/GWh	Gigawatt and Gigawatt hour

H

HEIs	Higher Education Institutions

I

IDC	Industrial Development Corporation
IDZ	Industrial Development Zone
IEA SHC	International Energy Agency, Solar Heating and Cooling
IEC	International Electrotechnical Commission
IEP	Integrated Energy Plan
ILO	International Labour Office
IPAP	Industrial Policy Action Plan
IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
ISES	International Solar Energy Society
ISMO	Independent System and Market Operator

K

KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
KSEF	KZN Sustainable Energy Forum

L

LTMS	Long-Term Mitigation Scenario

M

MD	Managing Director
MERSETA	Manufacturing, Engineering and Related Services Sector Education and Training Authority
MFMA	Municipal Finance Management Act
MIF	Multilateral Investment Fund
MoA	Memorandum of Agreement
MTSF	Medium-Term Strategic Framework
MW/MWh	Megawatt and Megawatt hour

N

NDP	National Development Plan
NEC	National Energy Council
NEDLAC	National Economic and Labour Council
NEEAP	National Energy Efficiency Action Plan
NEES	National Energy Efficiency Strategy
NEMA	National Environmental Management Act
NERSA	National Energy Regulator of South Africa

NGO	Non-governmental organization
NGP	New Growth Path
NMMU	Nelson Mandela Metropolitan University
NQF	National Qualifications Framework
NRF	National Research Foundation
NT	National Treasury
NWU	North-West University

O

OEMs	Original Equipment Manufacturers
OFO	Organising Framework for Occupations

P

PPA	Power Purchase Agreement
PV	Photovoltaic

Q

QCTO	Quality Council for Trades and Occupations

R

RDP	Reconstruction and Development Programme
RE	Renewable Energy
RECE	Renewable Energy Centre of Excellence
RECORD	Renewable Energy Centre of Research and Development
RECs	Renewable Energy Certificates
REDZ	Renewable Energy Development Zones
REEEP	Renewable Energy & Energy Efficiency Partnership
REFIT	Renewable Energy Feed-in-Tariffs
REFSO	Renewable Energy Finance and Subsidy Office
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RED Hub	Renewable Energy Development Hub
REMT	Renewable Energy Market Transformation
R&D	Research and Development
RFI	Request For Information
RFP	Request for Proposals

S

SABIA	South African Biogas Industry Association
SABS	South African Bureau of Standards
SADC	Southern Africa Development Community
SAEON	South African Environmental Observation Network
SAGEN	South African-German Energy Programme
SAIPPA	South African Independent Power Producers Association
SANEA	SA National Energy Association
SANEDI	South African National Energy Development Institute
SANERI	South African National Energy Research Institute
SAPVIA	South African Photovoltaic Industry Association
SAQA	South African Qualifications Authority
SAREC	South African Renewable Energy Council
SARETEC	South African Renewable Energy Technology Centre
SASTELA	Southern Africa Solar Thermal Electricity Association
SASTTP	South African Solar Thermal Technology Platform
SA-STTRM	South African Solar Thermal Technology Roadmap
SAURAN	Southern African Universities Radiometric Network
SAWEA	South African Wind Energy Association
SAWEP	South African Wind Energy Programme
SAWS	South African Weather Service
SEA	Sustainable Energy Africa
SESSA	Sustainable Energy Society of South Africa
SETA	Sector Education and Training Authority
SETRM	Solar Energy Technology Roadmap

SEZ	Special Economic Zones
SE4All	Sustainable Energy for All Initiative
SHS	Solar home system
SIPs	Strategic Infrastructure Projects
SOEs	State-Owned Enterprises
Solar PV	Solar Photovoltaic
SOLTRAIN	Solar Thermal Training and Demonstration Initiative
SSEG	Small Scale Embedded Generation
SWH	Solar Water Heaters
S4GJ	Skills for Green Jobs

T

TAF	Technical Assistance Facility
TIA	Technology Innovation Agency
TIH	The Innovation Hub
TISA	Trade and Investment South Africa

U

UFH	University of Fort Hare
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation

V

VNAMA	Vertically Integrated Nationally Appropriate Mitigation Action

W

WASA	Wind Atlas for South Africa

Executive Summary

The South African journey towards large-scale deployment of renewable energy (RE) technologies shows an eclectic mixture of Government policy interventions, which converged with market forces between 2008 and 2012 to deliver an unprecedented, world-class programme. This, the first State of Renewables Report in South Africa, traces the historic journey through the narratives of individual trailblazers and decision makers who influenced energy policy direction and, ultimately, RE implementation, in various ways. Building on these narratives, this report also highlights the main policy documents, legislative framework and institutions that are responsible for driving the RE agenda. It ends off by highlighting the integral role of research, development and human capital development, which are priorities for ensuring that South Africa keeps up with technological developments in this new field. A thread that runs through this report is that South Africa could not be where it is now without the financial and technical support of the international community and various Aid Agencies; there are too many to mention all of them in this report.

South Africa is fortunate in that, over and above its rich coal resources, it is also well endowed with non-depletable RE sources, notably solar and wind. The country has an average of more than 2,500 hours of sunshine per year and average direct solar radiation levels range between 4.5 and 6.5kWh/m^2 per day, placing it in the top-3 in the world.

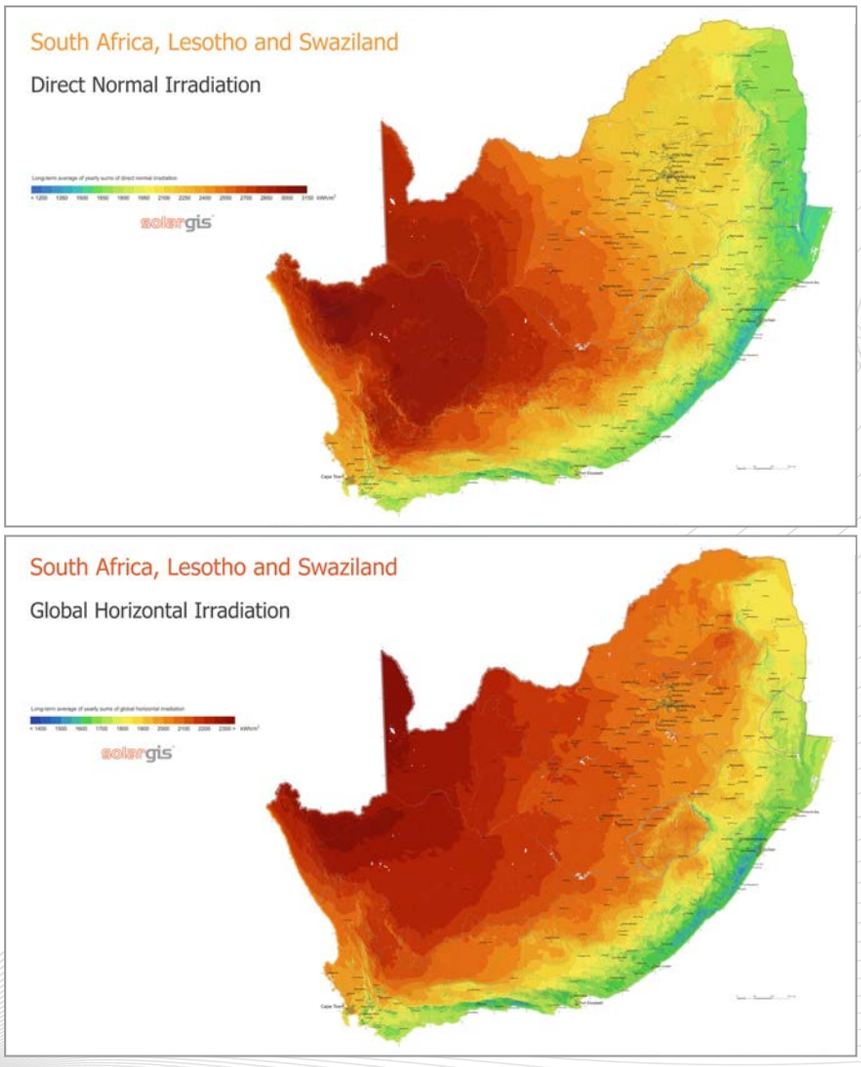


Figure 1: Solar resource maps for South Africa, Lesotho and Swaziland (annual sum of direct normal irradiation and global horizontal irradiation, kWh/m^2), GeoModel Solar[1]

1 Developed in partnership between Centre for Renewable and Sustainable Energy Studies (CRSES), University of Stellenbosch and Group for Solar Energy Thermodynamics (GSET) at UKZN (2014), www.sauran.net

A number of tertiary institutions from the Southern African Development Community (SADC) member states are collaborating on a new Solar Data and Resource Mapping study. The primary aim of this work is to promote the use of solar energy in SADC Member States and to improve the quality of satellite-derived solar data available for the area. Collaborating institutions will compile high-resolution, ground-based solar radiometric data, collected from stations located across the southern African region. The Solar Data and Resource Mapping study is conducted by the Southern African Universities Radiometric Network (SAURAN) and up-to-date progress can be found on the website, www.sauran.net. The outputs from this work will result in mutual benefits for South Africa and the SADC, whereby, in addition to improved national energy security, there will be a broader market for manufactured products and job opportunities. The SAURAN initiative is supported by GIZ and USAID.

The Department of Energy (DoE), with support from the Global Environmental Facility (GEF) through the United Nations Development Programme (UNDP), as well as the Danish government, represented by DANIDA, has developed the first numerically verified Wind Atlas for South Africa (WASA I). The WASA has confirmed results from the previous Wind Atlases developed in 1995 and 2001, which showed greater potential for wind energy in the coastal areas. In addition, the WASA has also demonstrated significant wind energy potential inland. Ten wind measurement masts, each 60 metres high, were erected throughout the Western Cape, parts of the Eastern Cape and Northern Cape provinces to provide observational data that was correlated with the modelled data to provide the numerical wind atlas.

The WASA I project also conducted analysis on extreme winds, with 50-year statistical projections. The Wind Atlas is ideally structured to inform general siting, strategic environmental assessment and wind farm planning and development, but does not substitute local, on-site measurements necessary for the detailed design and assessment of a new plant. The Extreme Wind Atlas is particularly useful for wind turbine selection. Since WASA I depicts the local wind climate that a wind turbine would encounter at very high resolution, it is a critical tool for protecting the most important asset in a wind farm – the wind turbine! The greatest recognition of the WASA outputs has been its adoption by other Agencies such as the World Bank and the International Renewable Energy Agency (IRENA). The WASA dataset has been used for verification of the IRENA Global Wind Atlas. The WASA I information is publicly available and can be used by both Government and the private sector for independent verification of other wind data. It is a critical tool for quick identification of wind hot spots prior to conducting costly on-site measurements. The second phase of WASA, involving the same partners, starts in 2015 and will expand to other provinces, i.e. KwaZulu-Natal and the Free State.

With respect to other technologies, there are no studies that have been conducted recently. However, it is estimated that the potential for new small-scale Hydro development – in the region of 247MW – exists in the rural areas of the Eastern Cape, Free State, KwaZulu-Natal and Mpumalanga provinces; these are embedded in water transfer and gravity-fed systems throughout the country. The power generation potential of this resource has not been fully exploited to date. Similarly, the Biomass resource potential was previously estimated to be significant. With technical support from the Netherlands government, work has begun to develop a Biomass Action Plan for electricity production in South Africa. The results from this 18-month project, which includes biomass resource assessment, are expected by June 2016.

Chapter three details the extent of the abundance of the national RE resources.

To enable the optimum utilisation of the country's abundant RE resources, the South African government has established excellent policy foundations. This report illustrates that the successful introduction of RE technologies can be firmly traced back into the 1996 Constitution, which has been translated effectively in at least three policy documents, the 1998 White Paper on Energy Policy (WPEP), the 2003 White Paper on Renewable Energy (WPRE) and the 2011 National Climate Change Response White Paper Policy. Also in 2011, the National Planning Commission located in the Office of the President completed the National Development Plan (NDP), which sets the overarching long- term vision for South Africa's growth and development.

The significance of the WPEP with respect to RE was its ability to recognise, as early as 1998, that the rapid development of renewable energy technologies (RETs) was imminent, and that these RETs would become cost competitive and cost effective in time. In addition, that the exploitation of these vast resources would create enormous opportunities in the future. These assertions could only be made due to firm policy-oriented research conducted by researchers, such as those who were at the Energy and Development Research Centre (EDRC) at the time. They formed part of the team that developed the WPEP. It is notable that close collaboration between policy makers and research institutions played a very significant role here.

The 2003 WPRE, which set the first target for RETs, clearly identified financial instruments; legal instruments; technology development; governance; and awareness raising, capacity building and education as the five key facilitative areas that needed to be addressed in order to enable the deployment of renewables on a large scale. It is through concerted effort and intervention in each of these priority areas that South Africa is able to speak of ambitious targets and record achievements in RETs progress today. Significantly, in each of these areas international partners have played a central role through providing financial and technical support to both industry and Government. Climate Change commitments driven by the President's undertaking at Copenhagen in 2009 – that South Africa would reduce its emissions by 34% by 2020, progressing to 42% by 2025 (compared to the 'business as usual' emissions baseline) and subject to international financial support – gave the implementation of RETs additional credence.

The 2011 National Climate Change Response White Paper (NCCRWP) has thus become an instrument to motivate and monitor implementation of climate change mitigation programmes across the key priority sectors, such as transport and energy. The NDP has become a rallying point for many Government initiatives. First highlighted by the blackouts of 2008, the NDP has brought the centrality of energy to people's livelihoods and the economy to the fore.

Chapter two elaborates on the evolution of the policies and regulation of RE in the country, which culminated in the Integrated Resource Plan 2010-2030.

Published by the DoE in May 2011, the Integrated Resource Plan 2010-2030 is the key document that provides a long-term plan for electricity generation. It calls for doubling of electricity capacity using a diverse mixture of energy sources, mainly Coal, Gas, Nuclear and Renewables, including large-scale Hydro, which is to be imported from the southern African region. Implementation of the IRP 2010-2030 is carried out through Ministerial Determinations, which are regulated by Electricity Regulations on New Generation Capacity. These are released periodically. Once released, the Ministerial Determinations signify the start of a procurement process and, most importantly, provide a greater level of certainty to investors.

The Electricity Regulations Act (ERA, 2006), as amended, and the New Generation Capacity Regulations have been the key legal instruments used by Government to unlock the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The ERA and its regulations enable the Minister of Energy (in consultation with NERSA) to determine what new capacity is required. So far, three Ministerial Determinations for the procurement of 3,725MW by 2016, 3,200MW by 2020 and 6,300MW by 2025, have been issued. The allocated quantities are derived from the IRP 2010-2030 target of 17,800MW new generation capacity set aside for renewables. Over and above this, the IRP 2010-2030 confirmed 2,600MW of large-scale Hydro to be imported from the southern African region as well as Eskom's 100MW each for solar and wind plants.

In 2008, South Africa initiated a process to introduce renewable energy feed-in-tariffs (REFIT) in order to facilitate the introduction of RE into the power system. This approach was informed by international experience, where feed-in-tariffs were successfully used in countries such as Germany to encourage RETs uptake. REFIT design work was accelerated in the wake of severe electricity shortages experienced during 2008. In 2009 NERSA published REFITs with proposed tariffs designed to cover generation costs plus a real after tax return on equity of 17 percent, fully indexed for inflation. In many ways, this REFIT tariff policy demonstrated South Africa's commitment to introducing RETs and, as such, it stimulated market interest. In the end, the REFIT announcement became what Malcolm Gladwell calls the 'tipping point' for RETs. The rapid changes following from this announcement catapulted South Africa into the world spotlight, drawing investor interest from across the globe. RE implementation became a topical issue nationwide. Ultimately, actual implementation was done through a competitive tendering system (the REIPPPP) with REFIT rates used as caps. The competitive bidding process, as it has become apparent in South Africa, has a great potential to lower prices while still providing adequate incentives for market entry by RE investors.

While RE implementation took more than a decade to realise the policy aspirations articulated in the founding policy documents, the rapid achievements within a period of three years since the procurement process started in 2011 shine brighter. Many reviews of South Africa's progress in implementing the REIPPPP have been positive, earning the country accolades from abroad. The overall design of the REIPPPP has been acknowledged by industry as being private sector-friendly.

The UNEP 2014 Report has placed South Africa among the top-10 countries in respect of RE investments. The procurement process started in August 2011 and, by November 2011, the DoE announced the appointment of the first 28 preferred bidders, collectively offering approximately 1,416MW. The total investment from these projects was close to US$6 billion. Some projects came on stream towards the end of 2013 while an additional 36 RE IPPs were selected as preferred bidders by October 2013.

Wind and solar photovoltaic (Solar PV) power plants have been the first power plants from the RE portfolio to start operations, steadily contributing additional capacity to the power system with each new successfully commissioned plant, as shown in the figure below.

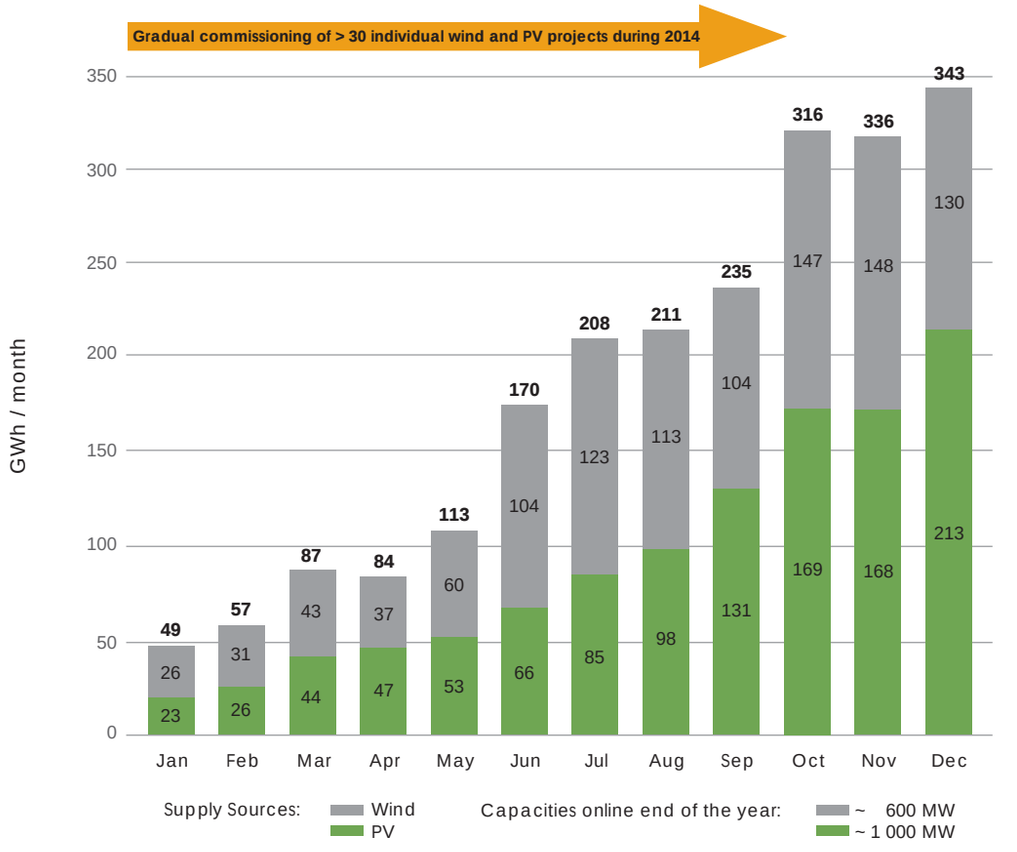
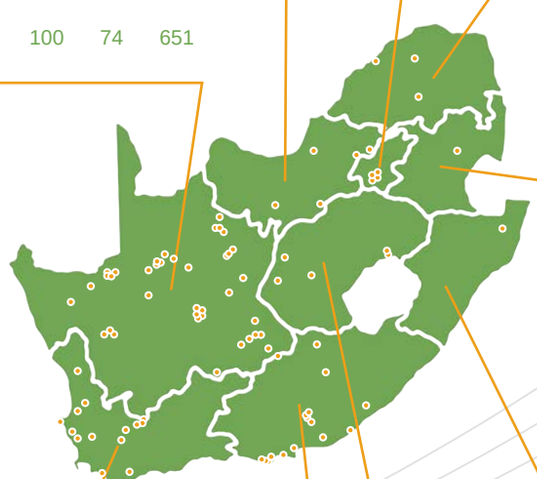


Figure 2: REIPP growth in energy produced during 2014 (Eskom, CSIR Energy Centre analysis)
Source: Eskom, CSIR Energy Centre analysis

From the completed four bid windows, a total number of 92 IPPs have secured contracts with Government to produce RE with a combined nameplate capacity of 6,327MW. At least 48 of these IPPs are located in the Northern Cape province; 17 are in the Eastern Cape; and 11 in the Western Cape Province. Free State and North West provinces share five each, Limpopo Province has three and the rest of the provinces each has one IPP . The figure below provides a snapshot of the distribution of these IPPs and the total capacity that has been acquired to date.



North West — PV

Number of projects	
5	5
Capacity procured (MW)	
275	275
Capacity online	
7	7

Gauteng — LG

Number of projects	
1	1
Capacity procured (MW)	
18	18
Capacity online	

Northern Cape

	SH	CS	OW	PV
Number of projects				
48	1	7	12	28
Capacity procured (MW)				
3 566	10	600	1 459	1 497
Capacity online				
237	10	100	74	651

Limpopo — PV

Number of projects	
3	3
Capacity procured (MW)	
118	118
Capacity online	
58	58

Mpumalanga — BM

Number of projects	
1	1
Capacity procured (MW)	
25	25
Capacity online	

KwaZulu Natal — BM

Number of projects	
1	1
Capacity procured (MW)	
17	17
Capacity online	

Western Cape

	OW	PV
Number of projects		
11	6	5
Capacity procured (MW)		
592	458	1 34
Capacity online		
237	183	54

Free State

	SH	PV
Number of projects		
5	2	3
Capacity procured (MW)		
208	9	199
Capacity online		
121		121

Eastern Cape

	OW	PV
Number of projects		
17	16	1
Capacity procured (MW)		
1 509	1 440	70
Capacity online		
603	533	70

Figure 3: Geographic distribution of IPPs in the REIPPPP

The introduction of IPPs at the scale shown in this report has contributed immensely to the transformation of the electricity generation sector, from one dominated by a single public utility to multiple generators. By design, the private sector is playing a dominant role in RETs deployment through REIPPPP. RETs are also proving to be key instruments for advancing social equity. For instance, both Northern and Eastern Cape provinces, which have received a greater share of REIPPPP projects, have higher levels of poverty and unemployment. REIPPPP contracts require IPPs to contribute to socio-economic development within their immediate locality, set within a 50km radius of plant location.

The REIPPPP has to date attracted R53.2 billion in foreign investment and financing across all bid windows. Foreign equity in the REIPPPP from the completed four bid windows amounts to R35 billion, equivalent to 34% of the total foreign direct investment (FDI) attracted into South Africa during 2013 (i.e. $8.2 billion). This success is largely ascribed to the well-designed and transparent procurement process. Bankability is enhanced by having the payment risk mitigated by Government guarantees. So far the REIPPPP has contributed to more than 109,443 employment opportunities during both construction and operational phases.

Progress on the REIPPPP is detailed on Chapter four of this report, showing the number, capacity and location of each of the projects as well as the socio-economic benefits that have been derived from the programme to date.

A reliable power supply is dependent on both adequate generation capacity and the availability of stable grid network infrastructure to deliver electricity to consumers (loads). Accordingly, the successful development of both utility scale RE resources and traditional thermal power plants, as prescribed in the IRP 2010, is critically dependent on adequate network infrastructure for the generated power to be transmitted through the national electricity grid. The spatially distributed REIPPPP development and the introduction of the non-renewable IPPs increase the complexity of the grid planning environment. In this context, future grid connection planning will be developed around a number of feasible and reasonable generation scenarios to accommodate the spatial location uncertainty associated with the implementation of the IRP 2010 generation plan. The expectation is for an increasingly more robust and effective planning of network expansion to support optimal infrastructure development delivery in the country.

Biogas, small-scale Hydro and Landfill Gas are still lagging behind, and Government is looking at mechanisms to bolster the development of these technologies under a tailor-made, small-scale IPP procurement programme. Analysis conducted by Prof. Anton Eberhard and others for the World Bank attributes slow progress with respect to small-scale IPP procurement (i.e. projects of 5MW and below), to a market shortcoming wherein the South African banking sector, that has been largely responsible for the bulk of funding to the IPPs, lacks the necessary incentives to participate in this particular programme. The Solar PV rooftop market, on the other hand, has been steadily growing without much Government incentives. A voluntary database of small-scale rooftop Solar PV installations established around 2011 suggests that by May 2015 these installations had already reached a total of about 43,8MW. A majority of these rooftop PV installations were in the commercial, agriculture, industrial and mining sectors. This is an area that still requires policy refinement at national level.

For the liquid fuels/transport sector, large-scale procurement has not yet started. However, following the 2007 Biofuels Industrial Strategy, mandatory blending regulations were promulgated in 2012 and will come into effect in October 2015. Government is still considering mechanisms that will reduce the risk of the impact of a large-scale Biofuels programme on food security as well as mechanisms that will reduce the impact of the biofuels financial support/subsidy on the fiscus.

There is an old adage that no one wants energy for its own sake, but instead for what he or she can do with it. This is a view that should underpin all efforts towards the provision of energy, particularly to the residential sector, if one wishes to support the call for Sustainable Energy Access for All (SE4All) by the United Nations Secretary General, Ban Ki Moon. Since the 1990s, South Africa embarked on an electrification drive supported by an ambitious target of achieving universal access to electricity by 2012. At the core of this programme was a need to redress past imbalances related to access to Government services. Despite sufficient supply capacity, it was clear that some remote rural areas would not be reached. As such, Solar Home Systems (SHS) were introduced to close the gap, primarily in the Limpopo, Eastern Cape and KwaZulu-Natal provinces. Compared to grid electricity, the SHS delivered quite limited services, but offered better quality services compared to candles and paraffin lamps, which all the recipients were previously dependent on. To date, more than 96,000 SHS have been installed under the rural off-grid electrification programme, which began in 2001. The South African government has invested in excess of R350 million in this programme, with other significant contributions coming from the off-grid concession companies responsible for actual implementation. Basic services offered are lighting and power for monochrome television sets, radio and mobile phone charging. The New Household Electrification Strategy (NHES), which was approved by Cabinet, foresees universal energy access (97% of households) by 2030 and has identified a target of 300,000 households for electrification with quality, non-grid solutions by 2025. Under the NHES, all efforts are directed at aligning the programme with the goals of the UN's SE4All initiative. The entire off-grid electrification programme is being redesigned to improve the quality of service offering, which involves strengthening institutional capacity through the establishment of a non-grid electrification authority. That said, South Africa has grown in leaps and bounds from seeing RETs as a stop gap measure to one where RETs are accepted as an integral part of the solution to energy problems.

Other off-grid solutions include the commitment to the rollout of solar water heaters (SWH) to both low-income and mid-to-high income households. The NDP has a long-term vision of 5 million SWH installations by 2030. From the initial target of 1 million SWH installations to be achieved by March 2015, the government has been able to install 407,463 SWH by February 2015. The programme is being re-designed to address some shortcomings observed during implementation, such as poor quality of installations and to also ensure that it is geared up to meet other Government priorities for job creation and local content requirements. There is a concerted effort led by NERSA to look at small scale embedded generation which covers solar PV rooftops, biogas etc in the short term.

Renewable energy R&D, skills development and training mainly inform and support the implementation of RE projects in South Africa. Local institutions have stepped up to the challenge to supply not only innovative technologies, but also a trained and skilled workforce to support this fledgling RE industry. A number of South African government officials and professionals have received RETs training and real-time exposure to RE plants abroad, through government to government facilitated initiatives. Chapter seven outlines national RETs skills development programmes that are aimed at ensuring the country realises the objective of reducing unemployment through large-scale deployment of RETs.

In conclusion, this report outlines how South Africa has moved from zero to hero in increasing the share of RE in the country's energy mix. An enabling environment for achieving the national objective of 30% clean energy by 2025 has been created, and South Africa is well on its path towards this audacious goal.

Chapter 1

CHAPTER 1

History of Renewable Energy Policy in South Africa

Key policy milestones shaping South Africa's renewable energy journey

South Africa's Constitution, which took effect in 1997, is unambiguous in its mandate for a sustainable energy future. Since the adoption of the Constitution in 1996, three government policy papers have created the foundation for South Africa's Renewable Energy (RE) programme, which has recently come into the global spotlight and is now receiving worldwide acclaim. The United Nations Environment Programme (UNEP)[2] ranked the country among the top-10 renewable energy investing countries in 2014 and, by breaching the 500MW of utility scale solar power in the same year, South Africa became the 10th biggest solar market in the world for installations sized 5MW and above[3].

The successful introduction of renewable energy into the country's electricity generation mix is founded in the Constitution and given effect in three key policy development steps:

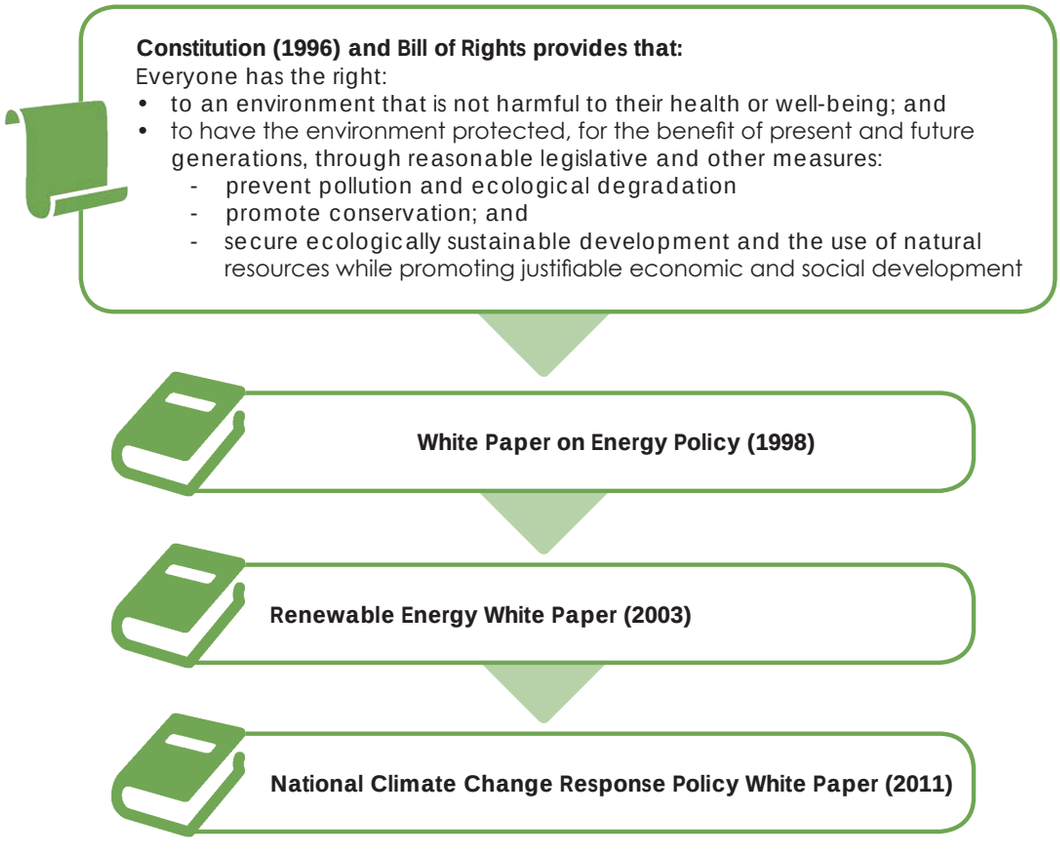


Figure 4: Key enabling policy for renewable energy

The first policy document was the 1998 **White Paper[4] on Energy Policy**. The Paper was groundbreaking from a South African perspective because it signalled a new direction. The Paper considered all South Africans, recognising inequalities in the energy sector, both in energy usage and access, and escalated the need for increased access to affordable energy services for all the country's citizens. In addition, it gave a Government commitment to support and promote the development of renewable energy

2 Prepared by Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance and Bloomberg New Energy Finance, March 2015
3 Wiki-solar.org, June 2015
4 Having adopted the United Kingdom's Westminster system in 1910, South Africa still observes many of the processes, with a white paper being a document produced by Government; it sets out policy on a particular subject and is used as the basis for more detailed plans and regulations to be put before Parliament for adoption.

resources in the country. The paper also emphasised the neo-liberal policy direction the country was embarking upon, by noting[5]:

> *''...significant international shifts have occurred in post-oil crisis energy policies. South Africa can learn from abroad. Perhaps the most significant shift is that energy security is now being achieved through greater diversification and flexibility of supply. One of the implications is that the energy sector is relying increasingly on market-based pricing. The state is placing greater emphasis on commercialisation and competition. Global financial markets are also changing. Private financing is becoming increasingly important. Government needs to create policy that attracts investment, while ensuring the national policy objectives.''*

The White Paper policy objectives were listed as:

- Increasing access to affordable energy services;
- Improving energy governance;
- Stimulating economic development;
- Managing energy-related environmental impacts; and
- Securing supply through diversity

Globally in 1998, large scale renewable energy was still in its infancy with many sceptics unconvinced of the technical and financial viability, reliability and the price at which the technology would be able to deliver energy. Global electricity generated by Wind and Solar at that time was less than 0.5% of total global primary energy. Figure 5 illustrates the exponential growth in contribution from wind and solar since 1998, yet it still contributed less than 2.5% to total primary energy consumption by 2013[6] (Figure 6).

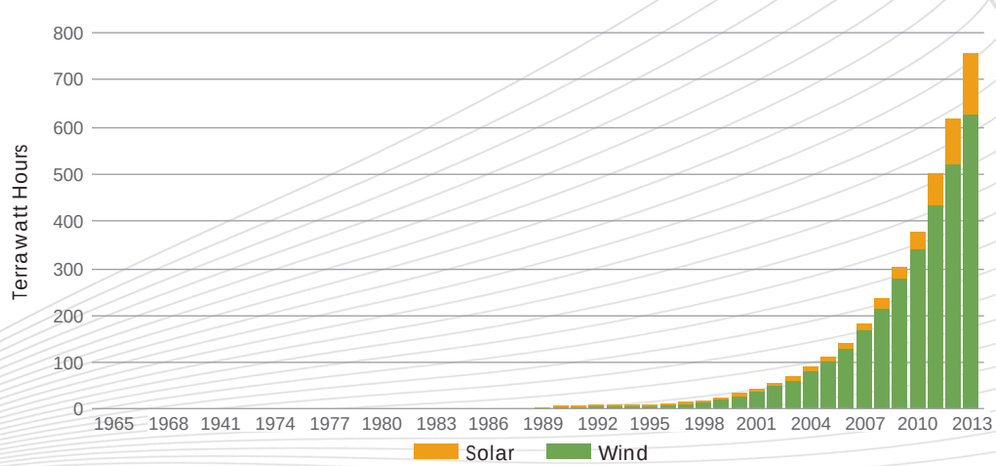


Figure 5: Global electricity generated by Solar and Wind (1965-2013)
Source: 2014 BP Statistical Review of World Energy

5 Energy Policy White Paper (1998), pg 7
6 British Petroleum. 2014 BP Statistical Review of World Energy

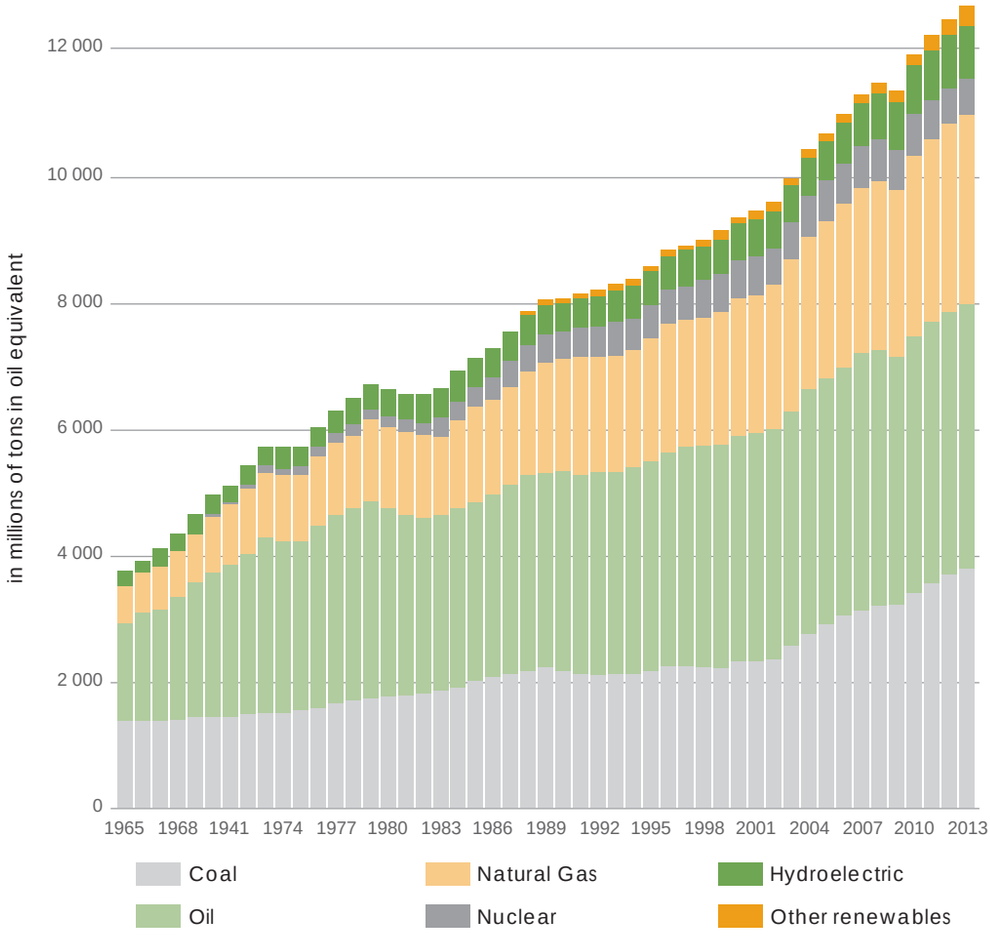


Figure 6: Relative contribution by RE to global primary energy consumption
Source: BP Statistical Review of Energy 2014

This was most certainly the case in South Africa where, at the time, the country had an entrenched mind-set of employing the vast coal reserves to generate electricity at scale in order to achieve the lowest possible cost. In fact, Eskom (the national utility) was required to operate 'at neither a profit nor a loss[7,8] until the mid-1980s. In addition, in 1998, the country had an oversupply of electricity and was mothballing and decommissioning operational power plants as the reserve margin was as high as 40% in 1992-1994 and close to 25% in 1998. A positive spin-off of this situation, and very importantly, was that Eskom and the newly elected democratic government were able to fast track their electrification programme to households to provide them with electricity for the first time. In the mid-1980s, electrification penetration levels for households were as low as 35%; this increased to 61% by 2001 and 83% by 2011[9]. During this time Eskom was also able to allow the price of electricity to reduce in real terms[10]. From an environmental perspective, however, these developments effectively tightened the grip of coal generation and ensured that coal would remain the country's primary energy resource for the foreseeable future. South Africa's electricity generation over-supply during the 1980s and 1990s can be seen in Figure 7.

The significance of the Energy Policy White Paper, specifically with respect to renewable energy (and given the prevailing context), was its ability to recognise that the rapid development of renewable energy technologies was imminent, and that they would become cost competitive and cost effective, meaning the country's vast renewable energy base would create numerous opportunities in the future.

7 Section 6(4) of the Electricity Act of 1922
8 http://heritage.eskom.co.za/annualreports/1983/1983-Page5.pdf
9 NER (2001): Lighting up South Africa, National Energy Regulator, Pretoria. And StatsSA (2011): Statistics South Africa, General Household Survey 2011, www.statssa.gov.za/publications/p0318/p0318april2012.pdf
10 Administered Prices, Electricity, G Steyn http://www.treasury.gov.za/publications/other/epir/Electricity.pdf

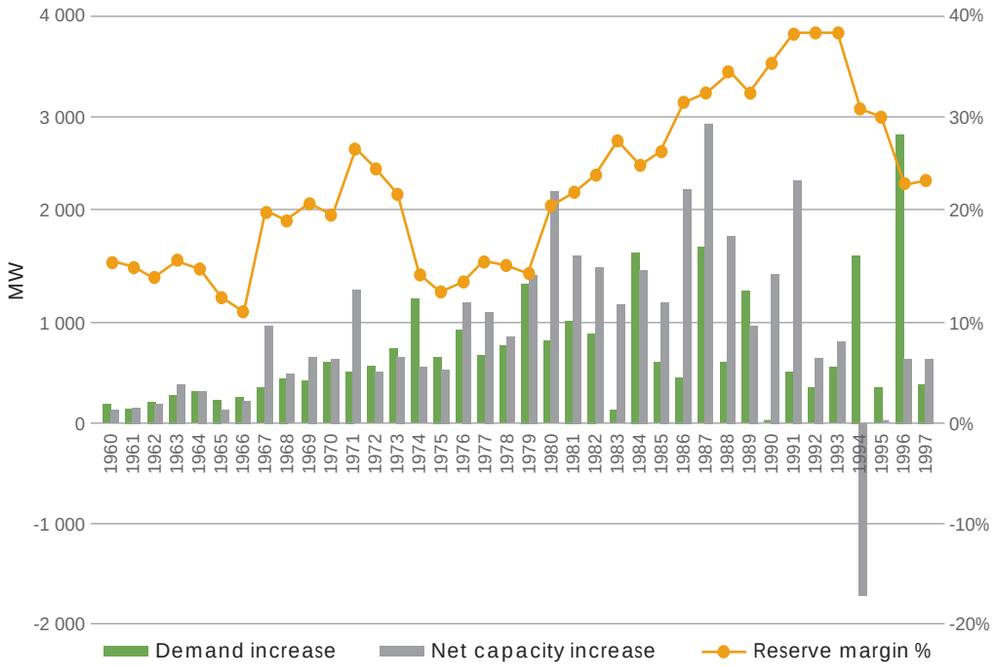


Figure 7: Eskom maximum demand and net maximum capacity
Source: Steyn (2006)[11]

Trailblazers in policy formulation and training – UCT Energy and Development Research Centre (EDRC)

The strong policy position given early on to renewable energy in South African policy, such as the 1998 Energy Policy White Paper, was largely informed by the pioneering work of the EDRC.

The EDRC was founded at the University of Cape Town in 1989 and was active for a decade until 1999, coinciding with the critical timeframe of South Africa's political transition to democracy. The centre was structured as "a transdisciplinary research institution committed to producing knowledge that will result in improved policy-making and practical implementation in the energy sector in Africa". Its work focused on three main areas: 'Energy Poverty and Development', 'Energy Efficiency and Environment', and 'Energy Markets and Governance'. As a result of this work at the time of transition, the EDRC played an important role in raising issues to the policy agenda, while at the same time providing support to various agencies trying to address these issues.

The initial funding for the EDRC came from a government grant, but quickly shifted to being funded by international donors and national, regional and international contract research. The centre established a wide range of partnerships and networks, and was the beneficiary of extensive support and contributions from the international community wanting to support the new government in this context.

11 http://www.gsb.uct.ac.za/files/Eskom-InvestmentUncertainty.pdf

Among others, the centre was responsible for a comprehensive energy policy review under the Energy Policy Research and Training Project (EPRET). EPRET's primary objective was to design policies that widen access to adequate and affordable energy services for poor urban and rural households. Stemming from this, the EDRC was contracted by Government for the process leading to the formulation of the 1998 Energy Policy White Paper.

The EDRC has since been incorporated into the Energy Research Centre (ERC) at UCT and continues to operate and contribute to national energy research and policy formulation, with specific focus on climate change and energy modelling.

"The greatest contribution the EDRC has arguably provided in the renewable energy field (and across wider energy issues) has been through education, training and research. Postgraduate students, researchers and interns have moved into vital sectors of industry, government and energy/environmental consultancy, both here and abroad." – Mr Bill Cowan, previously senior researcher at the EDRC.

To achieve the national policy objectives, two renewable energy paths, which were to be pursued simultaneously, were described in the White Paper.

The first identified renewable energy as an opportunity to extend the grid to remote rural areas 'where grid electricity supply is not feasible'. It was believed that, through the development and introduction of 'solar home systems, solar cookers, solar water supply systems, solar systems for schools and clinics,' Government could supply the least-cost energy service. This approach would also reduce the negative environmental and health effects of air pollution arising from coal- and wood-usage in households.

The second path considered in the Paper was the nature of the existing electricity generation in the country, 96% of which was generated by Eskom – and almost exclusively from coal.

The White Paper identified Government's need to improve its ability to address long-term issues, noting that the country was responsible for 1.6% of global greenhouse gas emissions, with the energy sector being by far the largest contributor. The development of renewable energy resources were needed to achieve a more sustainable energy mix, and in many instances was likely to provide the least-cost energy service when social and environmental costs are included in the equation.

Strengthening policy through consultation

The development of the Energy Policy White Paper incorporated an extensive process of public consultation that enriched and contributed to the quality of this far-sighted document.

There were two stages: consultation and writing, followed by production and approval. The first stage involved a number of stakeholder forums, leading to a discussion document as a basis for comment. After a period for inviting public comment, a National Energy Summit was held to arrive at a consensus on energy sector goals. The next stage, which was the production and approval part of the process, involved several consultation meetings. These meetings led to a draft paper in June 1996.

Under the auspices of the Parliamentary Portfolio Committee, further public hearings were held before the final Paper was published at the end of 1998.

The use of certain renewable energy sources may additionally be seen to protect further constitutional rights, such as access to clean "sufficient water".

The contribution of aid agencies, lobbying and interest groups

With the publication of the Energy Policy White Paper, South Africa, already a signatory of Agenda 21[12] and the Kyoto Protocol[13], demonstrated her commitment to both sustainable development and climate change. This Paper was welcomed by the international community, creating the context for international support for energy efficiency and renewable energy in the country.

After the democratic elections in 1994, energy diversity and clean energy were only two of the numerous immediate and pressing issues (such as housing, sanitation, education, water and electricity access) confronting the newly elected government.

During this time, renewable energy development in the country benefited from significant support and funding from the international community, promoting renewable energy and energy efficiency. The support and funding received to undertake research and demonstration projects were influential, as it started to create the foundation to shift general perception, introduce new concepts and ideas and, most importantly, dispel myths and pre-conceived notions through local scientific research.

All of the support made available to the South African government is acknowledged with appreciation (and noting a few specific contributions in

12 Agenda 21 is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development and a product of the Earth Summit (UN Conference on Environment and Development) held in Rio de Janeiro, Brazil, in 1992
13 An international treaty regarding climate change, adopted and signed in Kyoto, Japan, in 1997

the energy sector) in the period leading up to the 2003 RE White Paper:

- Danish Cooperation Programme (DANIDA) – infrastructural and knowledge transfer-based activities, including technical analysis support for the RE White Paper and support of the Capacity Building in Energy Efficiency and Renewable Energy (CaBREERE) project;
- German Technical Co-operation Organisation (GTZ) – solar cook stoves (1996 – 2005); and
- UNDP and World Bank – Global Village Energy Partnership (2002);

The international community continues to play a pivotal role by providing technical and financial assistance. Various bi-lateral donor agencies from Denmark, Germany, Spain and the UK provided technical support. For example, GTZ funded the creation of the South African Renewable Energy Council (SAREC), which allowed the various renewable energy industry groups to create an umbrella body to act as a collective custodian of the renewable energy industry in South Africa. The Global Environment Facility also provided a $6 million grant for advisory services under the Renewable Energy Market Transformation Project.

The Global Environmental Facility through the World Bank also provided a USD 6 million grant for pre-investment services under the Renewable Energy Market Transformation programme. DBSA implemented the programme on behalf of the DoE which contributed USD 975,693. Some of the outputs of this programme were instrumental in informing decisions around the IRP 2010-2030 and the National Solar Water Heating programme, which were the key priority areas for REMT. For example, prior work done on modeling of Renewable Energy Technologies (RETs) learning curves facilitated their incorporation into the IRP process. This resulted in a cost-optimized IRP model that allocated greater capacity for RETs, thereby providing a sound analytical basis for planning the implementation of the DoE's policy of substantially increasing the share of RE in the projected energy mix; a number of IPPs which became successful bidders under the REIPPPP obtained REMT grants; REMT procured the services of a specialist energy project finance law firm for review of the draft standardized PPA published by NERSA in July 2009. The specialist review laid the foundation for the standardized PPA that was used later as the basis for bankable IPP transactions; REMT supported a CSP workshop in September 2009 and one of the outcomes was the formation of the Southern Africa Solar Thermal and Electricity Association (SASTELA). On Solar Water Heating, REMT supported South Africa's SWH industry through targeted studies, reports, grants, and capacity building.

Lastly, over time a number of government officials and professionals from industry and academia have received training and/or practical exposure to renewable energy technologies abroad through sponsored seminars and study tours, e.g. China, Japan, Germany, Norway etc.

The changing focus of donor support - Mark Borchers, Director of Sustainable Energy Africa (SEA)[14]

SEA was established in 1992 to promote equitable, low-carbon, clean-energy development in South and southern Africa. It was founded by Mark Borchers who – as did many leaders in this industry – had spent time with the Energy for Development Research Centre (EDRC) at the University of Cape Town. During the past 23 years, Mr Borchers has led numerous sustainable energy projects contracted by international aid organisations, academic institutions, national and local Government and corporate clients. More recently, SEA's work is focused on supporting South African cities with sustainable energy transitions through research, capacity building and technical involvement.

SEA has received strong support from international donor agencies, especially during the 1990s when sustainable energy was still a fledgling industry and was not formally supported by national policies and regulations. Donor funding was used very effectively during this time, especially funding from DANIDA, which supported impact evaluation studies that demonstrated the value of promoting sustainable energy in urban South Africa. Mr Borchers strongly believes that the approach developed by SEA – whereby donor funds were used in a skilful, programmatic way, which maximised local capacity development and impact – were a key success factor that allowed it to continuously attract donor funding. Bringing in foreign experts is a bad way of using donor funding, he notes. SEA is now using the same approach in other African countries.

Mr Borchers's perspective is that despite significant industry development, there is still a role for donor funding, and will be for a long time. In recent years SEA has turned its attention to local Government and sustainable energy. South African cities and towns, as is the case with most developing countries, do not have capacity to service their populations adequately, and evidence suggests this won't change in the medium term, or even the long term. Donor funds can be used effectively to support cities and towns to address longer-term sustainability concerns, which normal Government budgeting and resource allocation processes generally fail to do.

Mr Borchers continues in his role as director of SEA.

14 www.sustainable.org.za

The second noteworthy policy was the **Renewable Energy White Paper** of 2003. The Renewable Energy White Paper states clearly that it derives its mandate from the Constitution; notes that the Energy Policy White Paper only 'touched on' renewable energy, but committed Government to setting a renewable energy target: "Government will work towards the establishment and acceptance of broad targets for the reduction of energy-related emissions that are harmful to the environment and to human health"; and, as part of South Africa's reintegration into the global economy, recognised that a definitive policy on renewable energy had to be fully developed and articulated.

The Renewable Energy White Paper clearly demonstrated that the South African government comprehended the framework and details needed to enable a sustainable, renewable energy industry. The document elaborated on these as financial and legal instruments, technology development, awareness raising, capacity building and education as well as governance[15]. The Renewable Energy White Paper had a number of objectives, including ensuring that an equitable level of national resources was invested in renewable technologies; directing public resources for implementation of renewable energy technologies; introducing suitable fiscal incentives for renewable energy and; creating an investment climate for the development of the renewable energy sector.

The key objectives of the White Paper were considered in the five major facilitative areas below:[16]

Financial instruments

- To ensure that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply;
- To set targets for directing of public resources for implementation of renewable energy technologies;
- To extend existing state financial support systems and institutions and introduce sustainable financing mechanisms for delivering renewable energy systems;
- To introduce suitable fiscal incentives for renewable energy;
- To create an investment climate for the development of the renewable energy sector, which would make it easy to attract foreign and local investors.

Legal instruments

- To develop an appropriate legal and regulatory framework for pricing and tariff structures to support the integration of renewable energy into the energy economy and to attract investors;
- To develop an enabling legislative and regulatory framework to integrate independent power producers into existing electricity systems;
- To develop an enabling legislative framework to integrate local producers of liquid fuels and gas from renewable resources into their respective systems.

15 Sebitosi, A.B. and Pillay, P (2008): Renewable Energy and the environment in South Africa: A way forward. Energy Research Centre UCT
16 Mwakasonda, S.A.J. (2004): Policies and Measures for Renewable Energy and Energy Efficiency in South Africa. Energy Research Centre UCT

Technology development

- To promote the development and implementation of appropriate standards and guidelines and codes of practice for the appropriate use of renewable energy technologies;
- To support appropriate research and development and local manufacturing to strengthen renewable energy technology and optimise its implementation.

Awareness raising, capacity building and education

- To promote knowledge of renewable energy and increase its use;
- To promote and stimulate the renewable energy market through dissemination of information on economic, environmental, social and trade benefits of renewable energy technologies and their applications. To persuade institutions to implement training and education programs on renewable energy;
- To actively involve women in decision-making and planning on renewable energy activities;
- To improve communication and interaction between Government and other institutions on renewable energy policies.

Governance

- The Department of Minerals and Energy (now the Department of Energy; DoE) would take overall responsibility for the development of renewable energy policy coordination in South Africa, but would work with the necessary government departments to create the required enabling environment, i.e. the devolution of responsibility to the most appropriate level of government;
- The National Energy Regulator, the South African Bureau of Standards and the Central Energy Fund are specifically cited as key role players.

The 1998 Energy Policy White Paper had also introduced a shift in the responsibility for energy planning. For electricity, the national planning function had until then resided with the national, vertically integrated utility, Eskom, which had been established in 1923. This policy change was given effect in the Renewable Energy White Paper with the important new requirement for the adoption of an Integrated Resource Planning (IRP) approach led by Government. This integrated planning approach was to ensure that the different energy resources being considered would be treated equitably from a financial analysis perspective to adequately evaluate their performance and potential.

The Renewable Energy White Paper outlined a long-term vision of a sustainable, completely non-subsidised alternative to fossil fuels. To get started, it set its aim at 10,000GWh of renewable energy contribution to be achieved over 10 years. This was to be produced mainly from Biomass, Wind, Solar and Small-scale Hydro – and is equivalent to providing electricity to 300,000 households[17] per annum. No long-term target was quantified.

The concluding section of the White Paper was 'The Way Forward', which stated: *''A Strategy on Renewable Energy will be developed, which will translate the goals, objectives and deliverables set out herein into a practical implementation plan.''* The drafting of such a strategy document was, however, not immediately undertaken. As a result there was a good deal of confusion regarding what this target actually meant: was it a cumulative or an annual target? Did it include renewable energy services other than electricity? In response, the DoE clarified (in 2004) that the target was cumulative and would be met by a combination of Bagasse (59%), Landfill Gas (6%), Hydro (10%), Solar Water Heaters (13 %), other Biomass (1%), and only 1 % Wind.

Intriguingly, no Solar Photovoltaics (Solar PV) or Concentrated Solar Power (CSP) were expected to contribute to this energy target. But, in the face of the prevalent energy paradigm, even these relatively modest targets could not be met in the given timeframe[18].

Our renewable energy policy journey – Dr Rod Crompton

Dr Crompton currently serves as full-time Regulator Member of the National Energy Regulator (NERSA), primarily responsible for petroleum pipelines regulation. During the critical policy development period, he was appointed Chief Director responsible for Hydrocarbons in the Department of Minerals and Energy (DME)[19] and later the Deputy Director-General of the same unit. He led the drafting of the hydrocarbons section of the White Paper on Energy Policy, the White Paper on Renewable Energy and several pieces of legislation on petroleum, gas and regulation.

Dr Crompton revealed that the newly elected democratic government of 1994 quickly came to the realisation that Coal, in the quantity and quality that would allow for low cost electricity generation, would not be available indefinitely. This necessitated greater consideration to be given to a more diversified, long-term energy strategy for the country. Consequently, the White Paper on Energy Policy required security of supply through diversity of supply. Renewable energy carriers are one of the alternatives to Coal and Oil. At the time the DME had limited knowledge and expertise on alternative, and specifically renewable energy. Therefore its primary objective was to strike a balance between protecting the country from excessively costly alternatives while promoting diversification and private sector investment.

The renewable energy knowledge 'black box' was bridged with assistance from DANIDA (Danish Development Agency), which funded a study on the cost of technologies that would inform the development of the RE White Paper. The development of the White Paper gained impetus in the lead-up to the World Summit on Sustainability Development, hosted by South Africa in 2002. During the course of the summit, the draft paper was shared with a select number of attending industry leaders for comment, and was then released in 2003.

Dr Crompton noted the impact the California electricity crisis of the early 2000s had on Government thinking. Having just released a policy paper advocating private sector investment, cabinet viewed with disquiet the US electricity supply crisis caused

17 Based on 3,319kWh per household, i.e. average household electricity use derived from Eskom residential consumption data and Amps data for number of electrified homes (2013)
18 Eberhard, A., Kolker, J. and Leigland, J. (2014) South Africa's Renewable Energy IPP Procurement Programme: Success Factors and Lessons. PPIAF and World Bank
19 Subsequent 2008, Department of Energy

by market manipulation and the collapse of the state's largest supplier. Would South Africa's developmental agenda really be served by IPPs? Further delays in decision-making was largely due to two reasons. The first was the over-supply of electricity at the time and, secondly, after a tumultuous transition to democracy and solid GDP growth during the 1990s, Government found itself in a position where it had 'space' to consider multiple options. Both these factors contributed to a deceptive sense of security and obscured foresight of impending industry challenges and disruptive forces, creating a lull in implementation.

The REIPPPP (Renewable Energy Independent Power Producers Procurement Programme), introduced in 2011, reversed the initial slow implementation progress. Dr Crompton commends the government-led programme as world class, expressing his approval of the competitive bidding approach that limits the country's exposure to excessive subsidies; oftentimes associated with the introduction of new technology.

The country's subsequent energy journey has been shaped by a changing energy and economic landscape and influenced by various political imperatives. Looking back, the implementation of renewable energy has deviated somewhat from the initial expectations of the RE White Paper. For instance, the integrated resource planning approach incorporated technologies that did not meet the 'efficiency' criteria envisaged in the White Paper. Also, progress with respect to the development of Biomass and Biofuels has been limited, both of which were anticipated by the White Paper to contribute significantly to energy production.

Irrespective of this, the RE White Paper continues to provide the basis for Government investment and implementation in the renewable energy sector, supporting the development of a sustainable market share for clean energy, as anticipated by the DME at the time.

The Department of Environmental Affairs (DEA) **National Climate Change Response Policy White Paper** of 2011 is the third influential policy paper that supported the country's renewable energy aspirations.

South Africa's renewable energy trajectory received an unexpected ally in the prominence and visibility of global climate change and mitigation efforts as well as the country's national commitments to emission reductions. The first related United Nations Conference was held in 1972, but it was only in 1992, at the same time that South Africa was negotiating its transition to democracy, that representatives from 178 nations met in Rio de Janeiro to discuss global environmental issues that would become central to policy implementation. At the conference more than 130 nations, including South Africa, signed a Convention on Climate Change and a Convention on Biodiversity[20]. This international commitment, although possibly not recognised at the time, signalled an important step in South Africa's journey to a cleaner energy future.

The Climate Change White Paper was largely informed by a process known as the Long-Term Mitigation Scenario (LTMS) formulation. The LTMS, led by the DEA, was a Cabinet-mandated process that took place in South Africa between 2005 and 2008. The LTMS[21] arose out of the realisation that South Africa would need to contribute its share to mitigation, but recognising that the economy had been built around energy intensive industry, which is heavily reliant on coal. The country also needed to address poverty and inequality, so any move to a low carbon development path would require a major shift in thinking and action. However, a potential 'advantage' was that such Third World issues could be strategically addressed in the process of creating renewable energy solutions, as the provision thereof is manufactured from scratch, using the most appropriate and affordable technologies.

Research culminated in the development of scenarios that presented four proposed strategic options that could be pursued. This work was submitted to Cabinet, which in mid-2008 adopted a peak, plateau and decline trajectory. A strategic direction was set where the country's emissions would grow for a while, but peak between 2020 and 2025 at 550Mt $CO_{2\text{-eq}}$, remain flat for a decade, and decline in absolute terms from 2030 onwards. This was a major step by a developing country in the climate negotiations. In Copenhagen in December 2009, President Zuma internationalised this pledge. He committed South Africa to take mitigating action that would reduce South Africa's emissions by 34% below the Business As Usual (BAU) trajectory by 2020, provided the international community supported South Africa with financial aid and the transfer of appropriate technology. The peak, plateau, and decline scenarios (Figure 8) for carbon emissions were taken into account for the development of the Integrated Resource Plan (IRP) 2010-2030.

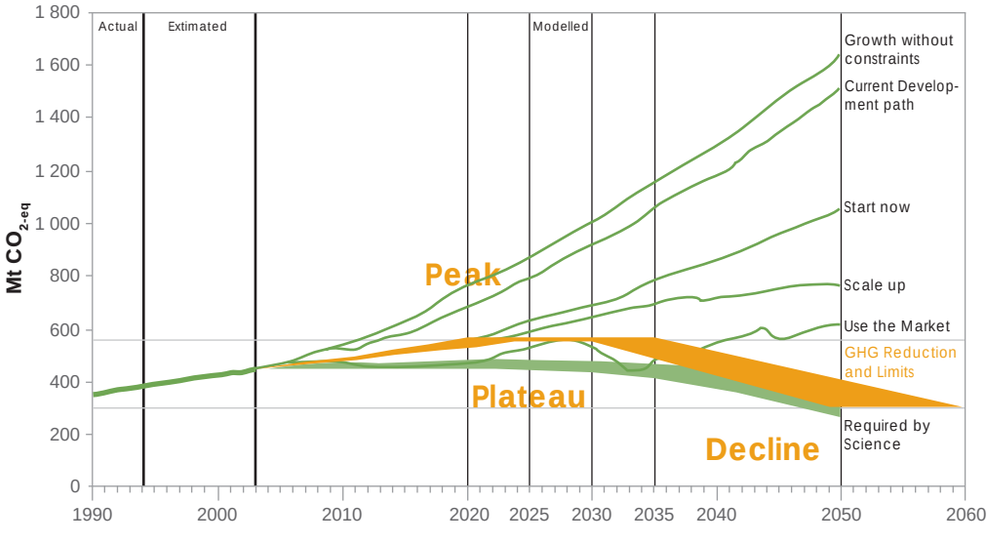


Figure 8: South Africa Greenhouse Gas (GHG) emission reductions and limits
Source: DEA

20 http://www.publications.gc.ca/collections/Collection-R/LoPBdP/BP/bp317-e.htm#A. History of the Summit(txt)
21 Harald Winkler, Energy Research Centre. University of Cape Town

Published shortly before the 17th session of the Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Durban in 2011, the White Paper established the overarching policy framework for South Africa's climate change response. The White Paper identified priority areas and activities for both adaptation and mitigation. The water, agriculture and forestry, health, biodiversity and human settlement sectors were prioritised for national adaptation[22] efforts, whereas the energy, transport, mining and industrial sectors were prioritised for mitigation[23] action.

The Paper was the catalyst for public and private sector stakeholder representatives agreeing at COP17 to 12 'commitments' aimed at achieving the government's goal of creating 300,000 new jobs in the 'green economy' of South Africa by 2020[24]. These targets are not deemed to be unrealistic or unreasonable given the experiences of other countries[25], illustrated in Figure 6.

Figure 9: Number of direct and indirect jobs (thousands)

22 Defined by the United Nations Framework Convention on Climate Chance (UNFCCC) as actions taken to help communities and ecosystems cope with changing climate condition
23 Defined by UNEP as efforts to reduce or prevent emission of greenhouse gases
24 Eberhard, A., Kolker, J. and Leigland, J. (2014) South Africa's Renewable Energy IPP Procurement Programme: Success Factors and Lessons. PPIAF and World Bank, pg 7
25 Walwyn, D.R. and Brent. A. (2015) Renewable Energy gathers steam in South Africa. Elsevier

Putting policy into action...

In 2010, the Integrated Resource Plan for electricity (IRP, 2010) was published as a notice under the Electricity Regulation Act with the intention for it to be seen as a document that gives effect to national policy and provides a planning framework for the management of electricity demand in South Africa for the period 2010 to 2030. Additionally, it formalises and extends Government's aims as set in the Renewable Energy White Paper of 2003.

In 2008 the country initiated a process to introduce renewable energy feed-in-tariffs (REFIT), to facilitate the large-scale introduction of renewable energy into the power system. This approach was informed by international experience, where feed-in-tariff structures have been widely and successfully used to encourage and/or accommodate renewable energy. In 2009, the National Energy Regulator (NERSA) published a tariff policy, proposing tariffs designed to cover generation costs plus a real after tax return on equity of 17%, fully indexed for inflation. This policy signalled an important position regarding the commitment to renewable energy in South Africa.

The IRP 2010 estimated that electricity demand by 2030 would require an increase in additional generation capacity of 52GW, 17.8GW of which will be from renewable sources – Wind, Solar, Biomass, Small-scale Hydro and Biogas - and 2.6GW from Large-scale Hydro. In 2010, at the time the IRP was being developed, the electricity mix included less than 0.5% capacity from renewables when excluding the existing large-scale Hydro capacity (2.1GW). This aspirational target for renewable energy was a deliberate policy adjustment to the IRP 2010, informed by the policy direction of the Energy Policy White Paper, the Renewable Energy White Paper and the peak, plateau and decline scenarios for carbon emissions[26].

Published REFIT rates included R1.25/kWh for wind, R2.1/kWh for concentrated solar and R3.94/kWh for Solar PV. In March 2011, NERSA announced a revision of the REFIT programme citing changes in

26 Eberhard, A., Kolker, J. and Leigland, J. (2014) South Africa's Renewable Energy IPP Procurement Programme: Success Factors and Lessons. PPIAF and World Bank pg 7

the original assumptions, such as cost of debt and the exchange rate. The tariffs were decreased by 25% and would no longer be indexed to inflation. This downward adjusted pricing more accurately reflected the technology advances and price trends in the market (Figure 10).

	Wind	Solar PV	CSP	Small hydro
Published REFIT tariffs[27]				
2009 tariff[28]	1.25	3.94	2.1	0.94
2011 tariff[29]	0.94	2.31	1.84	0.67

Figure 10: REFIT tariffs as published

The programme ran into several problems, which included the legality of a REFIT under the country's procurement framework and Eskom's willingness to support the programme by entering into power purchase agreements. A legal opinion sought by National Treasury and the Department of Energy concluded that the REFIT approach contravened public finance and procurement regulations. In the latter part of 2011, NERSA terminated the REFIT programme and announced that a competitive

27 As published, not adjusted to a common base year and not updated
28 http://www.nersa.org.za/Admin/Document/Editor/file/Electricity/REFIT%20Phase%20II%20150709.pdf
29 http://www.gsb.uct.ac.za/files/FeedintariffsorAuctions.pdf

bidding process for renewable energy would be launched, the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). This approach has proven extremely successful.

By June 2014, South Africa had established 1.9GW new renewable energy capacity for electricity production, including both utility-scale and small-scale installations, delivering in excess of 5TWh of clean energy per annum into the energy mix. From a starting point of less than 0.5GW in 2010 (excluding Hydro), this achievement represents a significant shift in the energy landscape of South Africa, placing it among the global leaders in renewable energy in only five short years.

Setting RE tariff…a long journey from REFIT to REIPPPP – Thembani Bukula

Mr Thembani Bukula has served as full-time Regulatory Member of Electricity at the National Energy Regulator (NERSA) – previously National Electricity Regulator (NER) – since 2006. Mr Bukula has a distinguished and diverse career in the electricity industry, both locally and abroad. He has been closely involved for more than a decade with the development and refinement of a regulatory framework for pricing and tariff structures to support the integration of renewable energy into the energy economy, and to attract investment.

Although not often recognised, South Africa's current renewable energy bidding programme has its roots in the 2003 RE White Paper. The White Paper gave direction to NERSA to investigate appropriate fiscal and financial support mechanisms within the relevant legal and regulatory framework that would promote the implementation of renewable energy in the country. Mr Bukula recalls that some of the options employed in the world at that time and identified for consideration included renewable energy subsidies as well as renewable energy certificates (RECs) with trading and feed-in tariffs.

According to Mr Bukula, the starting point for South Africa circa 2006 was to define what would constitute renewable energy; this occurred amid an ongoing global debate about how to define and distinguish renewable from non-renewable energy. A suitable definition has significance because of the potential impact on policy and regulatory efforts aiming to promote clean energy resources.

The second focus was to identify a suitable mechanism and way forward to enable the implementation of renewable energy, attract domestic and international investment and facilitate the effective integration of IPPs into the existing electricity system while ensuring that national policy objectives were achieved. Mr Bukula highlighted the value of international experience – including that of Germany, Spain and Denmark – and industry consultation to inform the identification of the most suitable instruments and framework for South Africa. The tremendous support from international donors, particularly funding from the Danish and Norwegian governments and technical assistance from Germany, is acknowledged with great appreciation. Based on this work and what was generally considered global best practice, a renewable energy feed-in tariff (REFIT) was introduced via Regulations issued by the Department of Energy (DoE). The Regulations gave instruction to NERSA to design and implement the REFIT and formulate criteria for procurement.

Design work was accelerated in 2009 in the wake of severe energy shortages experienced during the preceding year, resulting in the first set of REFIT tariffs published for Wind, Solar PV, CSP and Small-scale Hydro in April that year. An inclusion for REFIT was incorporated into Eskom's revenue determination to provide for funding, and the finalisation of the Integrated Resource Plan (IRP) in 2010 provided a longer-term view to investors on electricity planning and renewable energy objectives, creating an opportunity to move forward.

Even so, Eskom's deteriorating balance sheet and the successive downgrading of its credit rating raised concerns among potential investors, debt providers and developers

about financial sustainability, prompting them to seek guarantees from Government for long-term purchase agreements. This shift in the investor environment initiated internal discussions on an alternative procurement approach – and the rest, as they say, is history.

Mr Bukula notes that the scope and depth of industry consultation during the initial development period created a foundation for the REIPPPP success. The extensive industry engagement had built trust in the integrity of the process and the shared interest of Government to carve out a mutually agreeable and sustainable solution for the realisation of renewable energy in the country. As a result, investor interest and confidence weathered the lull during the transition from the REFIT to REIPPPP.

The many iterations and refinements that were done during the development of the REFIT and later incorporated in the REIPPPP, helped shaped the programme and provided valuable pricing inputs to inform price floors and ceilings. Today South Africa boasts a world-renowned renewable energy programme that is currently informing the design of other programmes on the continent as well as the globe.

The impact of policy shifts on RE deployment

It is often assumed that creating a conducive clean energy policy environment will deliver the desired energy developments and environmental and economic benefits. In South Africa, a clear policy direction, including a target for renewable energy, was in place for almost a decade, during which limited development in renewable energy took place. An assessment of policy effectiveness done in 2010 by the University of Cape Town's Energy Research Centre illustrated the actual and foreseen impact of the major policy drivers on RE deployment in the country (Figure 11).

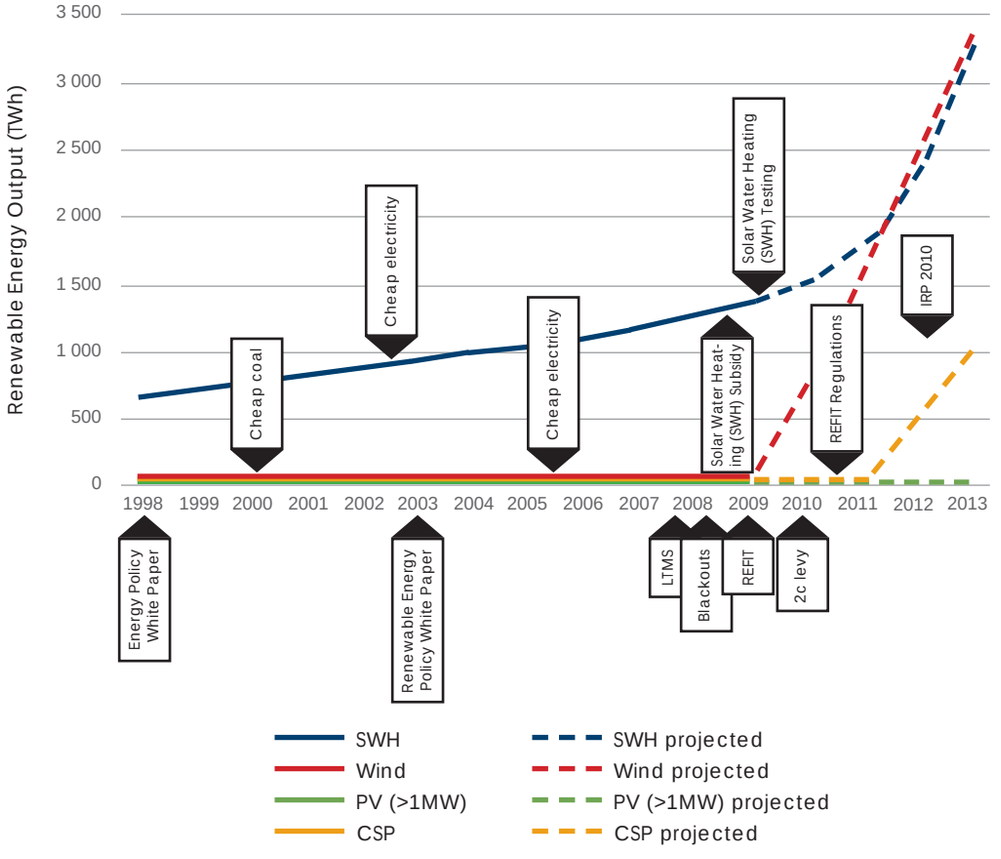
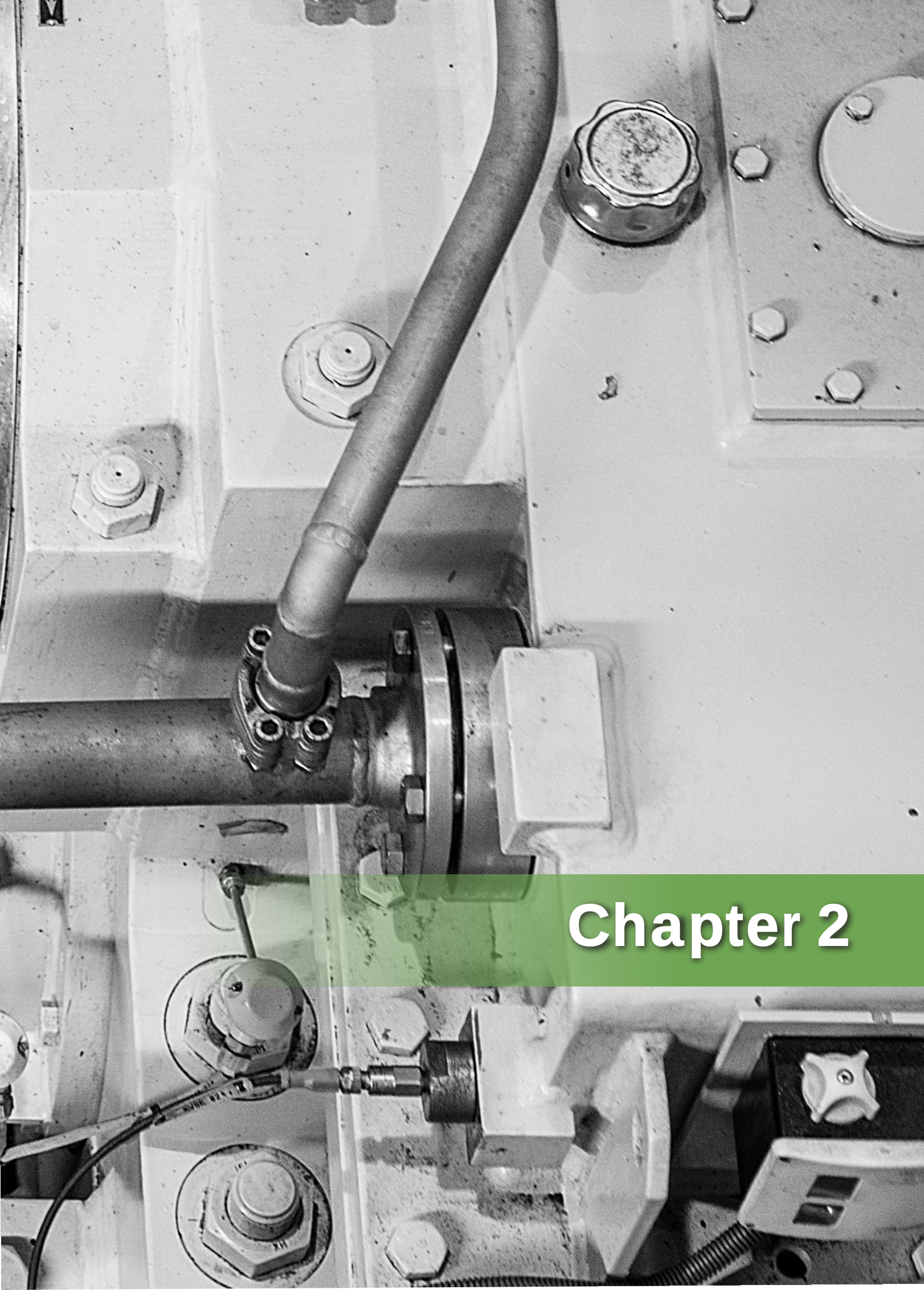


Figure 11: The impact of major policy drivers on renewable energy deployment in South Africa, 2010[30, 31]

As predicted by this assessment, it required renewable energy to be included in the national integrated electricity plan and the initiation of the government-led procurement programme, REIPPPP, to create market conditions that invited large scale renewable energy development. In this, South Africa's experience echoes that of international energy and climate change initiatives: that a combination of policy tools are most effective – in fact, essential – to unlock market potential and achieve national clean energy objectives.

30 Edkins, M. Marquard, A. Winkler, H. June 2010. Assessing the effectiveness of national solar and wind energy policies in South Africa. ERC

31 The 2c levy refers to a 2c/kWh environmental levy that was introduced in 2009 and imposed on all electricity generated from non-renewable sources. Refer chapter 5 for detail of the SWH programme in South Africa



Chapter 2

CHAPTER 2

Comprehensive and Conducive Regulatory Environment at National and Provincial level

South Africa's globally acknowledged renewable energy (RE) programme would not have been possible without natural resources in sufficient quantities to generate RE at scale, as well as an enabling operational environment that provides the opportunities and regulatory certainty required by investors. The tremendous success in developing RE in South Africa in the preceding five years is testimony to how effectively Government and industry have focused efforts to employ our readily available renewable resources towards sustainable development.

South Africa's RE policy context

A sustainable energy system, comprising economic growth, environmental sustainability and energy security performance, requires a sound, comprehensive energy strategy to balance these three elements. Such a balanced energy system has been depicted as a triangle with the three sides denoting, respectively: promoting economic development, providing energy security and access while achieving environmental sustainability. An appropriate approach to development of a sustainable energy portfolio has to take cognisance of how new development and capacity delivers against the imperatives of the energy triangle.

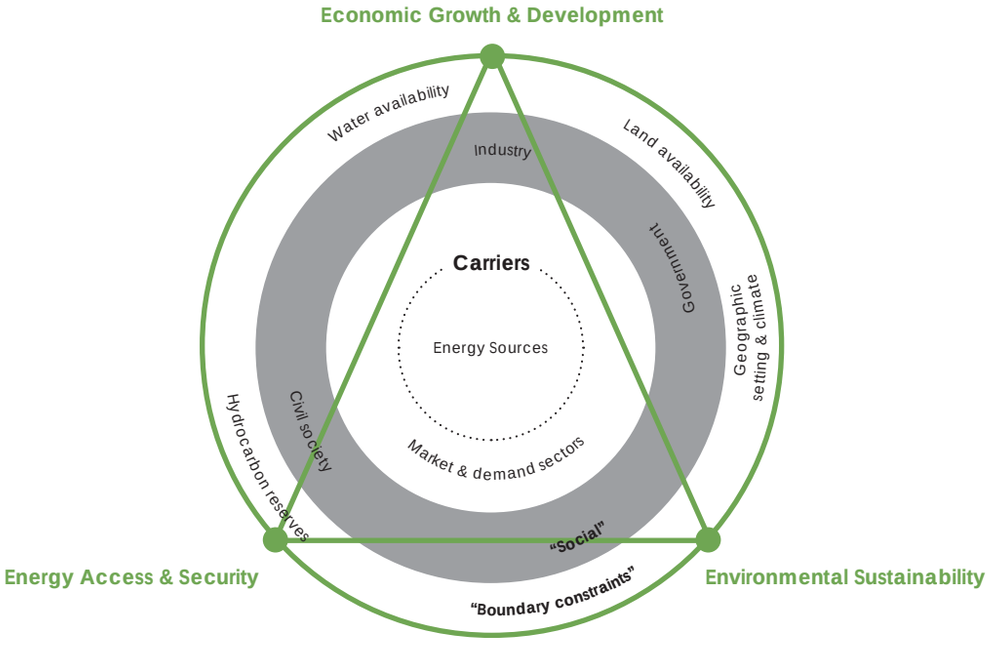


Figure 12: Energy Triangle (World Economic Forum – Global Energy Architecture Performance Index Report, 2013)

South Africa's enabling policy environment aims to achieve a balance between these three aspects, focusing on achieving a secure and diversified energy mix, including more renewables, while supporting the country's developmental needs. As the policy landscape continued to take shape on the basis of the Constitution and the two pivotal energy policy papers discussed in the preceding chapter, a

strong enabling environment has been created that aims to balance the complex trade-offs and dependencies to support all these three elements.

The previous chapter outlined the three primary, policy white papers that had shaped the RE landscape. These serve as the basis for strategy development and detailed planning in the sector.

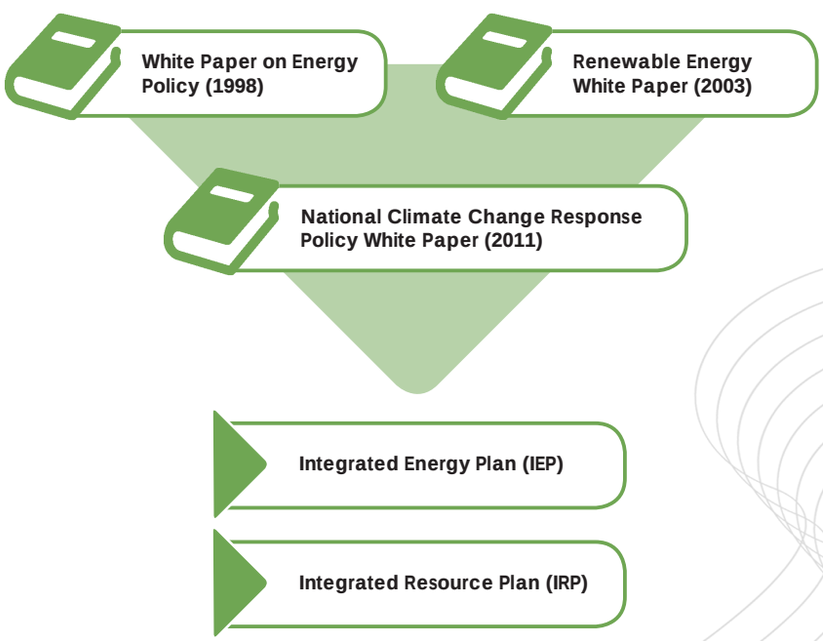


Figure 13: Policy platform for planning

The Integrated Energy Plan (IEP) and Integrated Resource Plan (IRP) are the most important documents shaping the country's energy sector, and can be regarded as the second level of implementation, with the policy papers being the first. Often confused with each other, the IEP is Government's strategic, coordinated master plan for the entire energy system that enables alignment and optimisation across the respective energy carriers and provides a coherent and holistic energy plan for the country. The IEP reflects the three developmental elements of the energy triangle with the imperative of a sustainable energy system apparent in its objectives: energy security, cost of energy, access to energy, diversification of supply sources, minimisation of emissions, promotion of localisation and technology transfer, water consumption and promotion of energy efficiency[32].

Subordinate to the IEP, the IRP (under the Electricity Regulation Act of 2006) comprises the national electricity sector plan articulating electricity policy and providing a planning framework for the management of electricity demand in South Africa. The IRP develops the preferred electricity mix and delivery timeline with which to meet the country's electricity needs over a 20-year planning horizon. The IRP 2010, the most recent plan[33] covering the period 2010 to 2030, estimates that electricity demand by 2030 will require an increase in generation capacity of over 46GW, of which 23.6GW is from renewables (including Hydro). This represents 26% from renewable energy sources, including Hydro, towards the total system capacity of 89,532MW planned for 2030.

32 Integrated Energy Plan http://www.energy.gov.za/files/IEP/IEP_Publications/Draft-2012-Integrated-Energy-Plan.pdf
33 An update to the IRP 2010 was drafted by the DoE and circulated for public consultation at the end of 2013, but has not been promulgated

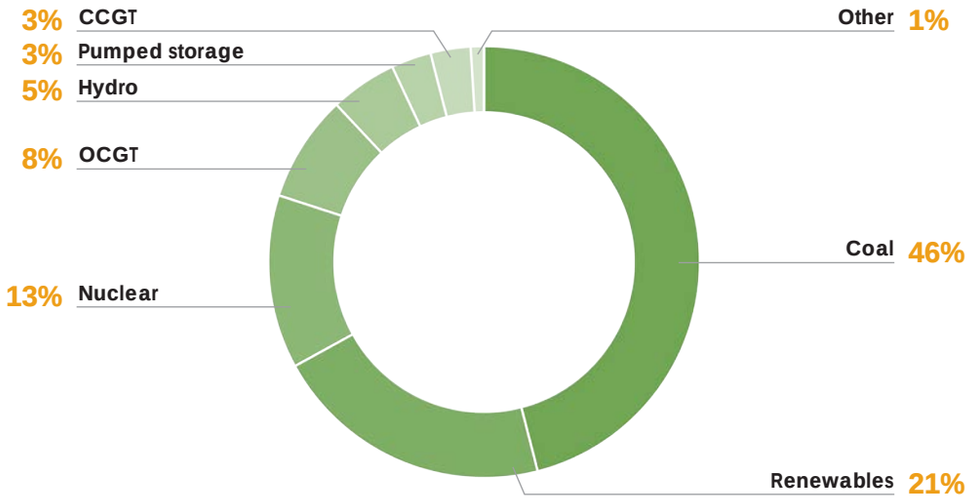


Figure 14: IRP 2010, targeted energy mix for 2030; OCGT = Open Cycle Gas Turbine; CCGT = Closed Cycle Gas Turbine

The IEP and the IRP are energy sector planning frameworks that create the context for supply side capacity development, and the issuance of a power generation licence for any new power plant is subject either to demonstrable alignment with these frameworks or an extraordinary approval from the Minister.

The National Energy Efficiency Strategy (NEES), along with the National Energy Efficiency Action Plan (NEEAP) and the Biofuels Industrial Strategy (BIS), are two further sector plans with relevance to the development of renewable energy resources in the country.

The NEES, with its supportive action plan (including the development and promotion of solar water heating in the country), targets one million solar water heaters (SWH) to be installed by 2015.

The BIS adopted a short-term focus with the aim to promote the development of a robust national biofuels industry, encourage investment in the biofuels sector and reduce the country's reliance on imported fuel. It provides for a 2% (or 460 million litres per annum) penetration level of biofuels in the national liquid fuels supply.

National and International RE and climate change targets

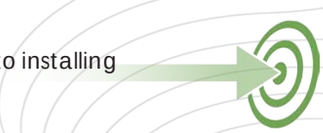
Renewable Energy White Paper (2003) targeted 10,000GWh of RE by 2013;

National Energy Efficiency Strategy (2005) set a voluntary target of reducing final energy demand by 12% by 2015;

In December 2009, South Africa pledged to take mitigation action to reduce emissions by 34% below the Business As Usual (BAU) trajectory by 2020. This is referred to as the Copenhagen Agreement;

The IRP 2010, which is the country's electricity master plan, set a target of 17,8GW of the country's 'new build'[34] generation from renewable sources (not including large-scale Hydro) by 2030;

In 2009/10 the President of South Africa and Minister of Energy committed to installing 1 million SWH by 2015.



In May 2011, the Department of Energy (DoE) gazetted the Electricity Regulations on New Generation Capacity (New Generation Regulations) under the Electricity Regulation Act (ERA). The ERA and its regulations enable the Minister of Energy (in consultation with NERSA) to determine what new capacity will be procured in line with the IRP.

The New Generation Capacity Regulations establish rules and guidelines that are applicable to the undertaking of an IPP bid programme and the procurement of an IPP for new generation capacity. These guidelines include:

- That an IPP demonstrate compliance with the IRP;
- Acceptance of a standardised power purchase agreement (PPA) by the IPP;
- Preference for a plant location that contributes to grid stabilisation and mitigates against transmission losses; and
- Preference for a plant technology and location that contributes to local economic development.

Ministerial determinations, as per the ERA and New Generation Regulations, give effect to components of the planning framework of the IRP and the NDP, as they become relevant. In three separate determinations[35] by the Minister, 6,925MW have been determined for capacity from RE sources and 2,609MW for imported Hydro. A further determination for 6,300MW from RE sources was announced by the Minster in April 2015 and gazetted on 18 August. These determinations provide a line of sight and greater level of certainty to the burgeoning industry, interested project developers and investor community.

Additional policy and regulatory developments that will facilitate the development of RE include amendments to the Electricity Regulation Act, National Energy Regulatory Act, introduction of a Carbon Tax and revisions to the Grid Code and the IRP.

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34 Planned generation capacity that had not been previously committed for development. A further 1.1GW from RE sources had already been committed for the planning period

35 Three determinations published: 1 August 2011 (RE) and 19 December 2012 (RE and hydropower)

These, and a selection of the most pertinent regulations, supportive policy papers and plans from other Government departments and agencies that delineate the energy development and investment environment in South Africa, are provided below. Together these provide the current and proposed or upcoming 'rules of engagement' for investors and developers, on which to base their investment decisions.

Considering the broad sphere of influence of electricity infrastructure development, renewable energy activities are steered by, and impact on, a broad spectrum of national objectives and spheres of Government. Although energy development is primarily the domain of the DoE, sustainable development is a shared responsibility across all spheres of government. For this reason, a comprehensive enabling platform is essential for the RE industry to operate, grow, and contribute positively to the South African economy and to the global environment.

Lead authority

national planning commission
The Presidency
REPUBLIC OF SOUTH AFRICA

Relevant focus/ contribution

Responsible for national planning, national priorities and directing the course of national development.

Most pertinent policies and regulations

National Development Plan (NDP)

The National Planning Commission was appointed in 2010 by the President to develop a long-term national development plan. Understandably a key focus of the NDP is the country's ability to return to a state of continued and uninterrupted electricity supply. This is to be achieved by increasing the electricity generation reserve margin from 1% (2014) to 19% in 2019, which will require the development of 10GW of additional electricity capacity by 2019 against the 2010 baseline of 44GW. Five of the 10GW are to be sourced from RE, with an additional 2GW to be operational by 2020.

Lead authority

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

Relevant focus/ contribution

Custodian of policy and planning for the energy sector focusing on energy security through diversifying the country's energy mix to include Renewable Energy sources.

Most pertinent policies and regulations

National Energy Act (Act No. 34 of 2008)

The Act aims to strengthen energy planning in order "*to ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy*" and more specifically to "*provide for energy planning, increased generation and consumption of renewable energies…*".

Electricity Regulation Act (Act No. 4 of 2006), Second Amendment (2011)

The Act gives power to the Minister of Energy to determine new generation capacity and to approve the generation and procurement thereof. A licence for generation capacity is subject to Ministerial approval. This establishes an enabling environment for IPPs to enter the market, the bid programme rules and guidelines as well as procurement of new generation capacity.

Amendment to the Electricity Regulations on new generation capacity (18 August 2015)

The amendment provides an extended definition of new generation facilities to include existing generation facilities not previously supplying electricity to the national grid and/or an extension or renewal of existing supply agreements from existing generation facilities for an additional period.

Biofuels Industrial Strategy, 2007

The Strategy approved the financial support (subsidies) for a national biofuels programme with a short-term strategy of 2% penetration level of biofuels in the national liquid fuel supply by 2013. The regulations to enable this programme are not yet in place hence there has been no progress in its implementation.

Biofuels Mandatory Blending Regulations, 2012

Pertinent for the implementation of the Biofuels Industrial Strategy of 2007 was the promulgation of the Mandatory Blending Regulations for the blending of biofuels with petrol and diesel.

The Regulations come into effect on 1 October 2015. The Regulations provide for all licensed petroleum manufacturers to purchase locally produced biofuels from licensed biofuels manufacturers.

Petroleum Products Act (Act No. 120 of 1997)

The Act prohibits the manufacturing of petroleum products, including biofuels, without a manufacturing licence.

Petroleum Products Amendment Act (Act No. 58 of 2004)

The Act authorises the Minister of Minerals and Energy to require licenced liquid fuel wholesalers and producers to supply and sell petroleum products made from 'vegetable matter,' i.e. 'blending' of conventional liquid fuel with biofuel. This is an important legislative vehicle for the development of biofuels in the country.

Lead authority	Relevant focus/ contribution
NERSA – National Energy Regulator of South Africa	Regulation of the energy sector in the context of national policy and planning; licensing of new energy infrastructure; regulation of electricity and hydrocarbons infrastructure tariffs.

Lead authority	Relevant focus/ contribution
Department: Environmental Affairs, Republic of South Africa	Ensuring sustainable development and environmental integrity; environmental authorisations in terms of the National Environmental Management Act (NEMA).

Most pertinent policies and regulations

Environmental Impact Assessment (EIA) 2010, under the National Environmental Management Act (NEMA) (Act 107 of 1998) and amendment Act (Act 62 of 2008)

The EIA process forms the framework for environmental authorisations. An EIA is required for RE generation projects which are[36]: > 10MW; the facility is > 1 hectare; transmission power > 33kV; and the construction of masts. Ordinarily applications are made to the provincial authority, but as projects under the IPP are treated as 'Strategically Important Development' (SID) applications, these can be sent directly to the National Department of Environmental Affairs.

Depending on the nature of the RE project the following additional licences or authorisations may be required including:

- Waste management and atmospheric emissions licence is required for high impact projects;
- Biodiversity authorisation where endangered fauna and flora are impacted;
- Water use licence when taking, storing, diverting, reducing stream flow and altering banks;
- Civil Aviation Authority authorisation when impeding an existing flight path;
- If storing a hazardous material, such as oil;
- Land use planning and sub-division requires the legal authority to do so;
- Considering the impact on buildings or sites with heritage status.

Lead authority	Relevant focus/ contribution
Department: National Treasury, Republic of South Africa	Governing fiscal and procurement policies

36 PDG (2012) Mapping of Authorisation Processes for Renewable Energy Projects

Lead authority

economic development
Economic Development Department
REPUBLIC OF SOUTH AFRICA

Relevant focus/ contribution

Responsible for economic policy, economic planning and economic development; focus on employment creation and the green economy.

Most pertinent policies and regulations

New Growth Path (NGP), (2011)

The NGP is Government's "framework for economic policy and the driver of the country's jobs strategy". Job creation is prioritised by outlining strategies to enable South Africa to develop in an equitable and inclusive manner. The NGP targets 5 million new jobs by 2020. It also aims for "300,000 additional direct jobs by 2020 to green the economy, with 80,000 in manufacturing and the rest in construction, operations and maintenance of new environmentally-friendly infrastructure"[37].

Green Economy Accord, (2011)

Supporting the NGP, the Accord was signed in November 2011 and is a comprehensive social partnership designed to grow and develop the green economy to meet the NGP objectives. Signatories to the accord include multiple Government departments, organised labour and business. An objective realised was the development of the South African Renewable Energy Council[38].

Lead authority

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

Relevant focus/ contribution

Development of local industries and trade with particular focus on green industries and job creation; attracting foreign investment.

Most pertinent policies and regulations

Industrial Policy Action Plan (IPAP) 6, (2014)

The dti plays a critical role in supporting the local manufacturing base, which includes renewable energy technology development and deployment. The IPAP is an annually updated, three-year rolling plan for industrial policy implementation; since 2011 it has specifically identified the energy sector (Solar and Wind energy; solar water heating and energy efficiency) as a priority for the country's industrial policy[39].

37 Covary, T. and van der Walt, ML. (2013) Renewable Energy Policy Mapping Study of RSA. Unlimited Energy
38 Covary, T. and van der Walt, ML. (2013) Renewable Energy Policy Mapping Study of RSA. Unlimited Energy
39 Montmasson Clair, G., Moilwa, K. and Ryan, G. (2014) Review of Regulation in Renewable Energy. TIPS pg29

How policy is integrated for RE delivery

The above policy environment integrates to deliver the permitting framework for the REIPPPP as illustrated in the diagram below (Figure 15) indicating the relevant regulatory authorities involved.

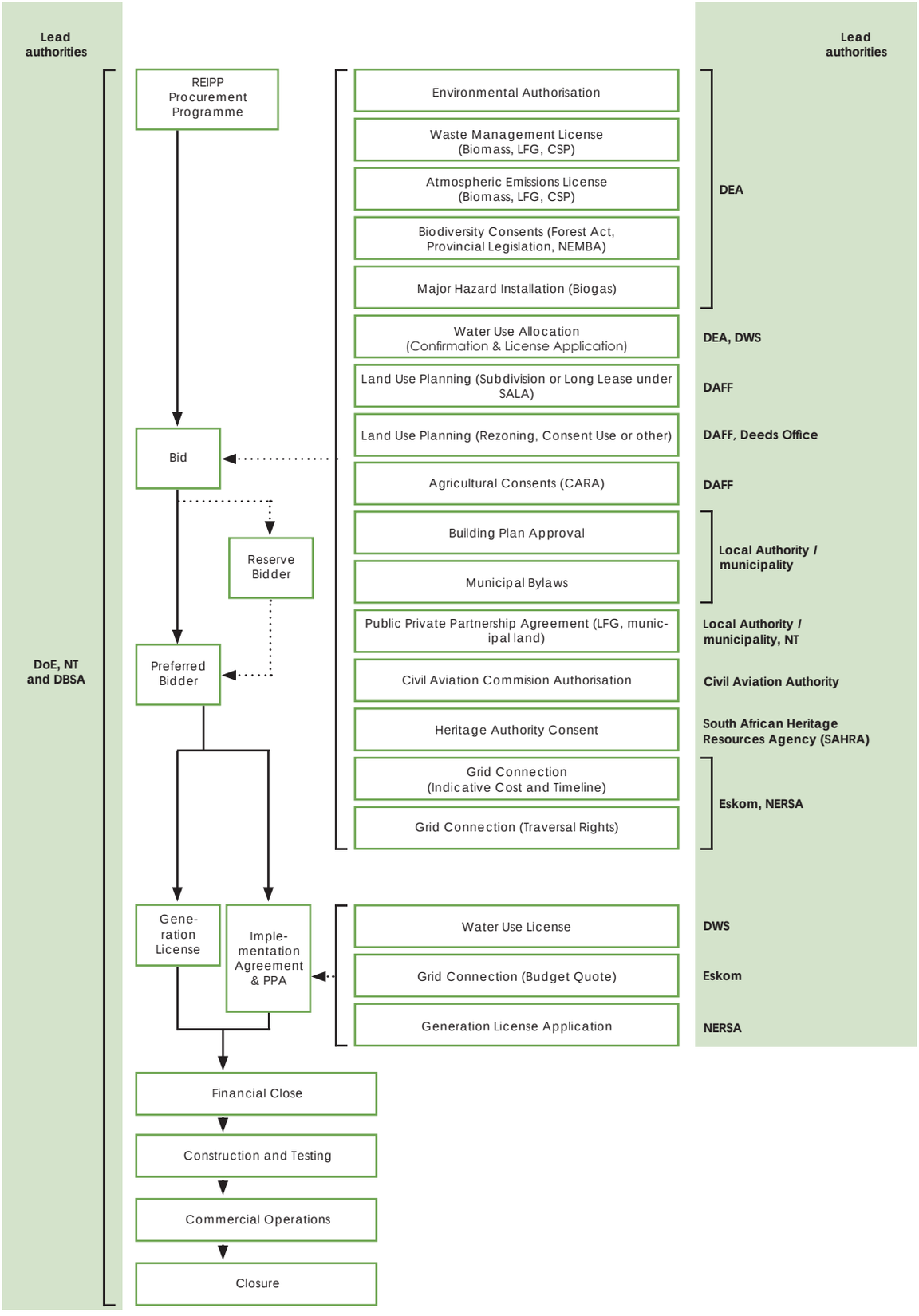


Figure 15: Indicative regulatory requirements for REIPPPP participation

The realisation of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) was dependent on a broad enabling platform, requiring successful integration and coordination across several areas and spheres of Government – at both national, provincial and local levels. The rapid development progress achieved by the REIPPPP demonstrates that the regulatory framework is suitably robust and flexible to support the emerging industry. Where necessary, regulations were adapted or amended (such as points 2 and 3 on page 35) to accommodate the sector. That said, the transaction costs of the numerous authorisations are high and administrative processes may not always be timeous or consistent. Ongoing improvements in legislation and its administration have been recognised as important in facilitating this fast growing industry.

The set of approvals illustrated are not necessarily comprehensive, but covers the majority of required consents in most cases. A comprehensive guideline for navigating this process, with full detail of each regulatory requirement, has been developed by the GIZ and is available on the websites of GIZ and their partners.

Provincial Government

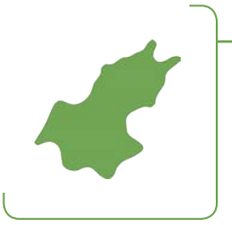
Since the formation of the Union of South Africa (1910), the Republic of South Africa (1961) and the first democratic elections in 1994, the country has had a three-tier unitary Government model: central, provincial and local. Under this model central Government formulates the country's overall policy direction from which the two lower, and subordinate, tiers of Government take their cue, though each has sufficient autonomy to take action and implement programmes best suited to its priorities, resources and circumstances. This level of independence was strengthened even further when the country's new Constitution (1996) moved away from an inter-governmental system by guaranteeing certain functions. There were several reasons that prompted this change, but a key motive was that provincial and local Government are closer to the public and thus best placed to respond to its needs.

Provincial frameworks that promote and support sustainable economic development are structured differently in the respective provinces. Provincial frameworks and structures are also informed by the availability of natural resources (Figure 21). Accordingly, each Province has taken a unique approach to renewable energy developments. The table below lists actions and programmes to enable and support national RE policy, undertaken by each of the nine provinces.

Limpopo Province

Relevant provincial department: Department of Economic Development, Environment and Tourism.

- In 2013 the Department of Economic Development, Environment and Tourism launched the Limpopo Green Economy Plan. The goals of the plan are to generate jobs, improve environmental quality, create conditions for a green economy and change behavioural and production patterns.
- The plan recognises the importance of energy in the economy and the potential for growing a green economy in the province. It identifies Solar and Biomass as the main renewable energy resources for the province.
- The province has identified the potential to develop RE through concentrated solar plants with generation capacity of no less than 100MW. Its geographic location will allow transmission and sale to Zimbabwe, Botswana, Mpumalanga and Gauteng. Potential also exists to increase capacity from small solar power plants on dwellings outside Eskom's grid.
- Limpopo has silicon reserves and the second biggest silicone smelter in the world is located in Polokwane. The plan identifies potential for beneficiation of the silicon resource, production of components for solar panels and production of solar chargers for cell phones and small-scale electrical devices as industrialisation opportunities.



Gauteng Province

Relevant provincial department: Shared by the Gauteng Department of Agriculture and Rural Development (for all environmental permissions and considerations) and the Department of Economic Development with its agency, the Gauteng Growth and Development Agency.

The province has a small geographic footprint, but high population density and concentration of economic activity. Solar and bioenergy from waste and wastewater offer the most significant resource potential.

- Department of Local Government and Housing developed a Gauteng Integrated Energy Strategy in 2010. The strategy encapsulates the vision for Gauteng as a province that promotes and implements sound energy decisions, based on principles of equity, a healthy environment, investment promotion and prosperity for all. The implementation plan has 4 year (2014), 15 year (2025) and 45 year (2055) timeframes. It aims to direct the way energy is supplied and used within the province in an integrated manner. It focuses on advancing and driving energy efficiency and support an energy syupply mix that includes RE technologies across the province. The strategy targets a RE share of 7% by 2014, 16% by 2025 and 47% by 2055.
- In 2011 the final Green Strategic Programme for Gauteng was published in partnership with the Gauteng Department of Economic Development and the Gauteng City Region Observatory (GCRO), with input from Gauteng Provincial Government departments and Gauteng municipalities.
- The strategic programme prioritises the shift towards green growth and creation of green jobs and envisages the province as a renewable energy hub.
- It identifies the need for institutional support through creation of a centre or Energy Office from where all energy matters and actions will be managed within Gauteng Province. The Office is expected to coordinate investor, municipal and sector departments' initiatives in renewable energy and energy efficiency. The Energy Office is in the process of being established.

Eastern Cape Province

Relevant provincial department: Department of Economic Development, Environmental Affairs and Tourism (DEDEAT).

The Eastern Cape has significant resource potential in terms of RE generation, with exceptional wind conditions by international standards, good solar conditions, as well as substantial potential for energy from the biomass and biofuels sectors. The province actively supports the development of RE projects and related industries.

- In 2012, the Province adopted the Eastern Cape Sustainable Energy Strategy, which focuses on improved provincial energy security and self-sufficiency, improved access to energy for all and the need to stimulate a green and low-carbon economy that creates employment.
- DEDEAT established a Sustainable Energy Forum[40] to facilitate the implementation of sustainable energy for the province. The forum aims to create an enabling environment for investment and implementation and

40 http://greenenergy-ec.co.za

covers all areas within the RE, sustainable and energy efficiency sector such as job creation, skills development, business / SMME support, REIPPPP participation and legislation.

- The DEDEAT, with support from GIZ, developed and published a REIPPPP Permitting and Authorisation Process Map and booklet for REIPP projects in the Eastern Cape to support investment.
- To enable participation by SMMEs in the REIPPPP, the DEDEAT developed the 'SMME Support Study' – with a second phase for the newly appointed IPPs under way.
- The DEDEAT issued a 'Bio Energy Support Plan' and is currently, with GIZ support, compiling a comprehensive 'Bio Energy Tool Kit' for municipalities. There are several biogas projects at schools and the research centre at the University of Fort Hare (UFH) in Alice is working on ones with dairies, bakeries and for general residential areas. All three universities in the Eastern Cape, UFH, Nelson Mandela Metropolitan University (NMMU) and Walter Sisulu University have divisions for research in RE.
- The Eastern Cape is well placed to establish itself as a clean energy manufacturing centre servicing local component targets for the national RE spend. Please refer to the Coega Box on page 44 for details.

Western Cape Province

Relevant provincial department: Department of Environmental Affairs and Development Planning (D:EA&DP).

- In 2010, Cabinet approved the Western Cape's White Paper on Sustainable Energy prepared by the provincial Department of Environmental Affairs and Development Planning. The Paper sets out the vision, policy, principles, goals and objectives to develop a sustainable energy system.
- The province committed to building a green economy, retrofitting existing public buildings with RE and improved water consumption, reducing carbon emissions per unit of Gross Provincial Product (GPP), reducing electrical consumption of provincial buildings, implementing an air quality plan, encouraging a shift from private to public transport and from freight transport by road to rail.
- In 2010 a Sector Development Agency called GreenCape was established by Provincial Government and the City of Cape Town to assist the manufacturing and employment potential in the green economy.
- GreenCape[41] is home to the RE Sector desk, which is a source of knowledge and information between industry and Government. The RE desk has forged relationships with industry, provides guidance within the region and communicates with entities such as DoE, **the dti** and NT, and remains current with the REIPPPP and legislation relevant to the industry. The desk offers a wealth of resources to support market participation by IPPs or investors in related industry or green manufacturing. The RE desk has also initiated an annual market intelligence report to guide investment decisions.
- In 2010 The Department of Economic Development and Tourism published Greentech, an important report that tracked renewable energy and energy-efficiency technology innovations relevant to the region.

41 www.greencape.co.za

- Atlantis is being positioned as a green manufacturing hub. A development facilitation team has been established to assist potential investors; streamlined application and approval processes are offered to promote Atlantis as a green technology manufacturing cluster (see the case study on page 103). Qualifying manufacturing facilities have benefited from active support by Trade and Investment South Africa (TISA), a division of **the dti**, and GreenCape.

Northern Cape Province

Relevant provincial department: Department of Economic Development (DEDT) and Tourism and its agency Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA).

Exceptionally high radiation levels make the province particularly suited for power generation from solar energy. Besides solar, the province also has potential for Wind, Hydro and Biomass power generation.

- The Northern Cape Provincial Spatial Development Framework (2012) specifically recognises the potential for solar development in the province, identified with the introduction of a solar corridor stretching between ZF Mgcawu and the Pixley ka Seme regions and the solar-themed special economic zone (SEZ) in Khara Hais Municipality.
- In 2014, the Renewable Energy Centre of Excellence (RECE) launched in the Northern Cape[42]. It serves as a platform for innovation and skills development in the renewable energy sector and focuses on unlocking potential and attracting investment.
- The province intends to become a net producer of RE to the rest of the country by 2020, inviting investment and development into the province.

North West Province

Relevant provincial department: Department of Economic Development, Environment, Conservation and Tourism (DEDECT).

The province identified high potential renewable energy opportunities within municipal waste conversion, biomass (converting alien invasive plants into energy) and solar technologies, including off-grid energy for rural areas.

- In 2012, the provincial Department of Economic Development, Environment, Conservation and Tourism and the Industrial Development Corporation (IDC) developed a Renewable Energy Strategy for the North West Province.
- The strategy identifies the following opportunities for renewable energy: solar water heating; clean cook stoves; energy-efficiency and energy-service companies; municipal solid waste; Solar PV technologies; cogeneration and waste-heat recovery; and hydrogen and fuel cell technologies.
- The North West Development Corporation[43] is actively promoting RE development and industrialisation opportunities in the province.

42 www.ewseta.org.za
43 www.ndwc.co.za

KwaZulu-Natal Province

Relevant provincial department: Department of Economic Development, Tourism and Environmental Affairs (EDTEA).

Wind, solar, biomass (most notably sugarcane fibre) and waste-to-energy offer the most significant potential for RE generation in the province. It is actively exploring and supporting development of both utility-scale and rural RE projects.

- In 2010, the KZN Sustainable Energy Forum (KSEF)[44] was established to facilitate the development of the sustainable energy sector in KZN. It is the product of the Durban Industry Climate Change Partnership Project, and is funded by the eThekwini Energy Office and United Nations Industrial Development Organisation (UNIDO).
- In 2013, The Renewable Energy Development Hub (RED Hub) was launched. It is a partnership between the provincial government, eThekwini Municipality, Ilembe District Municipality and a consortium of local and foreign firms who plan to build and operate a RE technology innovation hub. The project is expected to attract more than R2bn in private investment.

Mpumalanga Province

Relevant provincial department: Department of Economic Development, Environment and Tourism (DEDET).

Biomass from agricultural and forestry waste is considered the largest RE resource for the province. Opportunities for biodiesel production are also being investigated.

- The 2004 Provincial Growth and Development Strategy identified RE as a focus area for development.
- In 2010, the Mpumalanga Bio Energy Cluster, comprising various stakeholders from Government and the private sector, was established.

In implementing the above strategies, some of the provinces have set up industrial development zones. The East London Industrial Development Zone ELIDZ was created in 2002 in response to the need for a robust catalyst for economic development and industrial diversification in the country. It is a state-owned enterprise set up by Government through the South African Industrial Development Zones Programme (now the South African Special Economic Zones Programme) led by **the dti**.

ELIDZ aims to develop, operate and maintain modern infrastructure and attract strategic investments for the region. Since inception, ELIDZ has prioritised green, environmentally sustainable industrial development. As such, the ELIDZ targets "clean industries only", including RE-related industries. Since September 2014, ELIDZ hosts South Africa's first Solar PV panel manufacturing plant. The wafers aside (crystalline silicon will still be procured in Asia), everything is locally sourced. These locally manufactured panels meet all international standards and specifications and can, therefore, supply to the local and global market.

ELIDZ also hosts the Master Artisan Academy for becoming a solarteur (to date the first and only academy of its kind in South Africa), as well as a Renewable Energy Science Hub for research, in association with NMMU.

44 www.kznenergy.org.za supported by KZN Green Growth industry organisation www.kzngreengrowth.com

The 11,000ha Coega Industrial Development Zone, near Port Elizabeth, is South Africa's largest Industrial Development Zone (IDZ). Both national and international interest in Coega is growing and to date investments total more than R40 billion; more than 15,000 jobs have been created.

The Coega IDZ is aiming to become a leading RE hub in South Africa by hosting solutions for RE and opportunities in wind energy, photovoltaic and biomass-to-energy development. It offers available land, connection to the Eskom grid via approximately 30 substations within the IDZ, proximity to logistics solutions (such as the port), a lay down area within the IDZ designated for wind turbine components, custom built warehouses to manufacture green technologies components, green technology incentives and other IDZ-specific incentives provided by **the dti**.

How Provinces are creating favourable enabling environments
▷ The Eastern Cape example

The Eastern Cape province consumes approximately 9,538 (GWh)[45] per annum, i.e. 4.4% of the national total. With the introduction of the capacity procured under the REIPPPP, approximately a third of the province's power needs will be produced locally from RE sources[46].

In its Sustainable Energy Strategy[47], the province identified the opportunity to enable development for local electricity generation to exceed local demand within 15 – 20 years. Accordingly, the Eastern Cape's vision is to create "an enabling environment for sustainable energy investment and implementation in the country". In support of this vision, various South African government departments and international organisations have become involved in the development and implementation of innovative renewable energy programmes, and encourage the use of the energy created.

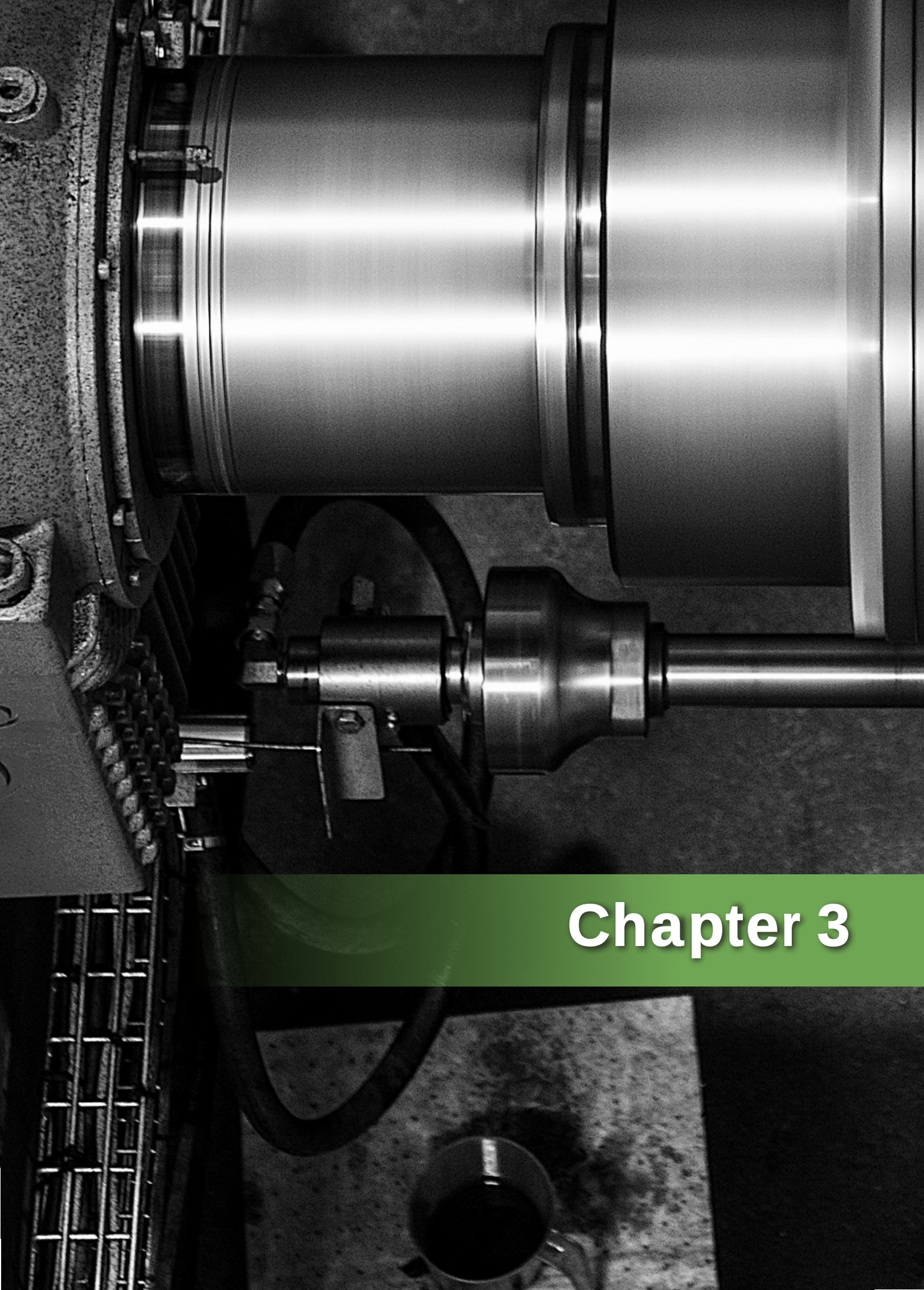
The GIZ South Africa-German Energy Programme (SAGEN), as mentioned above, has supported the DEDEAT since 2012 with general advice on RE, both for REIPPPP and off-grid electrification. Since then, the Sustainable Energy Forums have drawn more and more diverse stakeholders and the www.greenenergy-ec.co.za website was established. An Interprovincial Renewable Energy Forum has also been established, which enables exchange and updates within the provinces involved in RE.

A particular focus is the provision and support to, and training of, potential skilled labour for the ever-increasing amount of RE sector projects in the province. Skills for Green Jobs (S4GJ), a GIZ initiative, aimed to strengthen the relationship between the RE sector and the training sector via the creation of the Green Skills Forum in 2013.

A policy environment that enables RE implementation

South Africa has a robust policy environment that provides the enabling environment for the three tiers of government to effectively implement. This provides the platform for a better functioning energy sector that is vital for ensuring the citizens of South Africa can fulfil their aspirations.

45 StatsSA. 2013. Eskom energy sales to the Eastern Cape calendar year 2013
46 Equivalent volumes; in practice all energy is fed into the national grid and available nationally
47 Adopted by the Eastern Cape provincial government in 2012



Chapter 3

CHAPTER 3

Abundant and widespread renewable energy resources

South Africa's location, geography and size all play a role in providing it with multiple RE resources. A coastline of approximately 3,000km that goes around the tip of Africa, starting from the desert on the west coast and ending in Mozambique's warm tropical climate, provides favourable conditions for wind power throughout the country. Most of the country is classified as semi-arid, meaning there are large expanses of flat terrain with high irradiation, making it ideal for solar power. The east coast is tropical with large wood and sugar plantations creating biomass opportunities. Although a water scarce country, opportunities for small-scale hydropower do exist and have been exploited over the years.

Support from international agencies as well as Government have provided the technical studies and empirical evidence of the quantity and quality of available resources required by policy makers, developers and financiers. The collaboration during the preceding decade between Government, industry and international partners, has given rise to RE roadmaps or resource maps, providing collated datasets and clear guidance for resource and technology development in the country.

Wind Atlas for South Africa (WASA)

South Africa is among the countries participating in the International Renewable Energy Agency (IRENA) Global Atlas for Renewable Energy, which is used in the verification of the EUDP. The WASA project is an initiative of the South African government, the DoE, and is funded by the Global Environment Facility (GEF) via the South African Wind Energy Programme (SAWEP) with United Nations Development Programme (UNDP) support and co-funded by DANIDA (Danish International Development Agency). The development of the Wind Atlas was achieved as a collaboration between several institutions, each contributing specialised skills and knowledge to the project team:

- **SANEDI** (South African National Energy Development Institute), which is responsible for management, coordination, contracting;
- **UCT CSAG** (Climate System Analysis Group, University of Cape Town) in mesoscale modeling;
- **CSIR** (Council for Scientific and Industrial Research) for measurements, microscale modeling and application;
- **SAWS** (South African Weather Service) for extreme wind assessment; and
- **DTU Wind Energy** (Dept of Wind Energy, Technical University of Denmark), partner in all activities.

The first phase of the project was initiated in June 2009 and concluded in April 2014 with the production of the first ever Verified Numerical Wind Atlas (VNWA) in the world (see Figure 16). Additionally, the project has produced a database of wind time-series data, a high-resolution wind resource map (see Figure 17), an Extreme Wind Atlas (see Figure 18) and continues to deliver high quality wind data from 10 wind measurement stations across South Africa. Data from the 10 measurements masts have also been used to develop an observational wind atlas for each mast, and these were used to verify the numerical wind atlas (see insets on Figure 16 and Figure 17). Guidelines and tools have been developed to assist in using these products for planning and development of wind farms and off-grid electrification and are publicly available, free of charge[48]. The level of accuracy and spatial resolution of the data has proven invaluable for the planning and development of wind farms and off-grid electrification and has confirmed for the first time that South Africa not only has a good coastal, but also a good inland wind energy potential.

48 WASA project information and presentations: http://www.wasaproject.info; Online graphs of measurement stations http://www.wasa.csir.co.za/; and final reports, maps, guides and data downloads: http://wasadata.csir.co.za/wasa1/WASAData (register for free and log in)

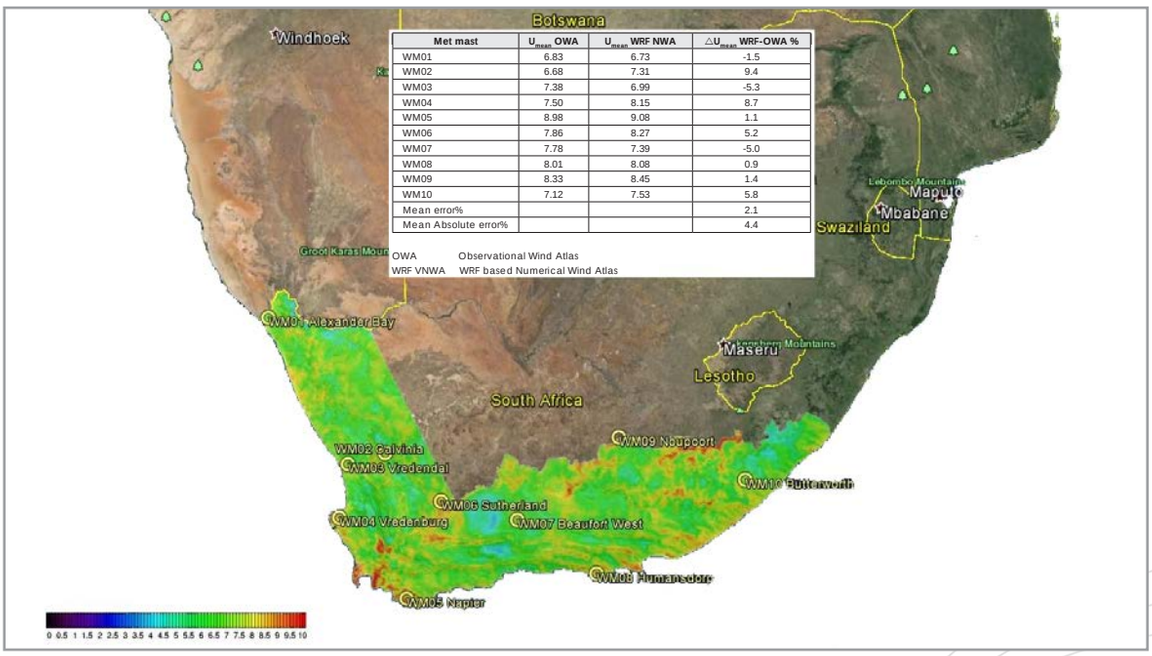


Figure 16: The first verified numerical wind atlas showing generalised wind speeds at 100 meters height (in ms^{-1}). The location of measurement mast are shown as yellow circles and the inset table indicates how closely the wind atlas results match the observational wind atlas developed at each mast

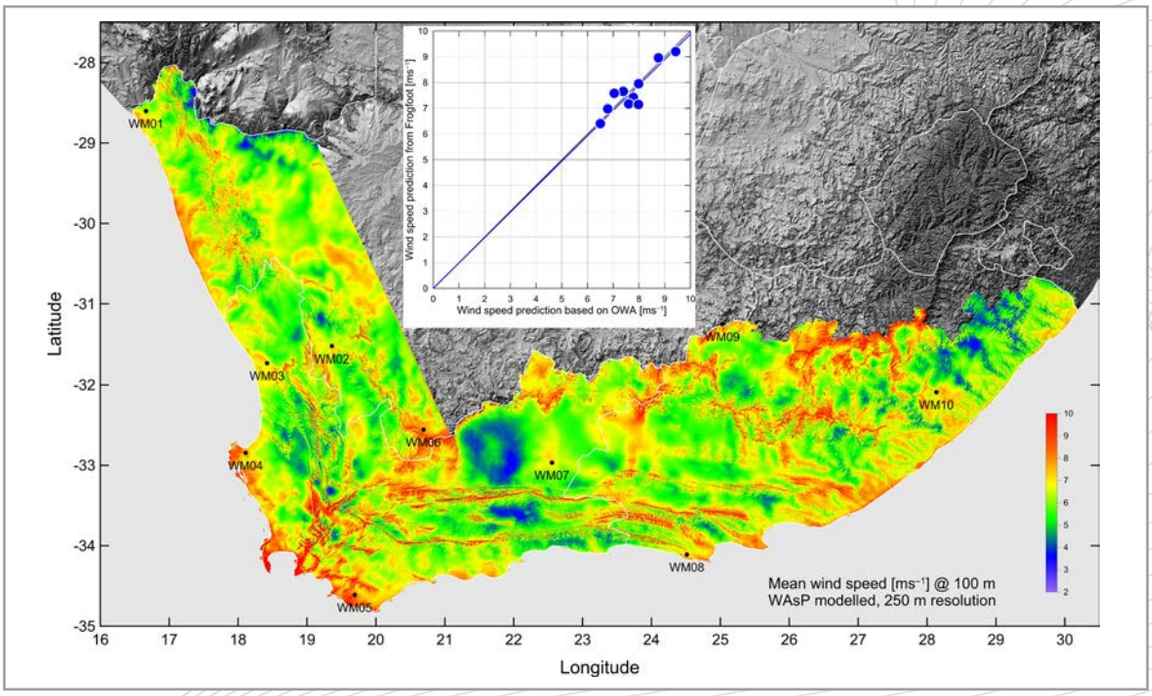


Figure 17: High-resolution wind resource map showing Mean wind speed (ms^{-1}) at 100m. The inserted graph shows the accuracy of the NWA (vertical axis) against the observational wind atlas(horizontal axis) at each measurement mast

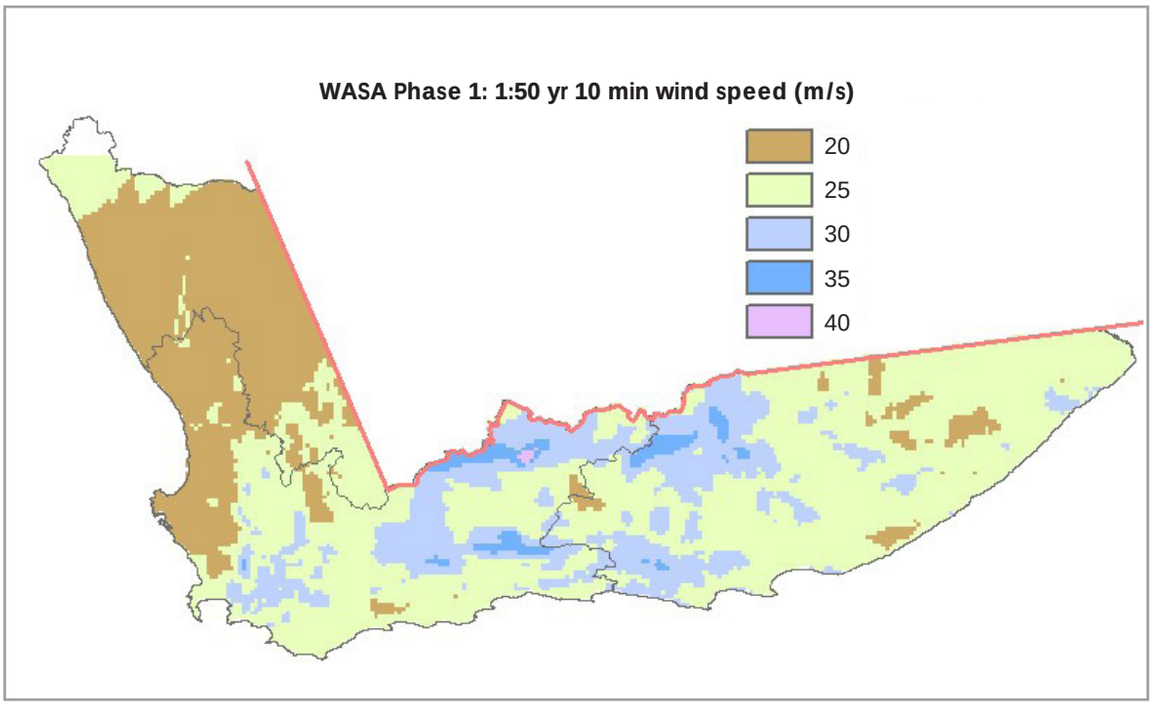


Figure 18: Extreme wind atlas showing the 1-in-50 year 10 minute wind speed

The VNWA and database can be used for estimating the annual energy production of a wind farm and the wind time series data for power system modelling. The high-resolution wind resource map, which was developed from the VNWA with local terrain data, is particularly useful for the identification of wind 'hotspot areas'. The VNWA is thus ideally suited to inform the general siting of wind farms, for strategic environmental assessment and wind farm planning and development. However, it does not substitute local, on-site measurements that are required by financiers of wind farms. The extreme Wind Atlas is useful for selecting wind turbines that can withstand extreme winds, and equally useful for informing national building standards, since wind loading is generally considered a key factor in structural design. The WASA dataset has been used for verification of the IRENA Global Wind Atlas.

In March 2013, the Danish government approved further support (DKK12 million) to expand the WASA project to cover the remaining areas of the Eastern Cape, KwaZulu- Natal and Free State provinces. Through WASA 2, an additional five wind measurements masts are being installed and will start operating from October 2015. Further to the Danish support, in May 2015 the GEF also approved funding for the SAWEP Phase 2. This support includes the expansion of WASA 2 to cover the remaining areas of the Northern Cape province, with implementation expected to start early in 2016.

South African Wind Energy Programme

The overall aim of the SAWEP Full Size Project Technical Assistance was to assist the South African Government and stakeholders in creating an enabling environment for the commercial replication of grid connected wind farms and the establishment of a vibrant and sustainable wind industry in South Africa. The objective of the project was to install and/or prepare the development of 50.2 MW (i.e. 5.2MW from Darling Wind Farm and 45 MW from IPPs) of wind power. At inception the project anticipated total emissions reductions of 4.6 million tons of CO_2 equivalent (over 20 years). The project was intended to contribute to national development objectives such as; to diversify power generation in South Africa's energy mix; to set up a wind energy industry that could generate employment and to promote sustainable development by making use of the nation's renewable, natural resources (such as wind). Key outputs include the Darling Wind Farm, a Green Power Guarantee Scheme was established at the DBSA to facilitate the signing of the Power Purchase Agreement with the City of Cape Town; Wind Atlas Project for South Africa (WASA); the revival of the South African Wind Energy Association (SAWEA) through assistance with the development of the Business Plan and initial Wind Energy Seminars which contributed immensely towards the IRP 2010-2030 target of 8,400MW for Wind.

The Terminal Evaluation Report review concluded that during project implementation, SAWEP played a highly visible, influential and critical role in catalyzing public interest in wind energy in South Africa and assisted the national governmental departments such as DoE, **the dti,** DST, National Treasury, NERSA and Eskom with the provision of relevant and required regulatory and implementation frameworks needed for investment in the sector. The SAWEP project was included as one of the 5 success case studies in the UN 2010 report on Climate Finance - Spending Wisely.

From inception, SAWEP was divided into 2 Phases.

- SAWEP I February 2008 – December 2010. Funding of USD2 Million received from the Global Environmental Facility through UNDP with about USD 600,000 allocated to WASA I; The Danish Government through the Royal Danish Embassy committed DKK 9.9 million (eq.USD1,5 million) for the WASA 1 Component.
- SAWEP II May 2015 - May 2019. The GEF confirmed USD3,5 Million in May this year, as such the project has just started.

Solar energy resource maps

Solar data and resource mapping (refer Figure 19) are being developed to promote the use of solar energy in the Southern Africa Development Community (SADC)[49] countries and to improve the quality of satellite-derived solar data available for the area. Six universities from South Africa, and one each from Île de la Réunion and Botswana, are cooperating in the Southern African Universities Radiometric Network (SAURAN) to compile high-resolution, ground-based solar radiometric data, collected from 15 stations[50] located across the southern African region. The initiative has benefitted from extensive

49 Initial focus was on South Africa. Extension into SADC recently initiated
50 Thirteen of these measurement stations are currently located within South African borders. A map of locations is available at http://www.sauran.net

financial support by GIZ, making it possible for measurement data to be publically available, free of charge, in support of industry development.

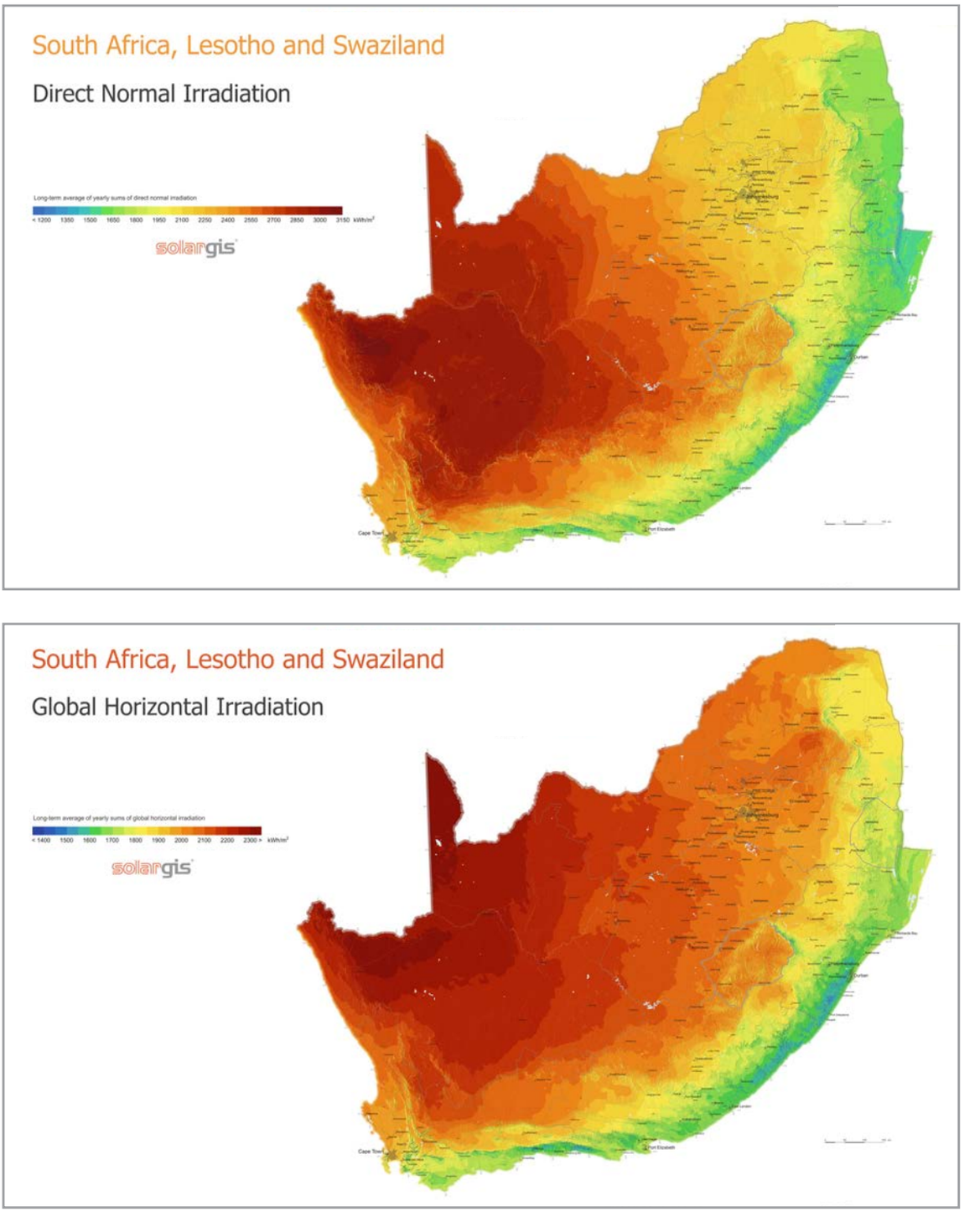


Figure 19: Solar resource maps for South Africa, Lesotho and Swaziland (annual sum of direct normal irradiation and global horizontal irradiation, kWh/m²), GeoModel Solar[51]

51 Developed in partnership between Centre for Renewable and Sustainable Energy Studies (CRSES), University of Stellenbosch and Group for Solar Energy Thermodynamics (GSET) at UKZN (2014), www.sauran.net

Solar energy is perhaps the most readily accessible RE resource in South Africa and lends itself to both solar powered heating and electricity. To unlock this solar potential, recent efforts have focused on developing more granular and credible resource data.

Solar Energy Technology Roadmap (SETRM)

The Solar Energy Technology Roadmap (SETRM) is a joint initiative of the Department of Energy (DoE) and the Department of Science and Technology (DST) supported by CSIR, SANEDI, the International Energy Agency (IEA) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), through the South Africa-German Energy Programme (SAGEN).

The purpose of the SETRM is to prepare a guide for the local development of solar energy technologies and their deployment, taking into consideration the relevant policy context and national initiatives. It is a component of a broader Solar and Wind Sector development strategy intended to support the development of green industries in the country. As such, the roadmap develops detailed information of the country's solar resources, and extends to the development of the Solar Sector, including opportunities to stimulate a local industry, build manufacturing capabilities and create employment opportunities. In recognition of the various national departments and industry players that have specific interests in respect of the development of solar energy technology in South Africa, a wide range of industry stakeholders (mainly represented through the two associations SAPVIA and SASTELA), relevant national departments and a number of academic institutions, were involved in the drafting process.

The development process, which started in 2010, was based on the IEA methodology[52] and concluded in mid-2015.

The complete solar energy technology roadmap consists of three sector components: Concentrated Solar Power (CSP), Solar PV and Solar Thermal Technologies, while drawing attention to research and development into hybrid technologies and solar fuels. The draft roadmap currently estimates that 40GW of Solar PV and 30GW of CSP can be developed by 2050 in South Africa.

South African Solar Thermal Technology Roadmap (SA-STTRM)

Parallel to the government-led SETRM, the SESSA industry with support from the Austrian government, developed a South African Solar Thermal Technology Roadmap (SA-STTRM). This is a sector-specific roadmap for solar thermal technologies. The SA-STTRM is coordinated by the CSIR and developed in partnership between the Centre for Renewable and Sustainable Energy Studies (CRSES), Sustainable Energy Society of South Africa (SESSA), Austrian Development Cooperation, Soltrain[53], and the University of Stellenbosch. It focuses on solar heating and cooling, with particular emphasis on solar water heating.

Unlocking the envisaged contribution from solar thermal technology would require an annual compounded growth rate in installed collector surface area of 25% over the next 15 years, a very ambitious target. This would require significant uptake in solar heating and cooling systems in the residential, commercial and industrial sectors in the country.

The SA-STTRM maps out the development, support and promotion of solar thermal technologies in South Africa and estimates that 4GW of solar water heating can be installed in the country by 2050.

52 IEA. 2010. Energy Technology Roadmaps, a guide to development and implementation

53 Soltrain is a 3-year solar thermal energy project set up by the Austrian Development Agency (ADA) and AEE - INTEC (Institute for Sustainable Technologies from Austria) in cooperation with Southern African educational institutions, renewable energy institutions and companies in South Africa, Mozambique, Namibia and Zimbabwe

Bioenergy

Being a semi-arid country, the availability of bioenergy feedstock in South Africa is constrained, accounting for comparatively low[54] levels of development, with utilisation confined mostly to the use of fuel wood by rural households. To better inform this view, the Department of Science and Technology (DST) commissioned the development of a Bioenergy Atlas for South Africa. The atlas, expected to be publicly available before the end of 2015, will significantly strengthen the availability of quality information on the topic, providing important input to policy and decision support.

Development of the atlas was led by the South African Environmental Observation Network (SAEON) and National Research Fund (NRF), with the assistance of a number of collaborators in academia, research institutions, and Government. This atlas was compiled over a period of two-and-a-half years with comprehensive data and thorough analysis of availability, potential (captured in a bioenergy resource map) and feasibility of the country's bioenergy resource. In developing the atlas, the potential, availability and application of biomass from household waste, wastewater and agriculture were considered. Various process technologies were also evaluated with consideration of appropriate and optimal sizes, location and type. In this, the atlas will provide invaluable guidance for project development.

The objective of the atlas is to establish a platform for continued collaboration and data sharing towards the increasing maturity of this national data resource.

Building on the work of the Bioenergy Atlas, the development of a Biomass Action Plan for Electricity Production (BAPEPSA) was initiated in November 2014. The project participants include Government departments – the DoE and Department of Public Enterprise (DPE) – as well as state owned companies (Eskom and SAFCOL), research institutions (SANEDI and University of Stellenbosch) and non-governmental organisations, i.e. WWF. It is co-funded by the Dutch government, through the Netherlands Enterprise Agency, and Eskom. The focus of the initiative is on the use of woody biomass and agricultural waste, for electricity generation (both on- and off-grid applications) in the South African context. BAPEPSA's primary objective is to identify and address the requirements for creating an environment that would enable and promote the utilisation of biomass resources in South Africa. It will also look at formulating

54 Ms. Mokgadi Modise, Chief Director: Clean Energy. 2013. Renewable Energy Resource Assessment in South Africa. Africa CEC session 3_RSA Department of Energy_Modise_220613

appropriate medium- and long-term national targets for electricity and heat production as well as opportunities for stimulating local economic and socio-economic development linked to this industry.

The outcome will be prioritised actions with timelines and responsibilities for addressing market barriers and developing market opportunities in South Africa.

Small-scale Hydro

Small-scale Hydropower is a proven, mature technology with a long track record. Although not well documented, small-scale[55] Hydro technology has played an important role in the provision of energy to urban and rural areas in South Africa. The gold mines at Pilgrims' Rest, for example, were powered by two 6kW hydro turbines as early as 1892. Two years later, a 45kW turbine augmented those turbines to power the first electrical railway in 1894[56].

In South Africa 247MW potential for new small-scale Hydro development is believed to exist in the rural areas of the Eastern Cape, Free State, KwaZulu-Natal and Mpumalanga[57] and embedded in water transfer and gravity-fed systems throughout the country. Of the country's hydro potential, South Africa only has an installed capacity of 38 MW.

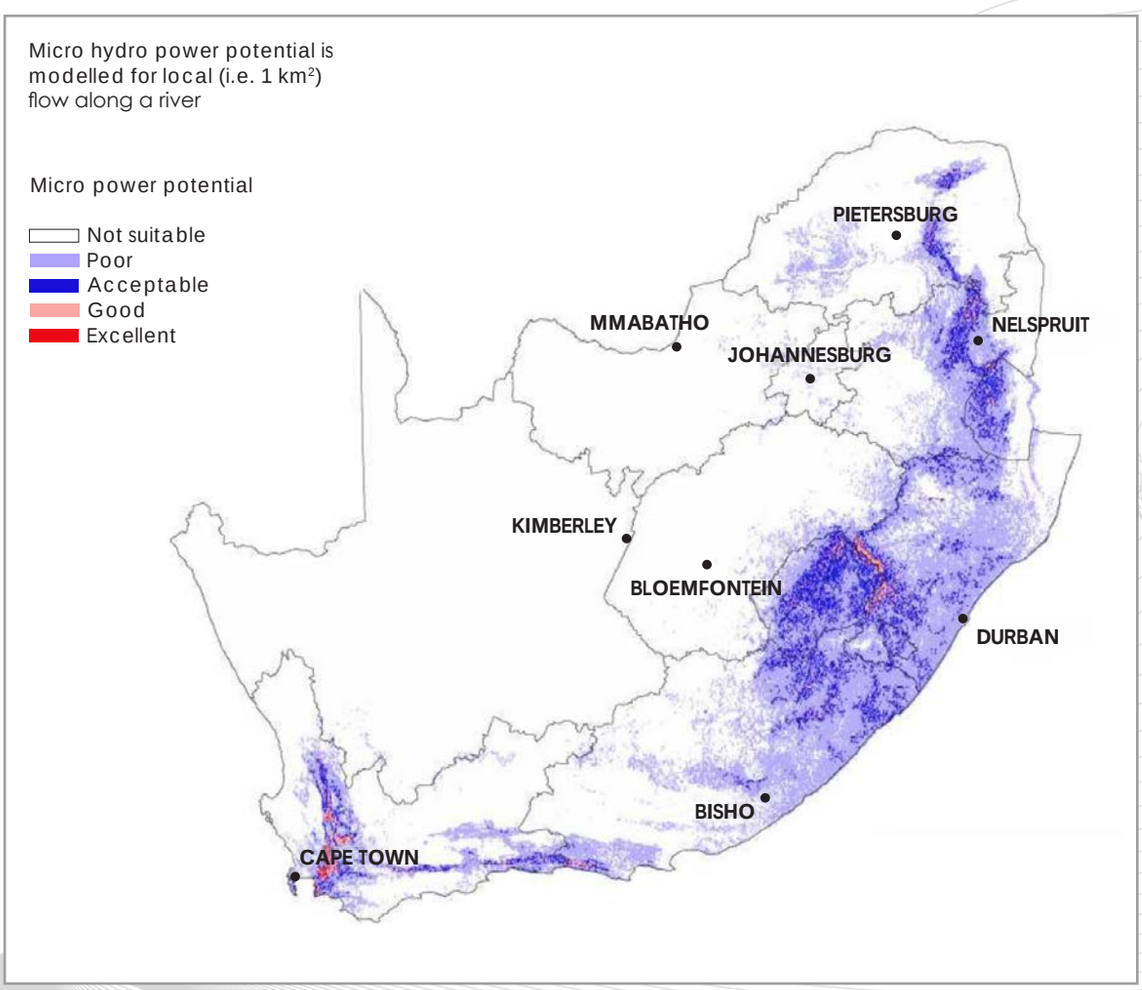


Figure 20: South African Renewable Resource Data - Micro Hydro Power Potential (DME, Eskom, CSIR, 2001)

55 An upper limit of 10MW installed capacity is used when referring to 'small-scale' hydropower (new definition of up to 40MW introduced in June 2014, smallhydroworld.org)
56 Klunne, W. J. 2013. Small hydropower in Southern Africa – an overview of five countries in the region. CSIR
57 Barta, B. 2002. Capacity building in energy efficiency and renewable energy. Baseline study on Hydropower in South Africa and Barta, B. 2011. Renewable energy: hydropower
58 DWA (now DWS). 2011. Appraisal of Feasibility of Retrofitting Mini Hydropower Plants on DWA Dams.

Currently Eskom is operating four large hydropower stations and two small hydro power stations, while local municipalities own at least two operational systems. Integrated in the water infrastructure eight systems are currently operational with a substantial number currently at different stages of development. Next to a very substantial number of privately owned systems, six IPPs are currently feeding power into the national grid (three of which are part of the REIPPPP) and it is estimated that between 50 and 60 systems have been installed underground in mines in the country. No recent study has been conducted on the full potential of hydropower in South Africa.

To support the development of small-scale Hydro resources, the South African government, through the Departments of Energy, Water and Sanitation and National Treasury, conducted a feasibility study[58] in 2011 for small-scale hydropower at twenty-six dams; part of the National Water Resource Infrastructure under the Department of Water and Sanitation (DWS). The study identified 22 sites with high potential feasibility for development. Based on the study findings, policy to regulate the development of these resources is being augmented by the DWS.

Continuous refining of RE resource data

With consideration of the resource mapping, it is evident that the type and extent of RE opportunities vary among provinces; the most prevalent RE opportunities per province are indicated in Figure 21. RE resources not shown are not absent, but relatively small compared to the highlighted resource opportunities. For instance, landfill and cogeneration opportunities exist in all large cities and are not specifically shown here.

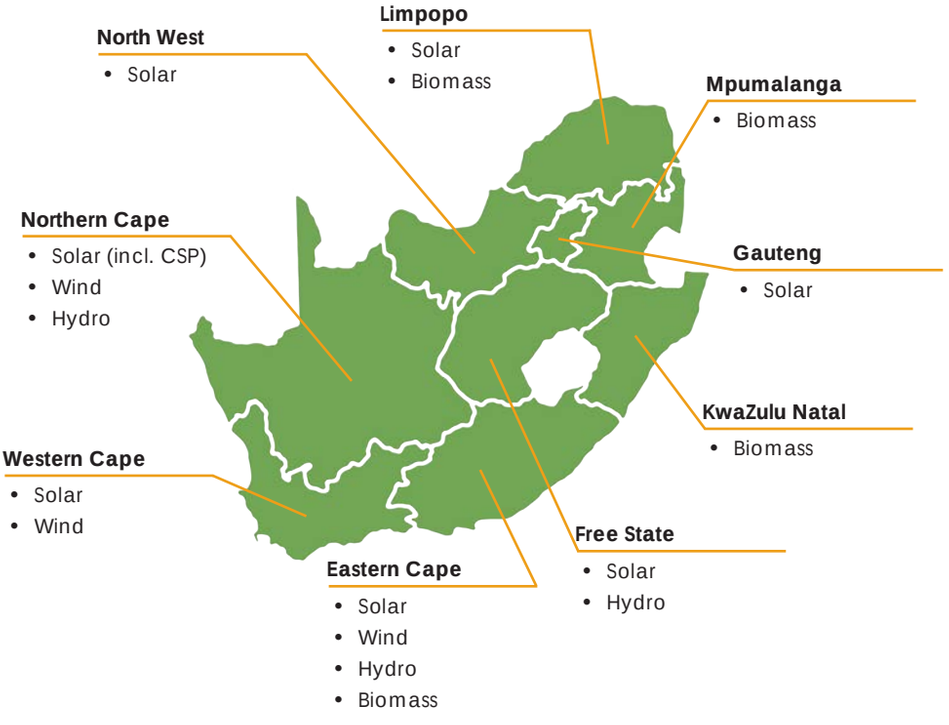


Figure 21: Provincial distribution of RE resources

South Africa's sizable footprint of plentiful RE resources have been well documented and has been well-accepted by investors and developers. Efforts to expand and refine resource maps with high quality, credible data are continuing.

58 DWA (now DWS). 2011. Appraisal of Feasibility of Retrofitting Mini Hydropower Plants on DWA Dams.

An industry structuring itself to participate

The number of industry stakeholders reflects the wealth of resources South Africa offers. Entities with interest in the development of RE and the green economy span a wide range of stakeholders, including various national departments and industry players, academia, local/international institutions and the private sector, as illustrated in Figure 22.

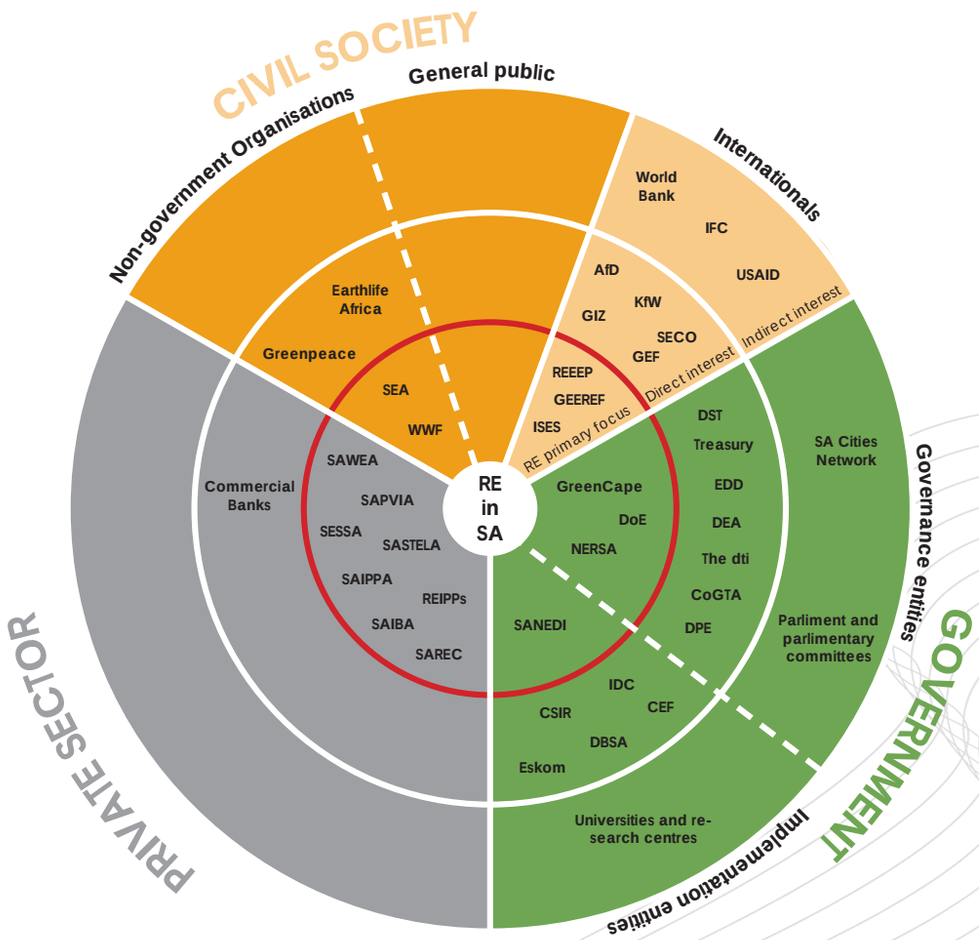


Figure 22: Main RE industry role players in South Africa

Interest in sustainable energy practices has a long history in South Africa and was active even prior to the release of the Energy White Paper in 1998. Of course, during those early days it represented a very small, but vocal, percentage of the overall population. The Sustainable Energy Society of Southern Africa (SESSA) was founded in 1974 by academics and other enthusiasts. SESSA is a national section of the highly regarded International Solar Energy Society (ISES), which was formed in 1954 and became a United Nations accredited body in 1963. Lobbying for RE prior to the release of the Renewable Energy White Paper in 2003 was difficult – funding was unavailable, the technology was expensive and unproven to many but, most importantly, commercial opportunities were virtually non-existent. During this time the work of a few committed individuals and funding provided by international agencies made all the difference. An example is the United Nations Environment Programme (UNEP), which funded the Market Survey of Solar Water Heating in South Africa. At the time little attention was given to Solar Water Heaters[59] (SWH) as there was an over-supply of electricity, tariffs were cheap and there were many vested interests to maintain the status quo of electric water heaters. The study, published

59 Market Survey of Solar Water Heating in South Africa for the Energy Development Corporation (EDC) of the Central Energy Fund (CEF) by Dieter Holm for SolaSure

60 http://www.theguardian.com/environment/2015/jun/01/how-renewable-energy-in-south-africa-is-quietly-stealing-a-march-on-coal

in 2005 but started a few years earlier, was seminal in the launch of a SWH incentive programme launched and funded by national Government in 2008. This is not an isolated example. Additional instances of early support are listed below and serve to illustrate rather than provide a definitive list:

- Concentrating Solar Power for Africa Study (1999), World Bank $0.75m;
- RE Market Transformation (2007), GEF World Bank $6m;
- Darling Wind Project (2001), Danish Development Assistance Programme DKK15.1m;
- South African Wind Energy Programme (2008), Global Environmental facility through the UNDP (GEF/UNDP) $2m; and
- The GTZ (currently GIZ) supported research into the viability of solar cookers for South Africa (1996-2000), €3 million.

For all the good work done by industry associations, which had grown in numbers by 2005, in response to the pronouncements made in the Energy Policy (1998) and Renewable Energy White Papers (2003) to represent the various RE resources (such as Wind, Solar PV, CSP and others), they remained under-funded, lacked influence and remained unstructured. This changed with the announcement of the REFIT programme in 2009 and the subsequent change to REIPPPP shortly after. The CEO of the South African Renewable Energy Council (SAREC), aptly described the resulting shift as follows: "In the last 16 years the best way to describe it [the transition to RE sources] is that it's a rocket launch after a very slow countdown."[60]

The sector has attracted foreign interest and investment, with many of the world's leading RE companies setting up offices in the country. Local companies also recognised the opportunities and expanded their services; for example, all investment banks are now funding projects, many of the large legal firms have introduced legal services to support the industry and consulting companies are providing RE services. All of these were largely non-existent prior to 2008. In addition to private sector companies, each technology has started its own industry association. The main industry associations are:

- **South African Wind Energy Association (SAWEA):** Representing the wind industry, membership is made up of national and international entities in the entire wind energy supply chain. The association is affiliated to the Global Wind Energy Council (GWEC). SAWEA has been instrumental in securing a large share of the total planned capacity for Wind energy in the IRP 2010. SAWEA, in partnership with the GWEC, has successfully established the annual WINDABA industry conference.
- **South African PV Industry Association (SAPVIA):** A not-for-profit association representing members largely made up of developers, manufacturers and service providers operating within the Photovoltaic (PV) industry. The association is devoted to promoting the growth of South Africa's Solar PV electricity market and representing the industry to provincial and national Government.
- **Southern Africa Solar Thermal and Electricity Association (SASTELA):** Promoting the deployment of Concentrated Solar Power (CSP) stations as well as the localisation and industrialisation of CSP components in the SADC region.
- **Sustainable Energy Society of Southern Africa (SESSA):** The longest standing sustainable energy association in South Africa was founded in 1974. It is a member of the International Solar Energy Society (ISES). SESSA supports energy efficiency and RE with the focus on Solar Water Heating and small scale (residential) PV installations.
- **South African Independent Power Producers Association (SAIPPA):** The association promotes the interest of IPPs, and considers all energy generation.
- **Southern African Biogas Industry Association (SABIA):** Established to represent the diverse biogas industry in South Africa. SABIA aims to promote the needs of industry stakeholders and facilitate the development of a prosperous biogas industry in Southern Africa.

60 http://www.theguardian.com/environment/2015/jun/01/how-renewable-energy-in-south-africa-is-quietly-stealing-a-march-on-coal

During 2011, the South African government articulated and communicated a comprehensive, ambitious vision regarding the creation of a Green Economy. This was done through the National Economic Development and Labour Council (NEDLAC)[61] structures and led to multi-lateral conversations between Government, Business (Business Unity South Africa/ BUSA), Labour and Communities. The RE community took part in these conversations and assisted in the development of the Green Economy Accord, which was signed in November 2011. On page 19 of the Green Economy Accord, the following is said: "establish an organisation that will facilitate the renewable energy sector working in partnership with other social partners in the development of the sector." Subsequent to the above and after indications of support from Government, four industry associations – SAWEA, SAPVIA, SASTELA and SESSA – formed the South African Renewable Energy Council (SAREC).

SAREC is now fully constituted, has an office in Johannesburg and fulltime staff. This was largely achieved with the financial support of the GIZ SAGEN programme. The main objective of SAREC is to promote the RE sector in South Africa by acting as an umbrella body to the industry associations representing specific RE technologies (such as Wind, Solar and Biogas) and to act as a collective custodian and voice for the RE industry in South Africa.

Mr Moeketsi Thobela, CEO of the South African Photovoltaic Industry Association (SAPVIA)

Mr Thobela was appointed as the CEO of SAPVIA in October 2014. An electrical engineer born in Benoni, east of Johannesburg, he has worked at Eskom's nuclear power station and more relevantly was part of the team that developed wholesale tariff at Eskom.

For Mr Thobela, three projects stand out that supported the development of the RE industry; (i) the DANIDA[62]-funded establishment of the Renewable Energy Finance and Subsidy Office (REFSO), at the then Department of Minerals and Energy, to provide capital grants to qualifying RE projects. National Treasury (NT), which was a bit sceptical at the time about prospects for the fledgling RE industry, had nevertheless set aside R14 million, over three years, for this purpose. REFSO's launch towards end-2005 was, however, a bittersweet victory as the funding at its disposal was inadequate to support projects meaningfully. Consequently, the uptake of grants was initially slow, which ironically risked confirming NT's view that there was no market to support. But the REFSO team finally got it right and six projects, with a total installed capacity of 23.9MW, were subsidised under the capital grant programme. A further notable achievement was that, during the preparation of the REFSO project, the idea to introduce a levy on the electricity tariff to fund a REFIT, was developed. This was presented to NERSA and, in Mr Thobela's view, planted the seed for the creation of the 2006 Request for Proposals (RFP) that called for a study to develop a REFIT for South Africa. REFIT eventually paved the way for REIPPPP.

(ii) The second project was with the Norwegian government, and incorporated support for small-scale Hydropower projects. This included support for feasibility studies, as well as setting up guidelines for assessing applications for water use licences, as in such cases 'use' was understood as 'non-consumptive'.

(iii) The third milestone project was the GEF World Bank-supported Renewable Energy Market Transformation (REMT) programme, a matching grant facility that was co-funded by the DoE and administered by the Development Bank of Southern Africa (DBSA). REMT provided grant funding for power generation projects and solar water heating initiatives in South Africa.

61 National Economic and Labour Council, a vehicle for cooperation between Government, Labour, Business and community organizations. It focuses on problem-solving and negotiation on economic, labour and development issues, and related challenges facing the country
62 Danish Development Agency

Advocate Johan van den Berg, CEO of the South African Wind Energy Association (SAWEA)

Mr Van den Berg is the CEO of the South African Wind Energy Association (SAWEA), the Chair of both the South African Renewable Energy Council (SAREC) and the African Private Sector Focal Point for the Africa-EU Energy Partnership. A barrister, he has spent 18 years in dispute resolution; environmental mediation; climate change avoidance/emissions trading and RE in southern Africa. He is a member of the Ministerial Advisory Committee on Energy.

For Mr Van den Berg, the birth of the RE industry was the Darling wind farm demonstration project in the Western Cape. The site was first identified and secured in 1997, but it took 11 years before it started producing electricity in 2008. As a director of the company from 2005 until 2008, he learned the trade on this project. Mr Van den Berg reflects that, during that time, Darling was the "beacon of hope" for the RE industry and became the centre piece of successive conferences in 2002 (World Wind Energy Conference in Cape Town and the World Summit on Sustainable Development in Johannesburg). The then Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka, also provided strong support.

It was to be expected that the first RE project in the context of South Africa's coal-dominated electricity generation was not going to be straightforward, and the project was not short of controversy, financial constraints, contractual disputes and other issues that resulted in delays, financial losses and a reduction of output from 13 to 8GWh. It also did not result in the RE 'floodgates' opening, as was hoped at the time. However, many positives were derived. It created human capacity with several individuals involved with the process still working in Government and the private sector; resulted in training programmes being developed; identified the regulatory issues which needed to be addressed; and ultimately demonstrated to everybody what a wind farm looks like.

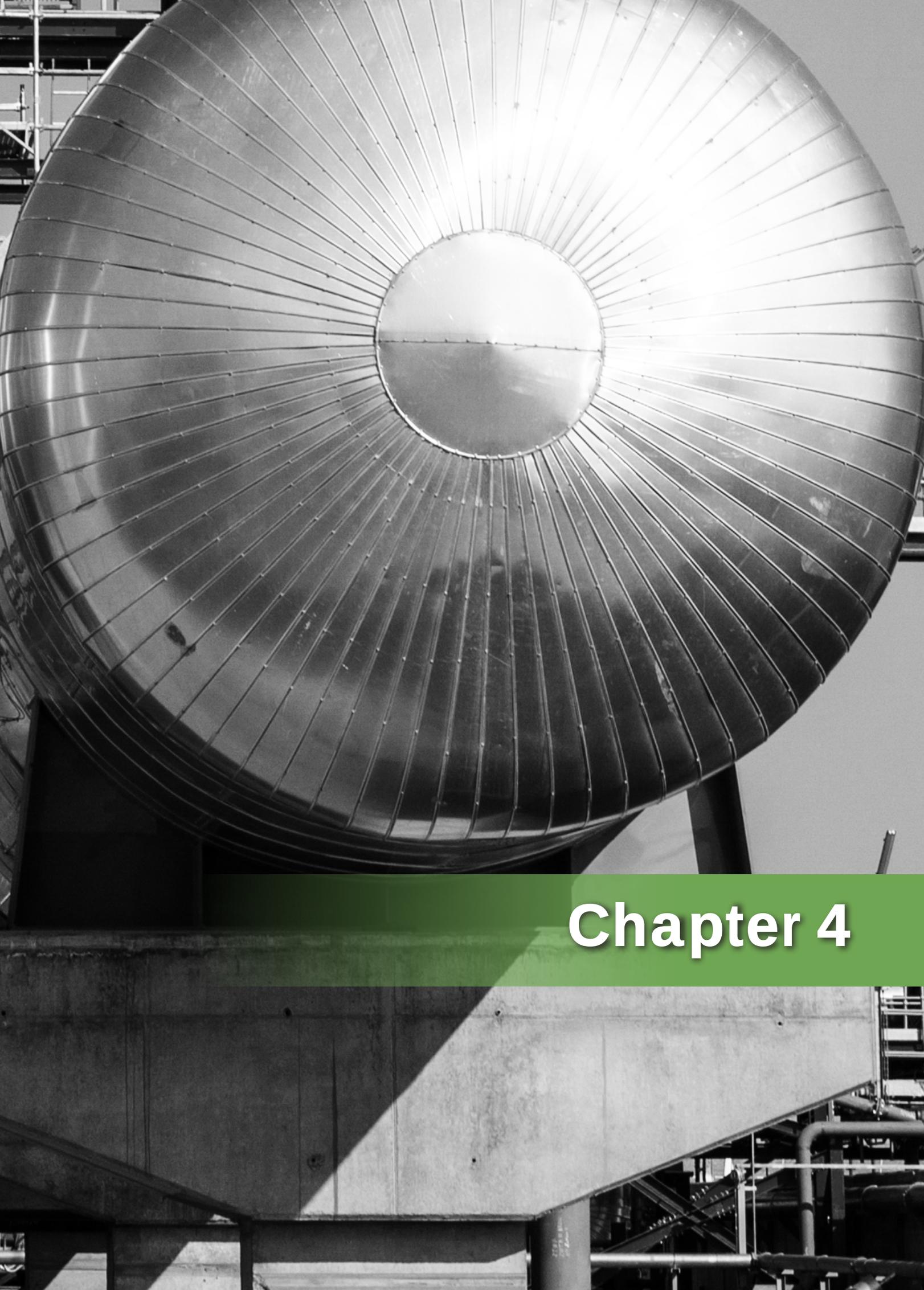
Mr Van den Berg believes that many deserve credit, though without the perseverance of Herman Oelsner and the financial support of DANIDA, the project would probably have faltered. The Darling wind farm project gave SAWEA impetus and focus and resulted in it being operational before the REFIT and REIPPPP programmes came into being. This was a unique situation as the international norm is for industry associations to form after commercial certainty has been secured. The converse allowed the association to be ahead of the curve and help shape the industry.

Post-2005, the RE programme benefited greatly from GIZ support. For Mr Van den Berg they played a crucial role early on with their focus on capacity development and by organising study tours for industry and Government officials. The obvious benefit of these study tours was the demonstration effect of visiting international RE projects. The second, and in his opinion the more crucial benefit, was that these trips facilitated discussions between the stakeholders in a conducive environment, creating new relationships between industry and Government.

Mr Van den Berg believes that it was on one these trips that NERSA realised the urgency of introducing an RE programme if the country was to have any chance of reaching its 10,000GWh RE target by 2013. This contributed to the accelerated publication of the REFIT tariffs, which in turn resulted in an investment of over R500 million by international companies in feasibility studies, establishing local offices and preparation.

GIZ went on to support the establishment of SAREC by providing funding of R1 million over an eighteen month period. This paid for constituting the association, securing offices and developing a promotional video. The ability of SAREC to organise itself in such a short period of time enabled it to be part of the Green Economy Accord with a direct line to national Government.

As the CEO of SAREC and SAWEA, Mr Van den Berg continues to contribute to the RE industry. He is positive about the future of RE in South Africa, which he ascribes largely to the existence of a world class REIPPPP and the IPP Office, which he considers to be a beacon of excellence.



Chapter 4

CHAPTER 4

Market overview and current levels of renewable energy deployment

From small beginnings and pioneers...

Historically, in terms of renewables, solid biomass and waste represented the largest renewable energy (RE) contributor in South Africa, estimated at 10%[63] of total, primary energy consumption in 2010. The largest share of biomass energy has been consumed in the residential sector among rural and low-income, urban households for cooking and space heating. Although a RE source, biomass in this application is not always utilised in a sustainable way. A smaller share of biomass energy, mostly in the form of agricultural waste or by-products, has been used in industrial processes or for on-site electricity generation. Other small-scale RE applications include decentralised energy services (such as solar and wind pumps) in remote, non-electrified areas. Measures implemented to displace electricity usage include passive solar design and solar water heating. None of these, however, made a marked impact on total energy consumption in the country.

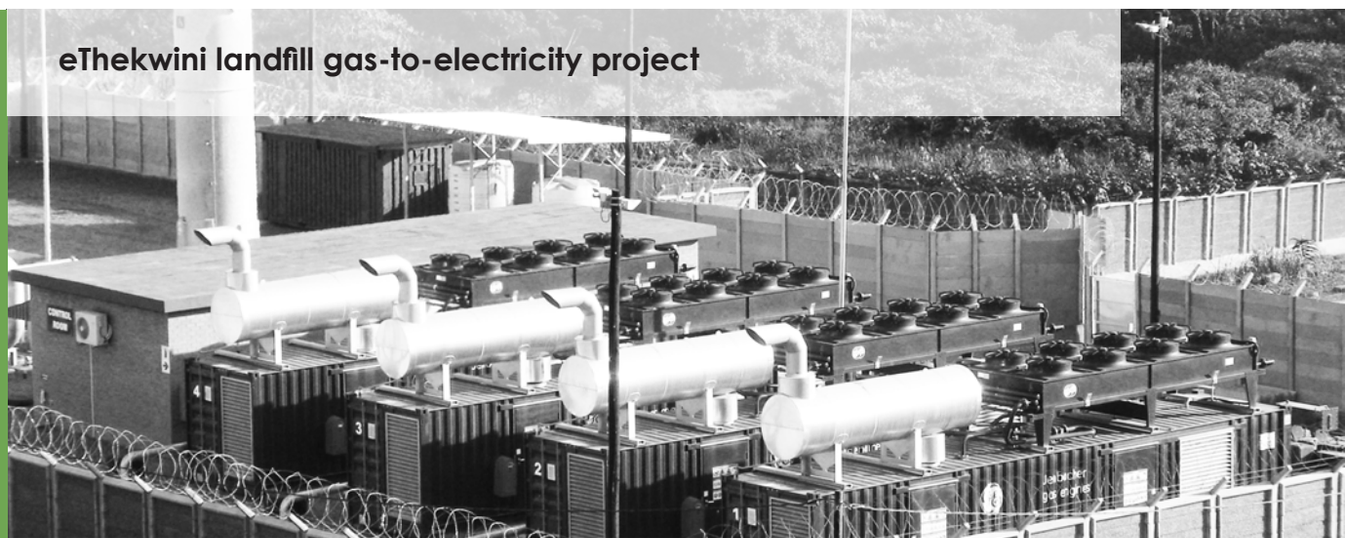
Prior to 2012, the contribution of RE to modern energy applications was limited to a small number of initiatives. Only Hydropower made a small, but recognisable contribution to mainstream electricity production.

In the wake of the 2003 Renewable Energy White Paper, a handful of pioneering organisations, companies and individuals led the way in developing RE generation projects. Despite the national policy direction, the regulatory and legislative environment for RE across all spheres of Government remained unchartered. Successful delivery of a RE project during this time relied in equal measure on technical and financial rigour as it did on perseverance and commitment to develop and navigate the regulatory requirements for generation licences, water use licences, environmental impact approvals and local bylaws, among others. It also required power purchase agreements to be established with local authorities under the stringent guidelines of the Municipal Finance Management Act (MFMA). These projects often had to draw on international donor funding support or supplemental, green funding mechanisms – including Clean Development Mechanism (CDM) – to offer a cost-competitive alternative to low cost national electricity supply. The unwavering commitment to RE solutions and perseverance demonstrated in an environment that was either not conducive to, or new to (and therefore mostly ignorant of) RE, make acknowledging and celebrating the achievements of the early trailblazers and their projects all the more important.

A few of the pioneering initiatives that demonstrated successful RE applications in the South African context in the decade to 2012 include Bethlehem Hydro, eThekwini Landfill Gas, Darling Wind Farm and PetroSA Biogas Power projects.

63 IIED Briefing, REEEEP. Aug 2013. South Africa biomass energy: little heeded but much needed; and Holm, D. Banks, D., Schäffler, J. Worthington, R., and Afrane-Okese, Y. March 2008. Potential of RE to contribute to national electricity emergency response and sustainable development. Renewable Energy Briefing Paper for the Trade and Industry Policy Studies (TIPS)

eThekwini landfill gas-to-electricity project



Owner: eThekwini Municipality

Developer: Various

Location: Mariannhill and Bisasar, Durban, KwaZulu-Natal

Capacity and annual energy production: 7.5MW; 45GWh per annum

Date project commissioned: 2006 and 2008 (initial investigation in 1994, first contact with Carbon Fund 2001)

Commercial arrangement: The capital and operating expenditures of the project are supported by two revenue streams: the sale of carbon credits and the sale of electricity. The electricity sale was facilitated through a Power Purchase Agreement (PPA) between the eThekwini Cleansing and Solid Waste Department (as the project developers) and the municipality's Electricity Distribution Utility at a rate equivalent to the Eskom standard.

Description: Landfill gas-to-electricity project implemented at two landfill sites, Mariannhill (1MW) and Bisasar (6,5MW). At both sites gas is collected and harvested, and burned in a spark-ignition gas engine that drives a generator to produce electricity, which is then fed into the municipal grid.

Challenges: As the project was the first of its kind in South Africa, several barriers had to be overcome throughout the process. Low electricity prices, at the time, impacted on the financial viability of the project. There were lengthy Environmental Impact Assessment (EIA) processes. Community and stakeholder education and engagement, relating to the new concept, had to be carried out. Municipal procurement processes had to be negotiated. There were extensive and costly monitoring and verification requirements to qualify for carbon credits – and, to add to the degree of difficulty, the carbon price collapsed. Lastly, the project required an attitude of 'learning by doing' from all participants.

Highlights: A first of its kind in landfill gas-to-electricity and the first registered and verified CDM project in South Africa.

- It has created permanent jobs within the City and 'own generation' contributes to reducing municipal electricity costs.
- The City also visibly demonstrates its strong commitment to carbon mitigation and carbon abatement, as well as to improving air quality for the surrounding communities.

International support or supplemental funding: World Bank-PCF, **the dti**, DoE (under the REFSO scheme), French Development Bank, eThekwini Municipality and reliance on the sale of Carbon Emission Reductions (CERs) under the UNFCCC[64] Cleaner Development Mechanism to made the project viable.

PetroSA Biogas-to-Energy[65]

Owner: MethCap SPV1 (Pty) Ltd.

Developer: MethCap, a WSP Group Company, the Central Energy Fund (CEF), NRG and a group of empowerment investors.

Location: PetroSA Gas-to-Liquids Refinery, Duinzicht, Mossel Bay, Western Cape.

Capacity and annual energy production: 4.2MW; 31GWh per annum.

Date project commissioned: 2007 (CDM registration requested in 2003).

Commercial arrangement: Plant owned, operated, and maintained by MethCap SPV1 (Pty) Ltd. Established as an on-site IPP, financed from two essential revenue sources: Electricity sales to PetroSA and the sale of Certified Emissions Reductions through the CDM.

Description: Waste biogas from the treatment of waste process water (using anaerobic digesters) is captured, piped to three GE Jenbacher reciprocating gas engines to generate electricity that is used on-site by PetroSA.

64 United Nations Framework Convention on Climate Change
65 http://cdm.unfccc.int/Projects/DB/PriceWaterhouseCoopers1148482596.97/view

Challenges: None noted, but duration from initial request for registration under the CDM until the eventual start of construction in October 2006 suggests a lengthy process.

Highlights: A first for petrochemical plants in South Africa.

- A share of carbon credit revenue is used to fund the creation of sustainable commercial farming operations in the local community.
- Achieved first prize for best Public-Private Partnership and highly commended in the Innovation Award for Sustainable Construction in the Construction World's Best Projects Awards for 2007.
- Second beneficiary of the DoE Renewable Energy Finance and Subsidy Scheme.[66]

International support or supplemental funding: Dependent on CO_2 emission reduction credits generated under the CDM.

Darling Wind Farm

Owner: Darling Independent Power Producer (DARLIPP)

Developer: DARLIPP in partnership with the Central Energy Fund and the City of Cape Town.

Location: Darling, Western Cape.
Capacity and annual energy production: Project was originally designed to have an installed capacity of 13MW. However, due to technical problems and the project's inability to comply with guarantees and standards, it was reduced to 8MW.

Date project commissioned: 2008 (site identified by project partners in 1997, sod turning ceremony 2007).

66 Minister of Energy (Ms Buyelwa Sonjica) speech at the launch of the PetroSA Biogas-to-electricity project

Commercial arrangement: Long-term power purchase agreement (PPA) with the City of Cape Town.

Description: Developed as a demonstration site.

Challenges: Being the first large RE project in the country, the project tested many of the existing but, up to that point, unused regulations:

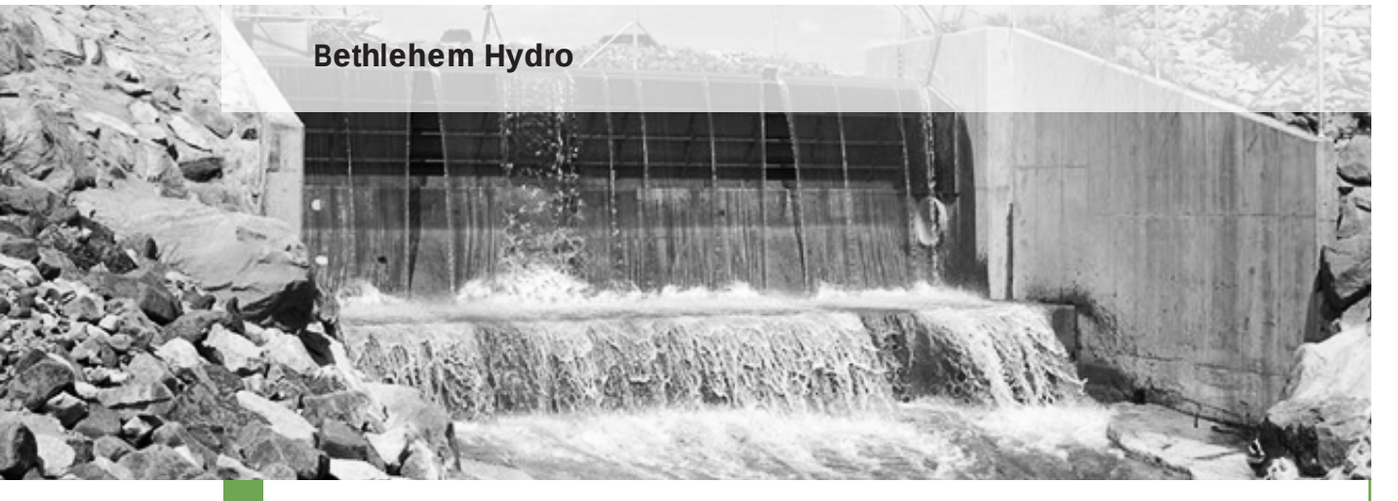
- Wheeling arrangements were new and difficult to secure.
- EIA process for wind was new and went through two High Court cases for approval.
- The electricity price was extremely low at the time (22c/kWh when buying directly from Eskom).

Highlights: The first of its kind in the country to generate electricity from wind power on a commercial basis.

- Declared a National Demonstration Project[67] in June 2000 by the Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka, and considered the keystone of the South African Wind Energy Project (SAWEP), supported by the GEF through the UNDP.
- The GEF/UNDP/SAWEP programme provided a guarantee scheme fund to buffer the City of Cape Town from any financial shortfalls that may arise due to the poor uptake of wind generated power and the difference between Eskom tariffs and the premium paid to the DARLIPP.

International support: A significant portion of this project funding was provided by the Danish International Development Assistance programme of the Danish government and GEF/UNDP.

Bethlehem Hydro



Owner: Bethlehem Hydro (Pty) Ltd.

Developer: NuPlanet Project Development (Pty) Ltd.

Location: Bethlehem (Dihlabeng Local Municipality), Free State, South Africa.

Capacity and annual energy production: 7MW; 38GWh per annum.

67 WASA Project Website: http://www.wasaproject.info/about_wind_energy.html

Date project commissioned: 2009 (Sol Plaatje power station) and 2012 (Merino power station), respectively. In 1999 a pre-feasibility assessment was initiated, in 2002 funding was obtained from The Netherlands Activities Initiated Jointly (AIJ) programme for a feasibility study, and in 2007 construction commenced.

Commercial arrangement: Long-term power purchase agreement (PPA) with the Dihlabeng Local Municipality, supplemented by the sale of carbon emission reductions (CERs).

Description: Comprised of two separate generation sites, i.e. Merino, a 4MW run-of-river site located on the As River, and Sol Plaatje, a 3MW site located at the wall of the Sol Plaatje Dam.

Challenges: Unanticipated range of regulatory requirements that took three years to resolve.

Highlights: First commercial hydropower station implemented in South Africa in 22 years, obtaining the first water use license for an Independent Power Producer from the Department of Water Affairs, under the Water Act (No 36 of 1998).

- Obtained a generation licence for operation as a first Independent Power Producer for hydropower from the National Electricity Regulator of South Africa.
- Power Purchase Agreement with the Dihlabeng Local Municipality.
- 'Competing' on commercial terms with Eskom.
- Kaplan turbines used in South Africa for the first time.
- BEE partnership through Women in Oil and Energy South Africa (WOESA).

International support or supplemental funding: DoE through REFSO, Netherlands AIJ[68] funding for feasibility assessment, registered as a Clean Development Mechanism project under the UNFCCC on 8 October 2009.

In spite of the innovation of such initiatives, the total RE power generation capacity (including conventional Hydro, but excluding pumped storage) in the country was estimated to be less than 1,000MW[69] in 2011[70] – and the contribution to primary energy consumption reported as less than 0.5% to the country's total as illustrated by the contribution from various energy sources in Figure 23.

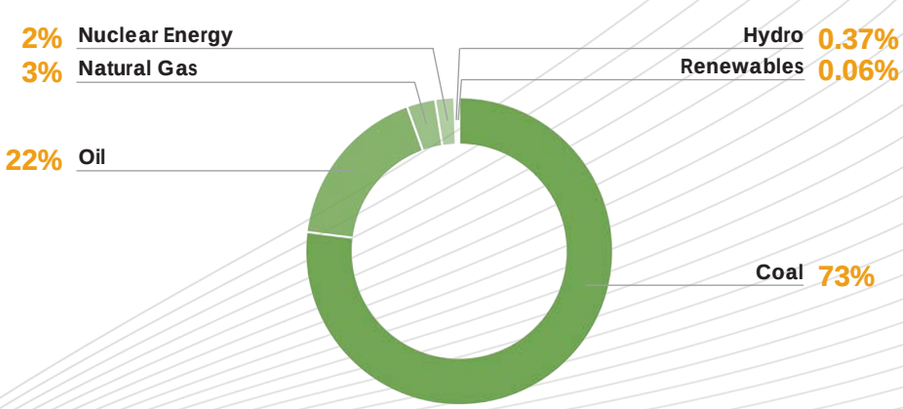


Figure 23: BP Statistical Review of World Energy: South Africa, Primary Energy Consumption, 2011

68 AIJ was a precursor to the Kyoto Protocol's Clean Development Mechanism, to look at ways in which first world countries could finance clean, green energy in developing countries to obtain the benefit of emissions reductions
69 Holm, D., Banks, D., Schäffler, J., Worthington, R., Afrane-Okese, Y. 2008. Potential of Renewable Energy to contribute to National Electricity Emergency Response and Sustainable Development. Renewable Energy Briefing Paper for the Trade and Industry Policy Studies (TIPS)
70 2008 data reported by TIPS briefing paper, Energy Information Administration Country Report, 2014

...To global recognition

Since 2011, with the release of the first request for proposals, South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) propelled RE into the mainstream and, within the short space of four years, South Africa was catapulted into a world leadership position with respect to RE investment and development. The 2014 ClimateScope[71] study placed South Africa third among 35 surveyed nations for its ability and potential to attract capital to low carbon energy sources as well as the realisation of this potential. Among the 19 African countries included in the ClimateScope 2014 investigation, South Africa held 43% of the total, operational, non-Hydro RE capacity. This is 75% of the capacity of the other 18 African countries combined. As previously indicated, South Africa is now also recognised among the top-10 countries with the largest installed, utility-scale, Solar PV capacity and among the top-10 RE investing countries in 2014[72].

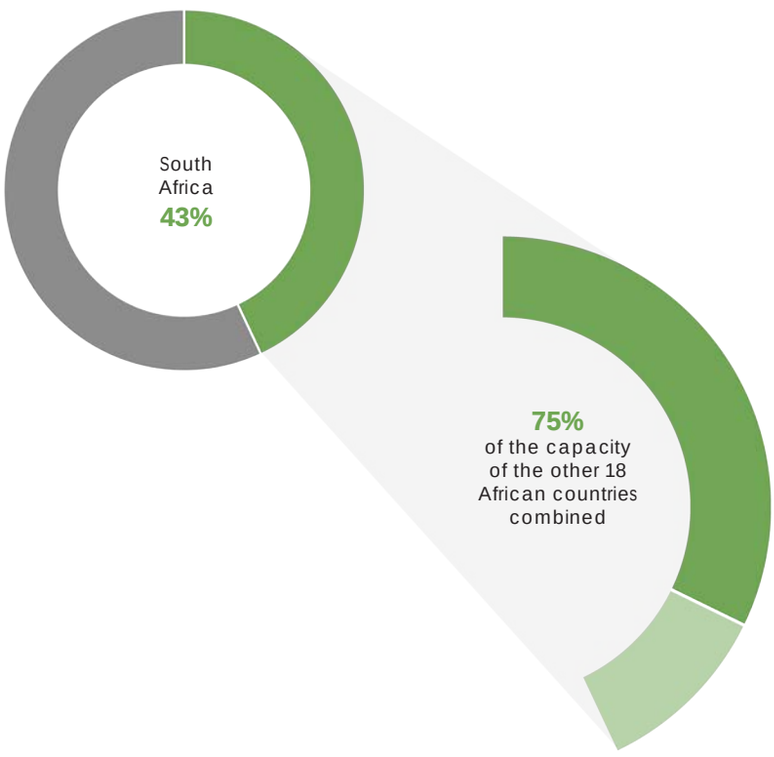


Figure 24: Operational, non-hydro renewable energy capacity of South Africa

71 The annual ClimateScope (published October 2014) was conceived and produced in partnership with the Multilateral Investment Fund (MIF) of the Inter-American Development Bank Group. ClimateScope surveyed and analysed 55 countries. South Africa achieved third place overall and second place in the category of Clean Energy Investment & Climate Financing due to the surge of investments attracted in 2013. The report motivates this score with: "developing countries to obtain the benefit of an energy investment in 2012 and 2013"

72 UNEP's 9th Global Trends in Renewable Energy Investments, 2015, Prepared by Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance and Bloomberg New Energy Finance, March 2015

The REIPPPP as vehicle for RE procurement

As identified in the 1998 Energy Policy White Paper, non-utility generation or Independent Power Producers (IPPs) were expected to play a key role in developing and producing new electricity capacity in the country. The introduction of private sector generation offers multiple benefits: it contributes greatly to the diversification of both the supply and nature of energy production; assists in the introduction of new skills and in new investment in the industry; and enables the benchmarking of performance and pricing.

On careful consideration of the various challenges that had hindered private investment in the energy sector, the establishment of a dedicated procurer of independently produced power in the country was identified to enable market participation and deliver urgent electricity generation capacity. The Independent Power Producer Procurement Programme (IPPPP) was introduced as the primary vehicle for securing private sector investment for the development of new electricity generation capacity, thereby giving effect to the policy decision captured in the 1998 White Paper on Energy Policy[73].

In November 2010, the DoE and National Treasury (NT) entered into a Memorandum of Agreement (MoA) with the Development Bank of Southern Africa (DBSA) to facilitate the implementation of the IPPPP and to establish an IPP Office as supplementary capacity to the DoE in its role as designated procurer of IPPs. While accountability for the procurement function resides with the DoE, the need to establish a function and capacity to execute on the procurement mandate was recognised.

Initially, it was envisaged that the IPP Office functions and capacity will serve as the nucleus of an Independent System and Market Operator (ISMO) that would manage trading of electricity at wholesale level. However, the establishment of the latter remains uncertain with the end-state of the policy, regulatory and institutional framework not yet defined. Pending resolution of this framework, the IPP Office is expected to continue to deliver the procurement function in the foreseeable future.

Arguably the most important arrangement under the REIPPPP was the directive for Eskom to enter into Power Purchase Agreements (PPA) with the IPPs selected as preferred bidders, securing an off-take agreement for RE for the next 20 years. The PPA provides for firm revenue projections, which, in turn, comprise the single most important criterion to render a power generation project bankable and appealing to investors. The guaranteed power off-take from preferred bidders, as secured through the PPAs, has provided the foundation for the REIPPPP success.

In addition, the programme has attempted to find an effective balance between the seemingly competing national goals of accelerated procurement of cost-effective energy at the required scale, while enabling and leveraging maximised developmental benefits for the country. The design of the REIPPPP as a rolling, competitive bid window procurement programme, has attracted vibrant investor interest locally and from abroad, with the potential to maintain and grow a pipeline of new power generation projects.

73 "The purpose of this policy is to: improve energy and capital efficiencies in the national interest; encourage the development of renewable and environmentally sound electricity generation technologies; and encourage more players to enter the generation industry in order to develop a competitive power market"

The REIPPPP competitive bidding procurement process

The development of new generation capacity is steered by South African planning and electricity policy frameworks and given effect by Ministerial determinations, as described in chapter 2. The process of Ministerial determinations provides suitable process flexibility to allow adjustments to accommodate power system requirements and technology developments and price trends. Within the scope of determined capacity, each IPPPP bid round is initiated with a DoE procurement instruction detailing a capacity allocation (or cap) and targeted technology mix.

The REIPPPP bid process comprises six distinct stages:

STAGE 1

Request for Proposals (RFP)

A bid round or bid window is opened with a request for proposals (RFP) issued to the market.

STAGE 2

BID Submission

Interested bidders prepare and submit bid submissions in response to the RFP within specified timelines. As minimum qualification criteria, every project has to show a very advanced stage of development, as demonstrated by:

Having secured land rights to the project site via ownership, leases or options;

- Having certain permits in place, most notably an authorisation under the country's environmental legislation;
- Having the whole project structure finalised, complete with technology suppliers, EPC contractors and financiers (both equity and debt);
- Fulfilling a range of technical requirements such as a yield assessment based on at least 12 months of measurements or data;
- Meeting minimum economic development requirements such as job creation and localisation;
- Offering an electricity tariff that is equal to or less than the technology tariff cap R/kWh (if applicable); and
- Providing a bid guarantee to Government.

STAGE 3

Preferred Bidders Announced

Qualifying bid submissions are adjudicated during an extensive evaluation process using independent advisors before preferred bidders are announced by the DoE.

STAGE 4

Financial Close

- Signing of Implementation Agreement
- Signing of Power Purchase Agreement

Preferred bidders are then required to finalise and sign all project and financing agreements (where applicable) and meet all required conditions contained in them, to reach financial close.

STAGE 5

Construction

Following financial close the construction phase for the IPP facilities commences. Each facility procured in terms of the REIPPPP is required to complete construction and achieve commercial operation by not later than the dates set out in the RFP. Within this prescribed window period, each IPP is contracted to their targeted commercial operation date (COD).

STAGE 6

Commercial Operation Date (COD)

Commercial operation date marks the successful completion and grid integration.

Bid rounds have been implemented on an annual cycle. The progress of the current RE portfolio through these key milestones in the procurement process, are reflected with milestone dates below.

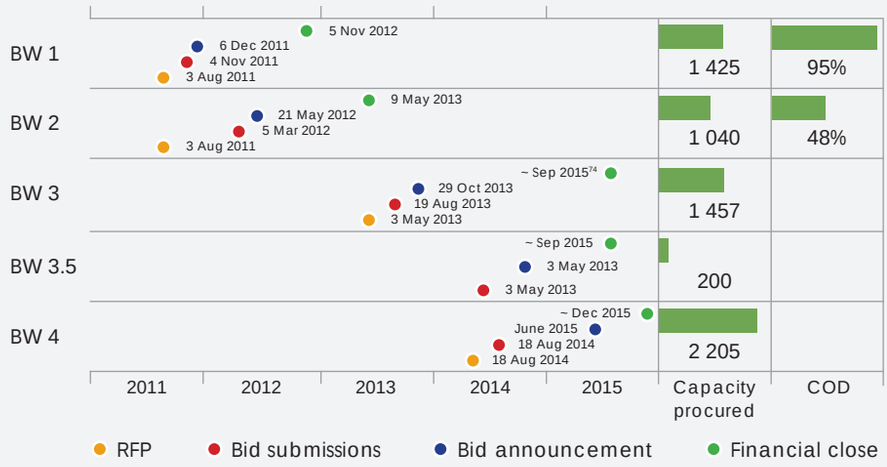


Figure 25: Procurement milestones and bid window status for the RE portfolio as at 30 June 2015

Bids totalling 17.5GW, from 305 bid submissions, have been received in the REIPPPP bidding process across all bid windows. From these, 6.3GW have been selected for procurement. The number of qualifying and competitive bids in windows 2 onwards[75] well exceeded the available allocation or cap that could

74 Fifteen of the 17 IPP projects concluded financial closure on 11 December 2014. Two IPPs still need to sign to finalise closure for the completed bid windows

75 Bid window 1 submissions exceeded the available capacity cap, but a large number of bids failed to comply with all bid requirements. Non-compliance was ascribed to the unfamiliar process and short submission preparation time (three months)

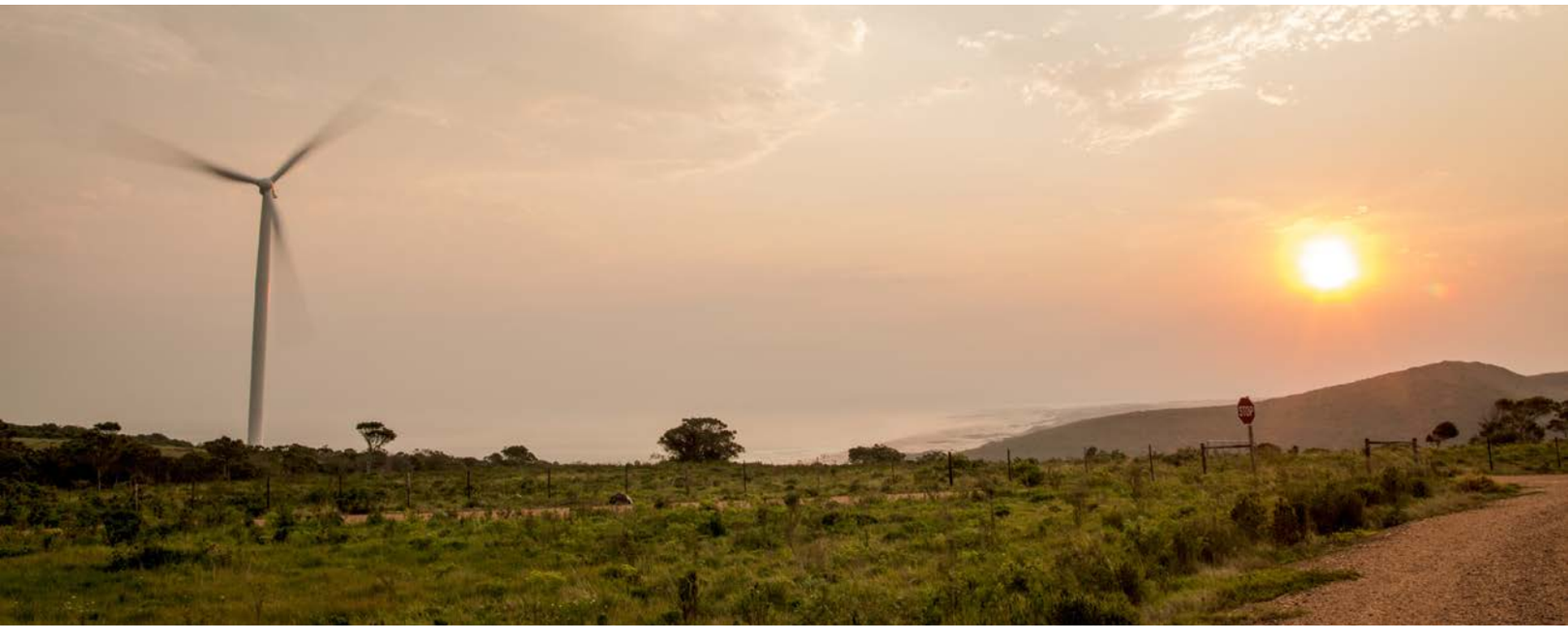
be procured. The ratio with which bids have exceeded bid allocations confirms the significant potential for RE in the country, but also the significant market interest in participating in the REIPPPP for developing RE supply capacity.

The enthusiastic market response has allowed selective procurement, ensuring that the strongest bids in terms of price, capacity, technology and developmental criteria could be selected. Selecting the most desirable bid options clearly communicated the message that offering the most competitive bid possible is critical for success. This market learning is most evident in the (declining) price trends observed between bid windows issued to date (see Figure 32).

Continued and growing investor interest is testimony to the well executed bidding process as implemented by the IPP Office. The credibility of the programme is ascribed to the transparency, fairness and efficacy of the bidding process; it has earned acclaim as "a flagship public-private partnership model for South Africa, and indeed the rest of Africa" during an assessment by the WWF[76] in 2014.

Through the selected procurement approach and bid obligations, the REIPPPP has contributed to industrialisation, skills development and broad-based black economic empowerment objectives. IPPs have also been committed to enterprise, economic and socio-economic development goals over the contracted 20-year operations period.

Annual bid windows allow for the incorporation of lessons learned, continued refinement of the procurement process and requirements as well as increased competitive pressure among bidders in each subsequent bid window. This continually improves the cost effectiveness of the energy procured. Learnings from the first bid windows have informed, and will continue to inform and refine, the optimal balance for realising national objectives in subsequent procurement windows. Some refinements, such as revised local content requirements, are already reflected, while further refinements will be incorporated in the revised tender documentation for bid window 5.



76 WWF. August 2014. Enabling Renewable Energy in South Africa: Assessing the REIPPPP

Urgent capacity requirements, demonstrated generation performance, system contribution (refer Figure 7), combined with the successful and timely project delivery by IPPs have led to an exceptional bid window in June 2015 aimed specifically at projects that narrowly failed selection as preferred bidders during the first bid rounds. This bid window will be structured as an expedited procurement round, with the intention of announcing preferred bidders before the end of the year. With this window, the DoE aims to procure an additional 1,800MW from RE sources.

The birth of a new industry – Mr Mark Tanton, MD of Red Cap Investments

Mr Mark Tanton's interest in RE spans a long time. He has spent a significant part of his career in leadership positions within the Central Energy Fund (CEF) Sustainability and the Energy Development Corporation, a division of CEF. A state-owned company, CEF pursues the development of pioneering energy solutions for meeting the country and region's growing energy needs. In this capacity, Mr Tanton had the opportunity to develop RE solutions and manage a portfolio of RE projects long before RE went mainstream in the country. This unique, local experience has proven of great value in the private sector where he heads up Red Cap Investments, a company focused on developing a portfolio of large-scale wind energy projects in South Africa.

Participation in the first bid round of the REIPPPP was painful. Mr Tanton recalls this as a period fraught with angst. Processes were well defined, yet unfamiliar, and there were varying interpretations of what exactly was required. Many of the first bid window participants had already invested significant effort and money in anticipation of the REFIT, so for them much was at stake. Even so, not only project developers, investors and lenders were affected by the high stakes. The REIPPPP had attracted global attention and close scrutiny of both the evaluation process and advisors. The resulting caution with which the process was approached made it excessively complicated and difficult to navigate. Even for those bidders who passed the meticulous evaluation to be selected preferred bidders, uncertainty remained as to the way forward and the likelihood of project realisation.

Red Cap has since had a second successful bid in bid window 3. In Mr Tanton's experience, the process has been refined and simplified; greater familiarity and higher confidence levels of all role players facilitated a much easier experience. These same factors have, however, given rise to greater market interest and competition.

Mr Tanton ascribes the success of the REIPPPP to four factors: sourcing the appropriate expertise to design a robust process; dedicated procurement capacity; maintaining alignment between the two key government role players (DoE and NT); and consistency in approach. This has enabled market confidence and attracted continued investor interest.

From an industry perspective, Mr Tanton identified the most burning issues to be grid capacity that is hampering cost-effective expansion of the programme and a clearer line of sight on the procurement plans five to seven years in advance. Industrialisation relating to the RE sector would require certainty on longer-term commitments.

RE capacity development taking big strides

Since August 2011, five procurement bid windows have been completed under the REIPPPP. Preferred bidders for bid window 4, the most recent bid round, were announced in April 2015 with a further selection of preferred bidders from the same bid round announced in June 2015. Following the announcement, it will take an estimated 12 months for IPPs to conclude financial close.

Bid window 4 initially enabled the addition of 1,121MWs from 13 preferred bidders. Due to the number of competitive and compliant bids received in bid window 4, the initial bid allocation was increased with the announcement of an additional 13 preferred bidders offering a further 1,084MW.

Bid window 4 thereby brought the total number of participating IPPs to 92, and the combined generation capacity[77] that have been procured since the announcement of the first preferred bidders in late 2011, to 6,327MW (refer Figure 26).

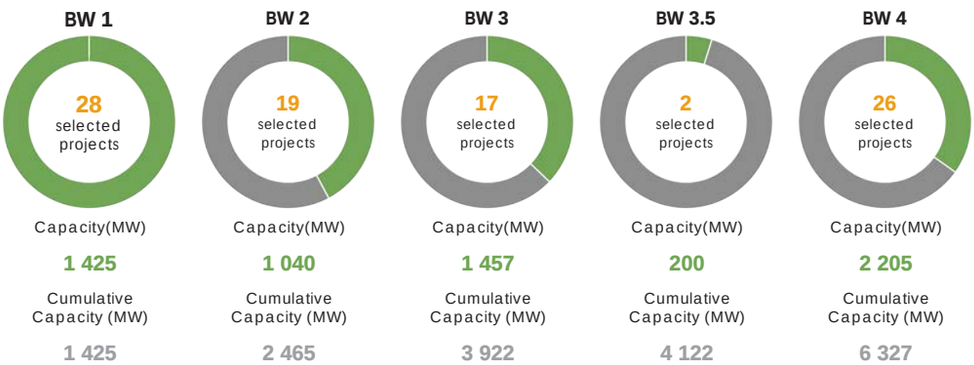


Figure 26: Bid window capacity contribution to cumulative capacity procured

Of the RE capacity procured, 3,922MW (from bid windows 1, 2 and 3) are at various stages of construction or have commenced with commercial operation. By end June 2015, 37 IPPs had already started commercial operation, adding 1,860MW capacity to the power system (i.e. 4% of the total installed capacity[78] in the country) within 2.5 years[79]. Construction lead times for completed projects have averaged between 15 months and two years, delivering operational capacity to the system within relatively short timeframes. The majority of REIPP projects have been delivered on time (or within a reasonable window) and within budget (Figure 27).

Since November 2013, the growing number of operational REIPPs supplied 4.3TWh electricity to the grid, 15% of which contributed to the system peak[80] periods.

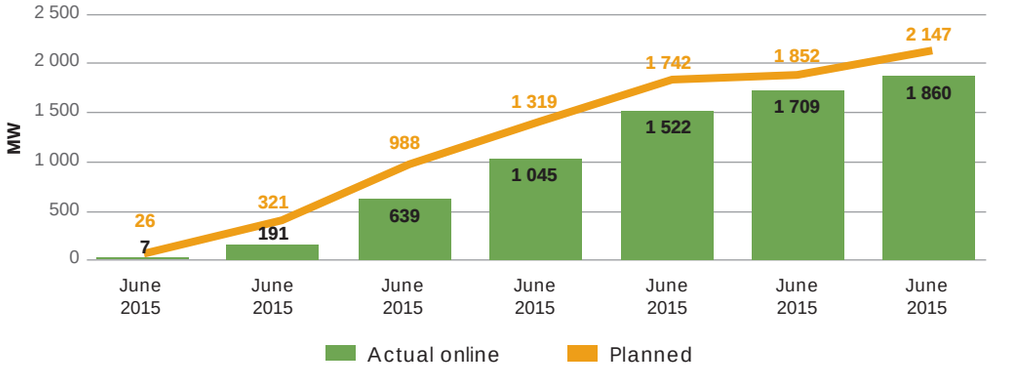


Figure 27: RE generation capacity that has commenced commercial operation

77 The maximum rated output of a generator or other electric power production equipment under specific conditions designated by the manufacturer
78 Total estimated at 46.88GW consisting of 44.26GW (2013), CIA The World Factbook; 0.8GW, Unit 6 Medupi; 1,8GW REIPPPP
79 From bid window 1 financial close in November 2012
80 System peak as defined by the Eskom Megaflex tariff

In terms of national targets for RE capacity, as defined by the IRP and National Development Plan (NDP), operational capacity represents 11% towards the 2030 target (Figure 27) for new RE and 24% towards the 2020 target (i.e. 7,000MW RE capacity to be procured by 2019 and commissioned by 2020).

Planned and actual RE capacity	Target date	Target operational capacity
NDP and IRP 2010 RE target (new build[81], not including large-scale Hydro)	2030	17.8 GW
Determined by Minister	2025	13.2 GW
NDP interim RE milestone	2020	7 GW
Procured	2015	6.3 GW
Commissioned (operational)	2015	1.9 GW

Figure 28: Progress against planning targets

Government procurement of RE has significantly accelerated compared with original planning, reflecting a growing confidence in the procurement process and contribution by RE and IPPs to South Africa's energy solution.

81 Showing the RE from 'new build', not including 1.1GW of RE planned under 'committed build'

RE making a tangible contribution to the power system

The value of the energy, demand and financial contribution from RE procured by the REIPPPP has been validated by two independent analyses. By June 2015, 1,850MW[82] Wind and Solar PV capacity had been commissioned and were producing and supplying energy into the national electricity network. Although less than a third of the procured RE portfolio and still a comparatively small share of South Africa's total installed capacity, it already makes a visible contribution to the power system during an average day (see Figure 29).

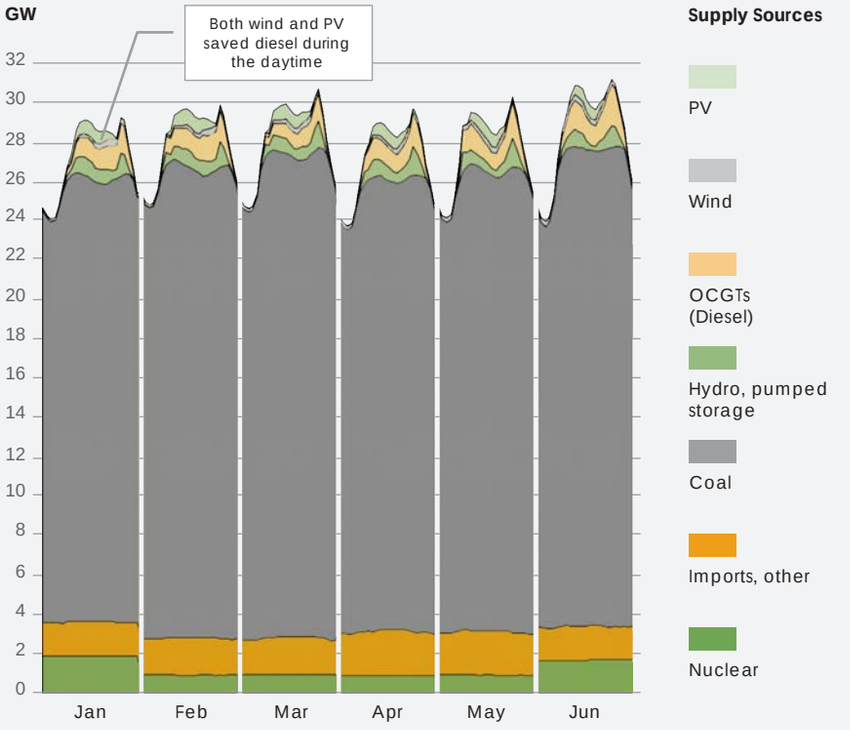


Figure 29: Actual monthly power supply in South Africa, showing an average day for each month, Jan – June 2015 (CSIR Energy Centre analysis)

An assessment completed by the Council for Scientific and Industrial Research (CSIR) Energy Centre determined that the 2TWh generated from these Solar PV and Wind facilities during the first six months of 2015, had contributed a net benefit for the economy of up to R4 billion[83]. This financial benefit was calculated with consideration of:

- Fuel savings when displacing coal- and diesel-powered alternatives (Figure 30, refer to points indicated A and B).
- The economic benefit of avoiding unserved energy[84] during severe shortfalls, i.e. where power cuts would have resulted if the RE had not been available. (Figure 30, refer to point C); and
- Tariff payments made to IPPs.

82 Excluding 10MW from Hydro

83 The same analysis by the CSIR for the 12 months of 2014, showed a R800 million benefit to the economy achieved from the 2.2TWh generated during the full year. Diesel price fluctuations and avoided load shedding events informs the difference in economic benefit between 2014 and 2015

84 The 'cost of unserved energy (COUE)' is a macroeconomic cost per kWh to the entire South African economy of not being able to serve customers' electricity demand. The IRP 2010 assumed a COUE of R90/kWh (in April 2015 terms). An alternate methodology for calculating direct and indirect COUE is being developed, but not yet adopted

These calculations do not reflect any socio-economic or secondary industry benefits associated with the REIPPPP.

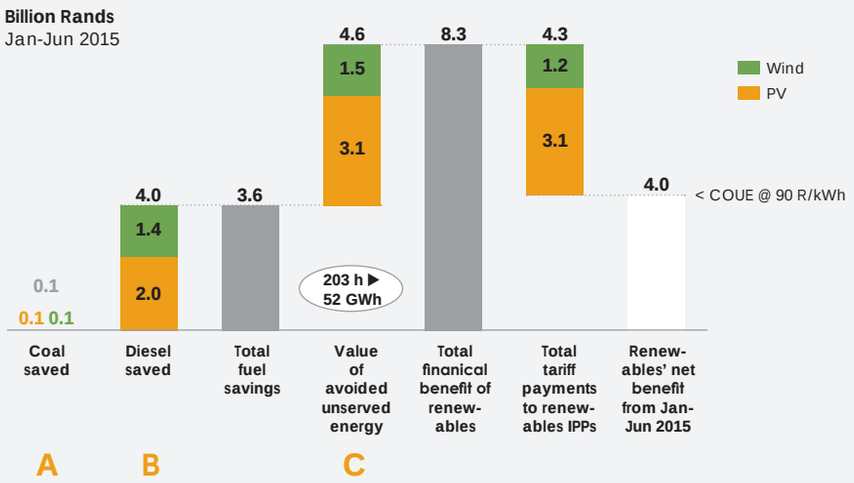


Figure 30: Economic contribution, Jan – June 2015 (CSIR Energy Centre analysis)

During this six-month period, direct cash savings from reduced fuel purchases amounted to R3.6 billion (see Figure 30). The most significant contributions from Solar PV were seen during winter mornings and throughout the day in summer, displacing the volume of diesel required for supplemental power during these times (Figure 31). Wind power contributed around half of all RE produced during the period. On average, peak production from Wind generation coincided with the evening consumption peaks (Figure 31), reducing the need for costly alternatives to provide for peak demand.

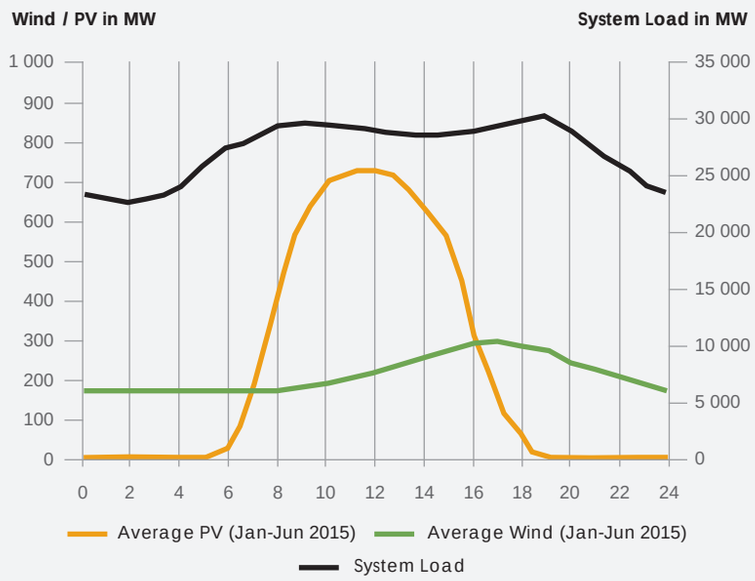


Figure 31: Average 24 hour Solar PV and Wind production profiles and average system load for Jan – Jun 2015

These findings were substantiated by research undertaken at Stellenbosch University's Centre for Renewable and Sustainable Energy Studies (CRSES). The CRSES analysis for quarter two of 2015 showed that the daily contribution of RE was often greater than the supply shortfall, meaning that the frequency and duration of load shedding is being averted or reduced. The study also showed that the RE contribution is providing relief to the country's pumped storage facilities, allowing them to be used during peak consumption hours, when they are needed most[85].

Cost effective procurement of RE

Bid prices have fallen markedly from round to round. The average per kWh tariff for the portfolio, in April 2015 terms, has declined by 68% when compared with the first bid window (Figure 32). The tariffs bid into the programme demonstrated the effectiveness with which the competitive bidding process leveraged technology advancements and international price trends as well as the increasing competitiveness of RE as a generation supply option.

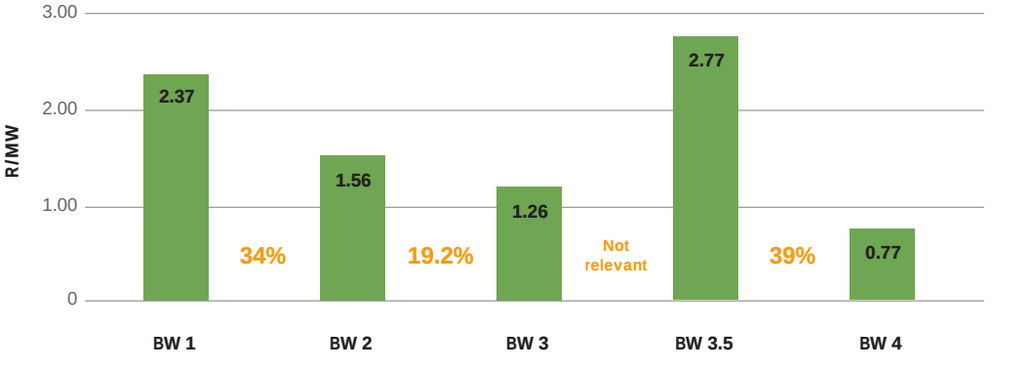


Figure 32: Energy weighted average price (R/kWh)[86] per bid window (April 2015 terms)

The rapid rate of capacity ramp-up is a remarkable achievement corresponding with market penetration rates achieved by global leaders in RE. In addition, South Africa is achieving this growth rate cost effectively relative to international experience.

RE market experience of Spain and Germany

For the period from 2000 to 2014, the energy contribution from RE sources to total electricity production grew by 26% in Spain[87] and 20% in Germany[88], i.e. an average, annual growth rate of 1.7% and 1.3%, respectively. The introduction of new RE capacity in South Africa has achieved a similar growth rate of ~1% during 2014, which is expected to continue as commissioned REIPPs ramp up to full annual production and more IPPs become operational during 2015.

85 Karin Kritzinger, senior researcher at the Centre for Renewable and Sustainable Energy Studies, Stellenbosch University. 8 June, 2015
86 Weighted average per bid window considering average, technology RFP submission price (published) for each bid window and the projected annual energy contribution/share per technology type. Contracted price (at which power is sold to Eskom) per IPP was weighted with consideration of the technologies and their relative, projected annual energy contribution (P50) (in April 2015 terms). BW 3 estimated rate incorporates the peak tariff (270% of base rate) applicable to CSP. BW 3.5 is not included as it is technology specific
87 CSIR Analysis. 2014. RED Electrica de Espana
88 CSIR Analysis. 2014. German Federal Ministry for Economics and Energy; CSIR analysis

As an example, in Germany the initial growth rate was slow despite a high tariff offer; 70%[89] of the capacity developed in Germany during the last 15 years was acquired at tariffs ranging between 12 and 40 Euro cent per kWh (Figure 33). In comparison, South Africa has seen a rapid cost reduction, with bid window 3 and 4 prices for Solar PV on par with the lowest tariffs in Germany.

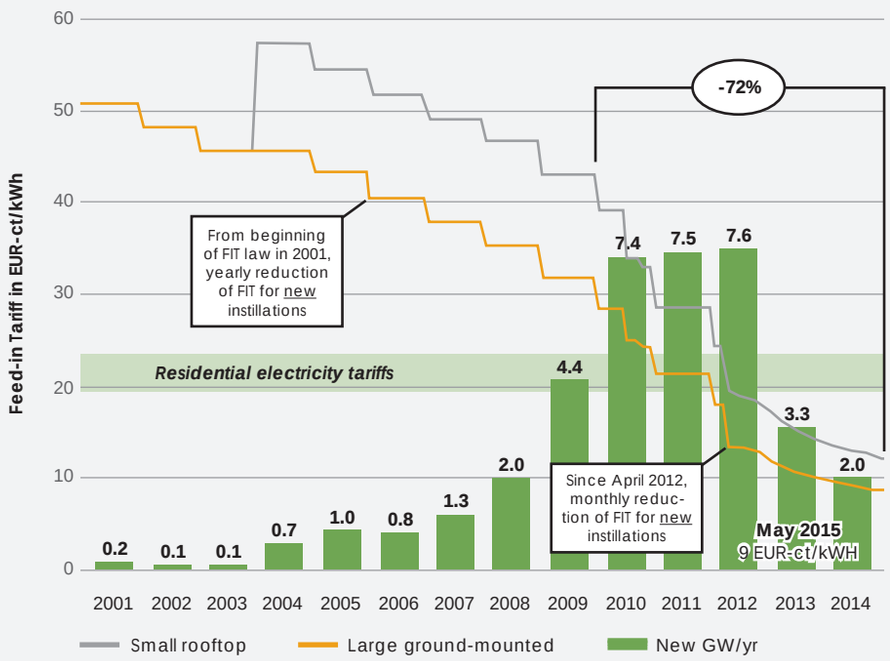


Figure 33: Germany REFIT tariff trend (CSIR Analysis)[90]

89 26.9GW of 38.4GW was procured between 2009 – 2012
90 Analysis by the CSIR using data published by the German Federal Grid Agency and CPI data by the German Federal Statistics Agency

Wind and Solar dominating the current RE market

Bid windows 1 to 3 and bid window 4 sought to procure RE across the full range of RE sources in the apportioned capacities and technologies corresponding to the IRP (Figure 34), while bid window 3.5 focussed exclusively on procuring additional capacity from Concentrated Solar Power (CSP) facilities.

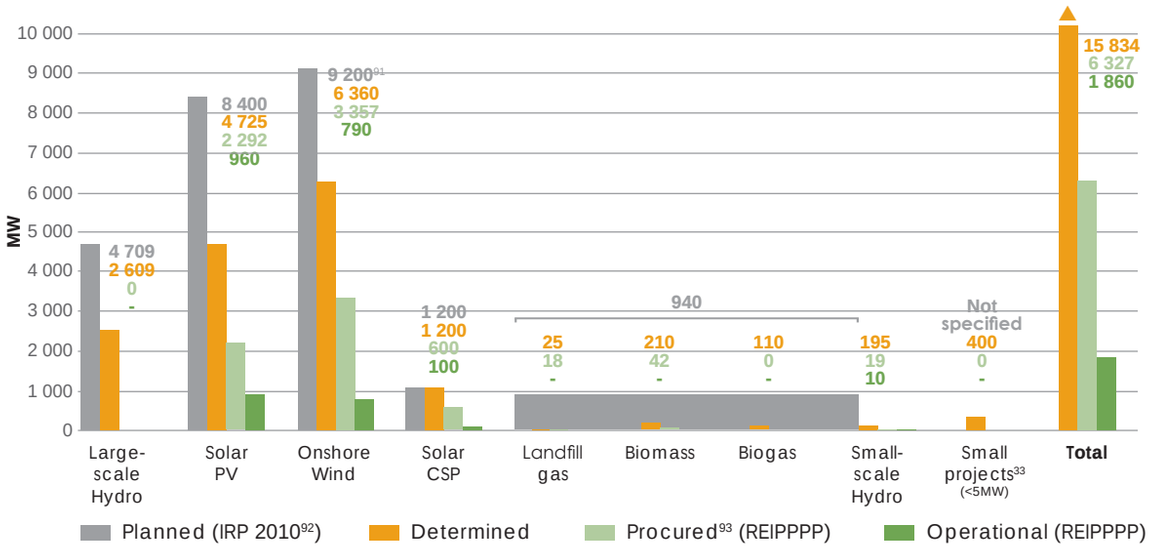


Figure 34: RE capacity planned, determined, procured and operational as at 30 June 2015

The composition of the procured RE mix has varied very little between bid windows and, in line with the IRP 2010, Solar PV and Wind contribute the largest share of new capacity (Figure 35).

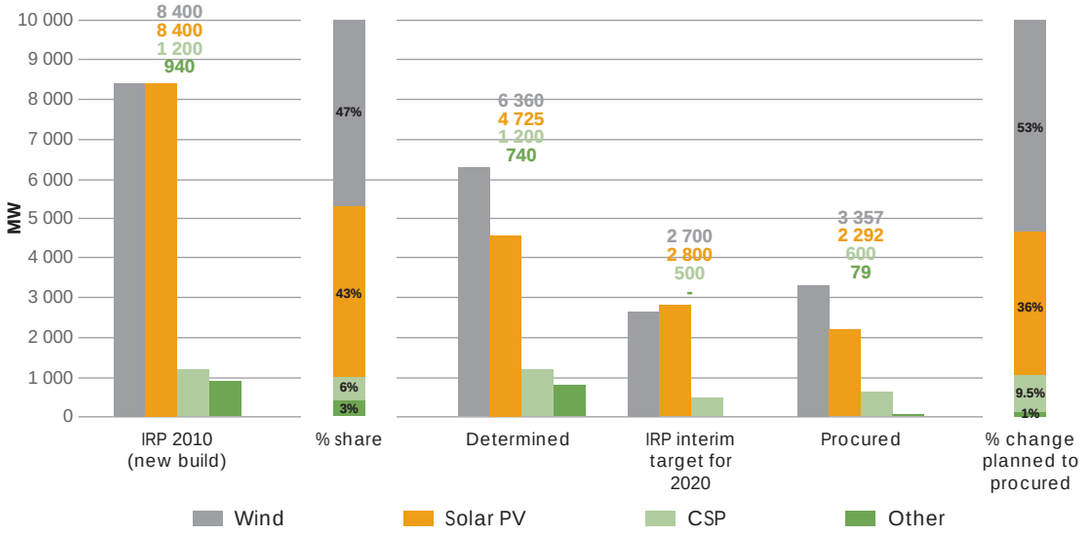


Figure 35: Renewable energy mix of planned and procured RE capacity , excluding large-scale hydro

Wind power was anticipated by both the IRP and independent researchers[95] as the technology most likely to contribute significantly to the South African energy mix because of technology maturity and established global capacity. Across the five bid windows, 3,357MW was procured, presenting a third of the capacity planned by the IRP 2010 and 53% of the procured portfolio.

91 Including 800MW 'committed build' and 8,400MW 'new build' for wind
92 Including both 'committed build' and 'new build'
93 Procured capacity reflect contracted capacity at financial close for projects that have reached this milestone. For projects in the later bid windows that have not achieved financial close the capacity bid is reflected
94 400MW have been determined for small projects (<5MW) to be procured from an unspecified mix of Solar PV, Wind, Biomass, Biogas, Landfill Gas and Small Hydro technologies
95 Energy Research Centre at the University of Cape Town, Markal model, 2011

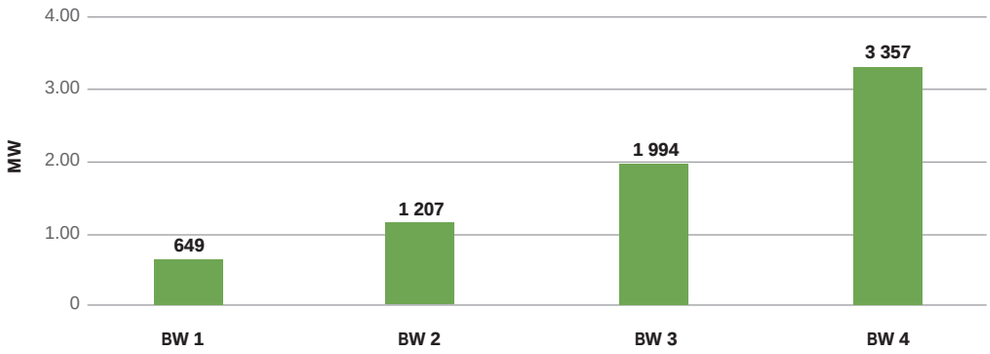


Figure 36: Wind capacity procured (cumulative)

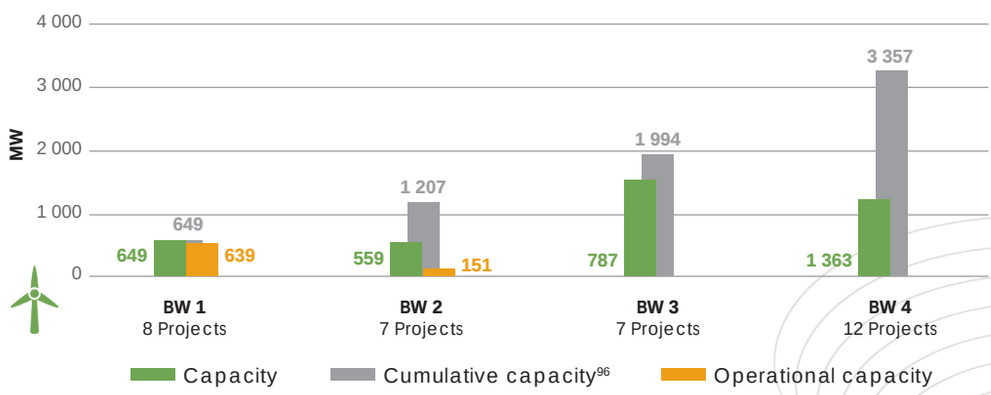


Figure 37: Wind capacity per bid window (as at June 2015; IPP Office analysis)

By June 2015, 790MW capacity from wind IPPs were already operational and delivering electricity onto the power grid. The prices associated with wind projects in the last bid window had averaged 71c/kWh, having fallen by 50% when compared with the first bid window.

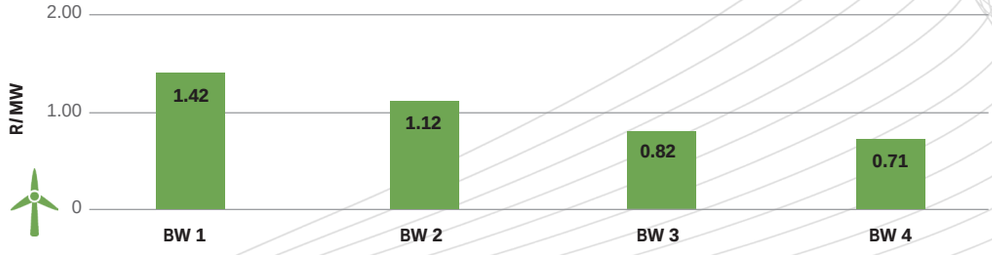


Figure 38: Average prices from Wind per bid window (April 2015 terms; IPP Office analysis)

Solar power, both from Solar PV and CSP, also offer mature technology solutions well suited to the excellent solar radiation resources in South Africa. On the back of focused research and development investments by both China and the USA[97], Solar PV has seen the most dramatic technology and cost advancements[98] in the preceding decade. Consequently, rapid improvement in conversion efficiency coincided with significant cost improvements. The timing and selected procurement approach positioned the REIPPPP perfectly to capitalise on these developments. Solar PV bid tariffs had decreased by around 75% from the first bid window to 82c/kWh in bid window 4, making it a cost-competitive contributor to the RE portfolio.

96 Rounding of individual values may cause an apparent discrepancy with the cumulative total
97 US Department of Energy SunShot Initiative
98 New or emerging technologies are typically subject to an experience curve. The experience curve suggests that product price will drop as production volumes increase. Typically, the ratio is about 20 – 30% for each doubling of volumes. For new technologies the combined effect of learning (more experience in manufacturing), technology advances and the economies of scale of increasing volumes, may accelerate the experience rate

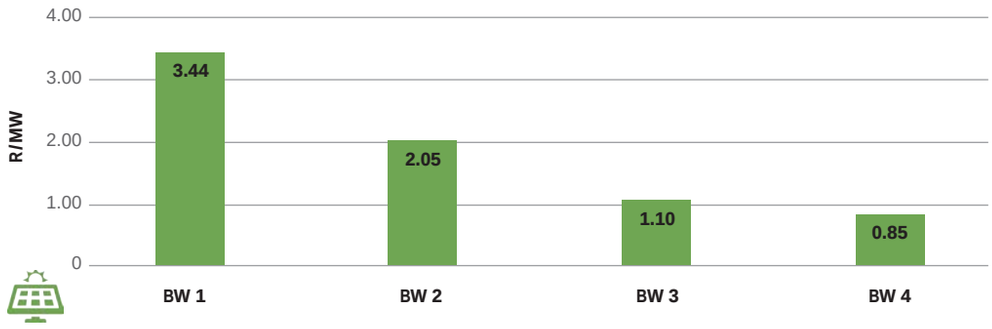


Figure 39: Average prices from Solar PV per bid window (April 2015 terms; IPP Office analysis)

A total of 2,292MW Solar PV capacity has been procured in the five bid windows, contributing more than a third of the total procured RE capacity. Solar PV projects were delivering 960MW into the grid by June 2015.

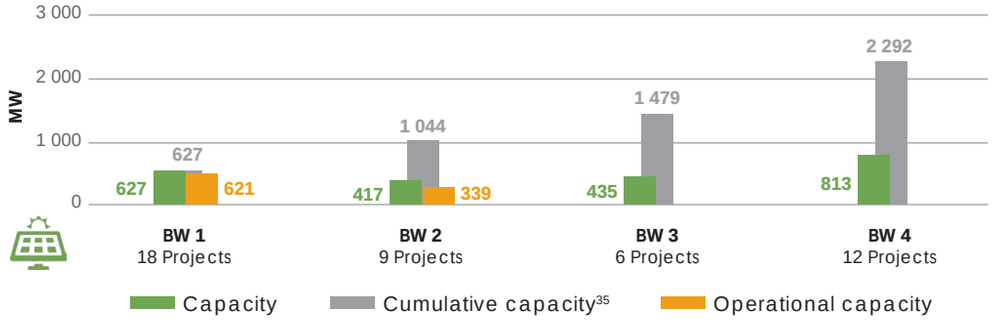


Figure 40: Solar PV capacity per bid window (as at June 2015; IPP Office analysis)

Wind and Solar PV power plants have been the first power plants from the RE portfolio to start operations, steadily contributing additional capacity to the power system with each new successfully commissioned plant (Figure 41).

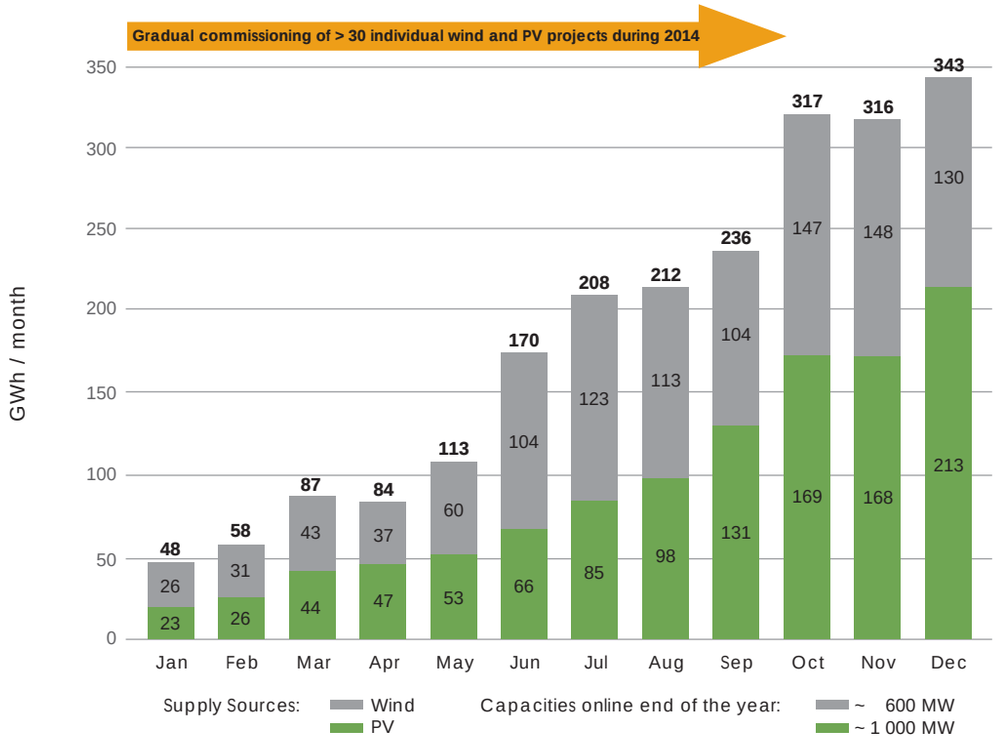


Figure 41: REIPP growth in energy produced during 2014 (Eskom, CSIR Energy Centre analysis)

Total global capacity for CSP has remained relatively low, ascribed mainly to the comparatively high cost of this technology. CSP technology offers the added benefit of inherent thermal storage with up to 12 hours supply capacity. Because of this, CSP technology has greater flexibility in terms of when electricity is supplied, making a valuable contribution to the RE portfolio. In recognition of this, a differentiated tariff with a base and peaking rate component (270% of base rate) was introduced for CSP in bid windows 3 and 3.5. The average base rate of CSP decreased by 6% between bid window 1 and 2 and by 7% from 3 to 3.5.

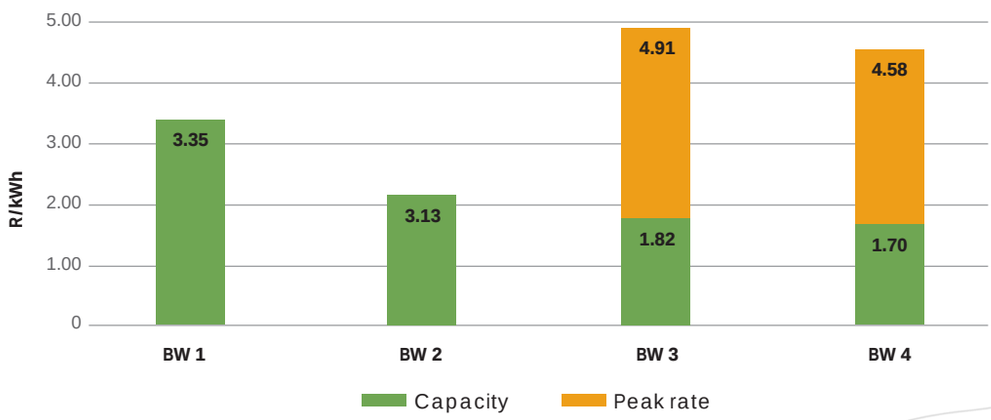


Figure 42: Average prices from Solar CSP per bid window (April 2015 terms; IPP Office analysis)

Half of the allocation of 1,200MW for CSP, as determined by the Minister, had been procured with the completion of bid window 3.5. The flexibility created by thermal storage and the benefits it offer to the power system have informed a slight acceleration in the procurement of CSP compared to the IRP 2010 (Figure 41). More wind capacity has also been procured than what was foreseen to be operational by 2020, while procured capacity for Solar PV is still 500MW short of the 2020 target.

Capacity from small-scale Hydro, Biomass and Landfill Gas have been comparatively small, but commensurate with the anticipated contribution in the IRP. Generation from landfill gas and biomass power plants are less constrained by energy availability and typically offer higher capacity factor. With higher capacity factors, these facilities make an important contribution to a more diversified, cleaner energy composition.

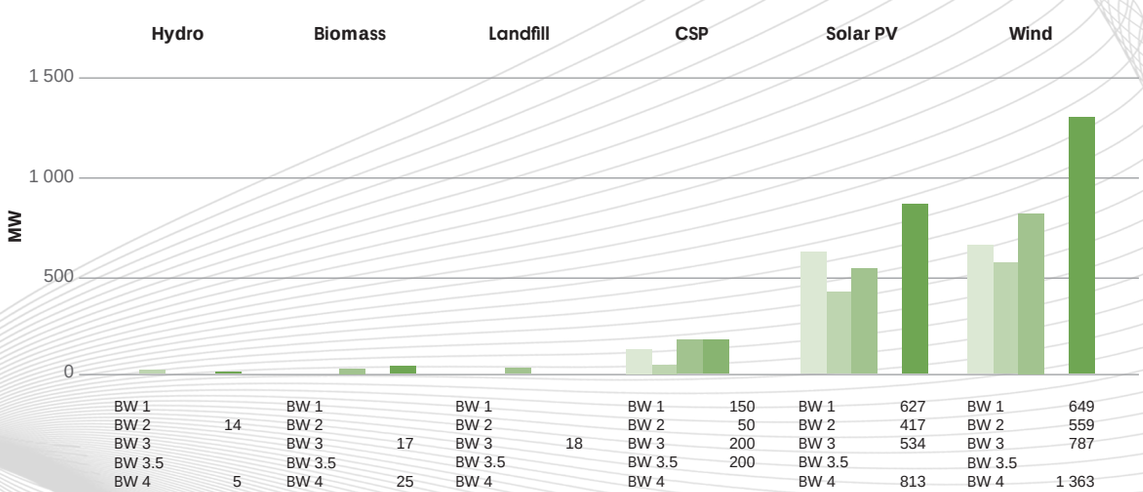


Figure 43: Technology contribution (MW) per bid window

Prices contracted under the REIPPPP for all technologies are well below the published REFIT rates (refer to Figure 10 on page 25). The REIPPPP has, therefore, effectively translated policy and planning to deliver clean energy at very competitive prices.

South Africa's growing RE footprint

The geographic distribution of REIPPs corresponds broadly to the distribution of resource potential in the country. Accordingly, the share of projects in the respective provinces reflects each province's natural endowment of RE resources. Most IPPs are located in the rural areas of the Northern, Eastern and Western Cape (Figure 44).

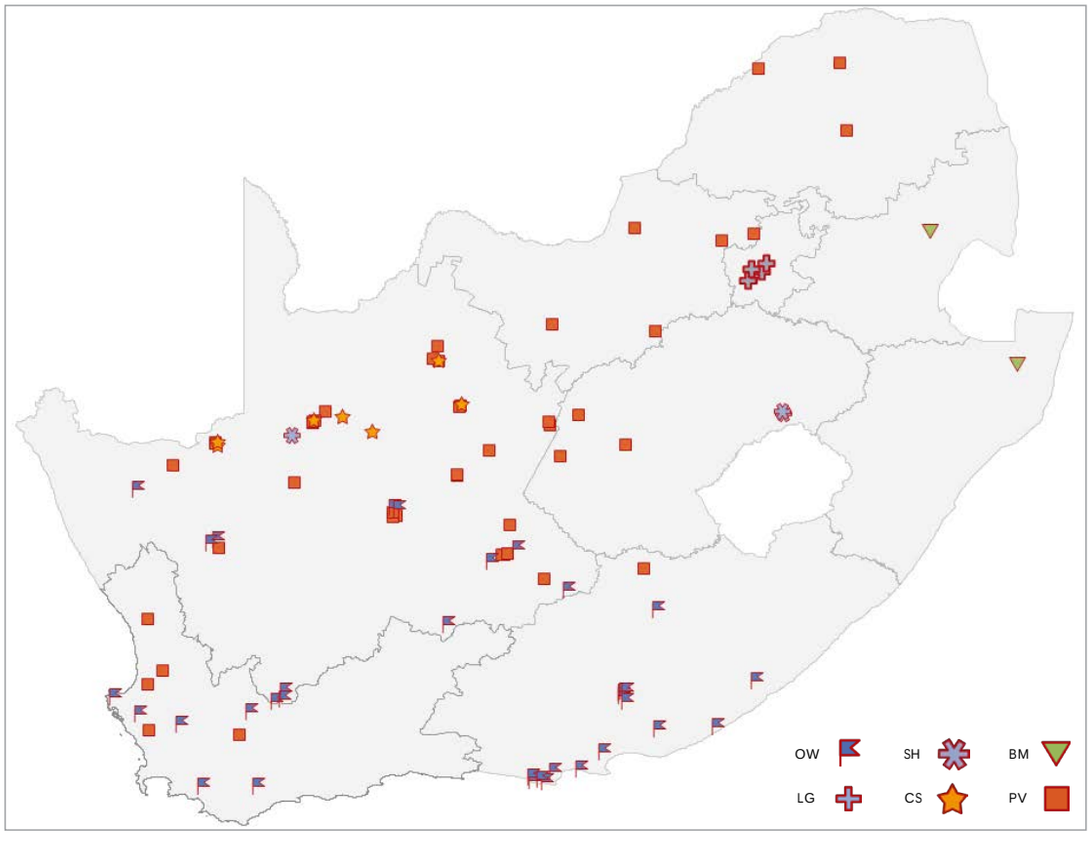


Figure 44: Technology and project distribution (BW 1 – 4)

The Northern Cape, offering the most favourable solar radiation levels, has attracted the majority of Solar PV projects and all of the CSP projects. The province, host to 48 of the 92 IPP projects in the country, is expected to contribute 3,566MW to the total procured RE capacity once construction is complete.

The Eastern Cape has attracted 17 of the 92 IPPs totalling 1,509MW; the second largest share of the total procured capacity. Corresponding to the province's excellent conditions for the generation of on-shore wind power, 16 of these are wind projects representing 43% of the procured wind power.

Eleven IPP projects are located in the Western Cape, contributing 592MW to total procured capacity. The number of projects is shared roughly equally between six wind (458MW) and five Solar PV (134MW) IPPs.

The remaining 16 IPP projects are distributed among the other provinces, with Free State and North West Province sharing five each; Limpopo boasts three; and there is one IPP project per province in Mpumalanga, Gauteng and KwaZulu-Natal.

Bid window 3 included the first Landfill Gas and the first Biomass IPPs as well as the first projects in both Gauteng and KwaZulu-Natal.

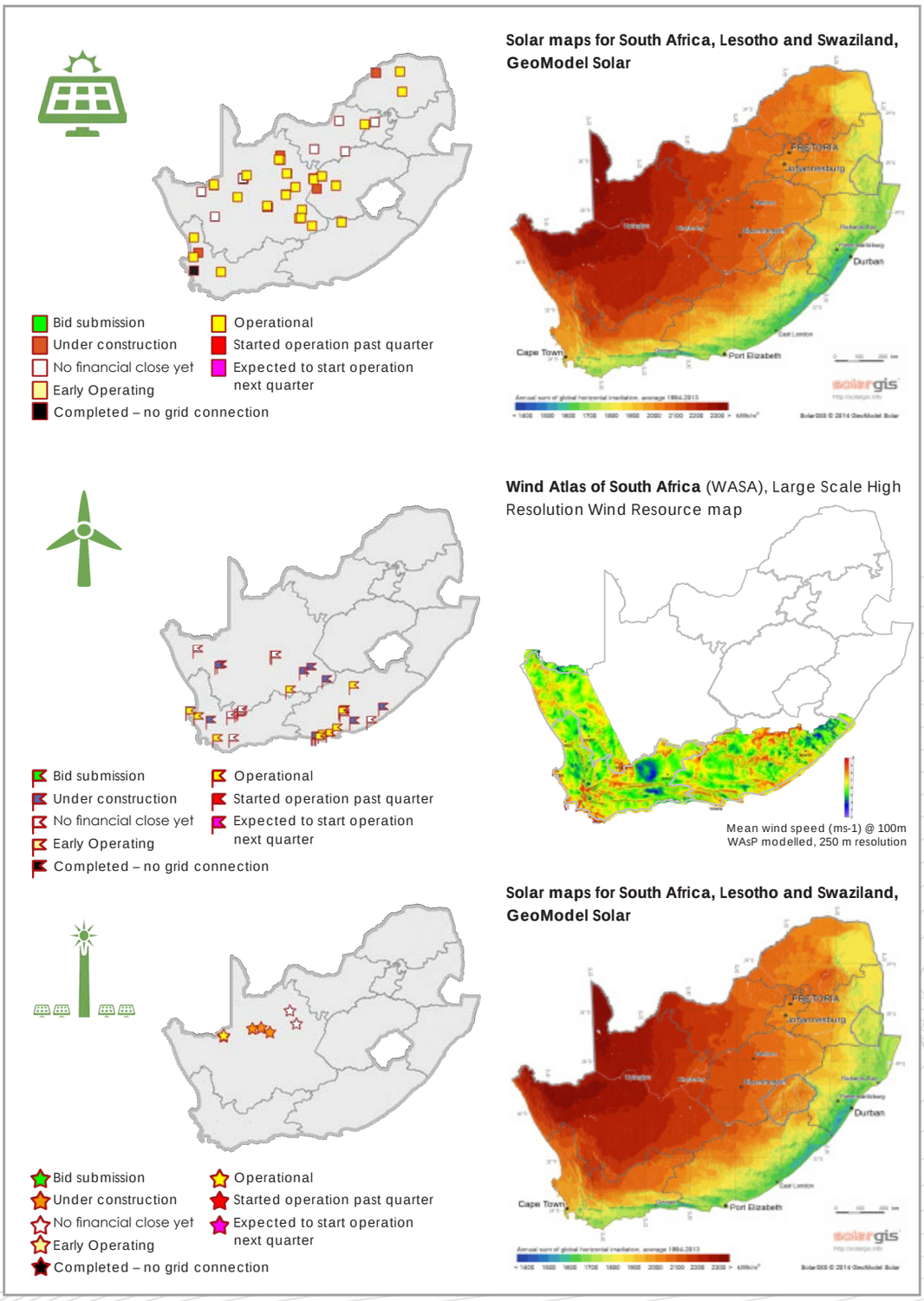


Figure 45: IPP distribution against corresponding resource maps

The growing contribution from Solar PV in distributed generation applications

Renewable off-the-grid energy installations and distributed power systems, have emerged as a global trend on the back of rising electricity costs, rapid technology advances and price improvements in alternative energy options. In South Africa, a further driver is the current and foreseen constraints of the electricity supply system that is prompting an acceleration of distributed generation, including Solar PV.

With the continuing, sharp decline in technology costs, Solar PV offers an attractive option for private building owners and is, increasingly, expected to make a marked contribution to RE capacity in the country. A Solar PV baseline study[99] completed in 2013 as part of the South African Solar PV technology roadmap, considered current trends and different penetration rates; it predicted the combined commercial, industrial and residential installations of rooftop PV in the country is likely to be between 3.5GW and 11.6GW by 2035. A voluntary database of small-scale, typically rooftop, Solar PV installations in the country had, by May 2015, recorded 43.8MW[100] capacity since 2011. Since the first publication of the database in January 2015 with 19MW installed, the registered capacity has more than doubled. Among those listings that were specified, the majority of installations were recorded in the commercial, agriculture, industrial and mining sectors.

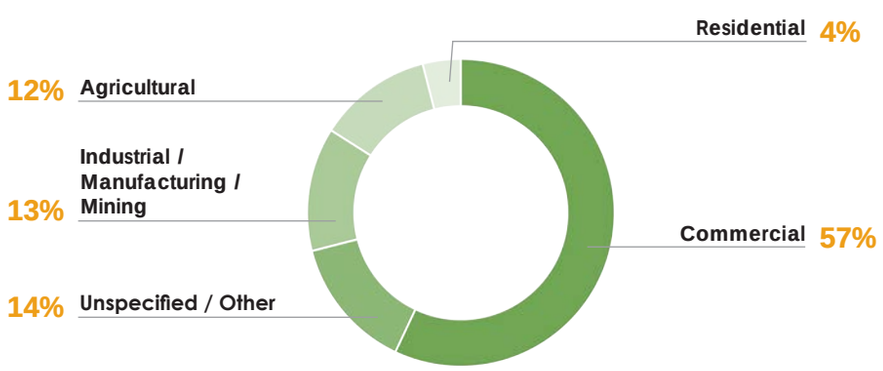


Figure 46: Sector distribution of registered Solar PV installations

99 Maphelele, T., Standord, R., Kooverji, B. May 2013. Solar PV baseline report
100 Unverified industry project database: http://pqrs.co.za/s-a-solar-pv-list-2/as published 21 June 2015

The majority of recorded installations have been in Gauteng and the Western Cape. Surprisingly, considering the solar radiation statistics for the country, KwaZulu-Natal has recorded the third highest installed capacity.

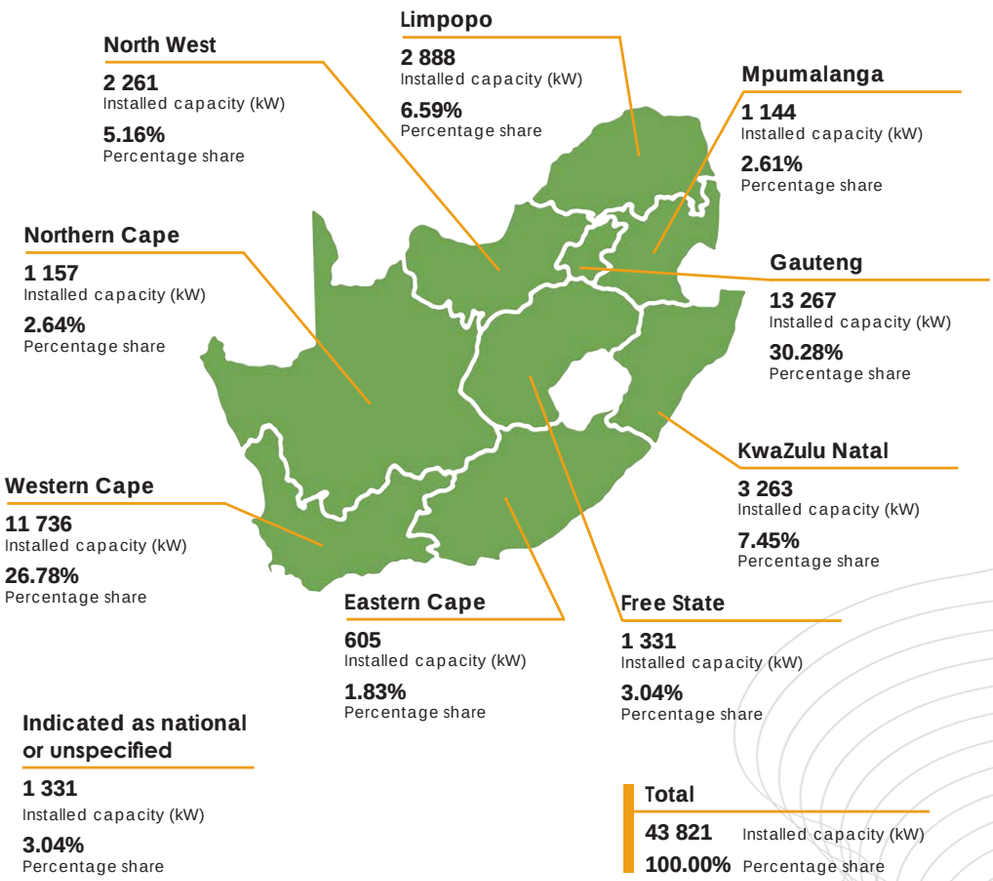


Figure 47: Provincial share of recorded small-scale (rooftop) Solar PV

The trend is likely to accelerate with streamlined regulatory processes and greater clarity regarding tariff structures (resolution of uncertainty in this environment has already been prioritised, refer to Figure 15 on page 38).

The Finance Minister, in his February 2015 Budget Speech, announced a financial incentive in the form of an accelerated depreciation for Solar PV installations. The announcement reinforced Government's commitment to this initiative and the promotion of energy efficiency and lower greenhouse gas emissions.

Bioenergy, an untapped resource

Compared with the market gains of RE technologies in general, development of Bioenergy[101] solutions has been slow, despite the important initial contribution to RE in the country, as well as the significant market potential and contribution expected by the RE White Paper, 2003. Opportunities to unlock the country's bioenergy potential are therefore under development.

101 Bioenergy defined as "energy generated by combusting solid, liquid or gas fuels made from biomass feedstocks", UK Bioenergy Strategy

Biogas

Biogas is recognised as an exceptionally sustainable form of RE, converting agricultural or other organic waste into a RE source, contributing to sustainable waste management and reducing carbon emissions, both from the waste decomposition and by displacing conventional energy supply. This is relevant to small-scale applications or on a commercial scale for large organic waste streams. Both domestic and commercial applications have, however, been limited in South Africa to date.

Commercial scale biogas digesters that processes organic waste streams to produce methane as an energy source, is increasingly common worldwide, but only a handful of installations have been developed in South Africa to date. SABIA, the Southern African Biogas Industry Association, estimates that biogas can contribute 2.5GW generation capacity in the country, employing waste streams from wastewater treatment plants, food waste, manure, agricultural residues and commercial processes including abattoirs, breweries and cheese factories. Biogas is the only RE technology included under the ministerial determinations for which no IPP bids have been received to date. The DoE, SABIA and GIZ are working to address this and the IPP office has revised the tariff on request.

Smaller scale biogas production facilities have been more prevalent in rural areas where there is no electricity supply from the national grid. In terms of national legislation[102], the owners of biogas operations not connected to the national gas pipeline grid do not have to be licensed, but they are required to register with NERSA. Less than 200 biogas operations have been registered in South Africa since 2011, a small number compared with the vast numbers in both India (12 million) and China (17 million).

In recognition of the barriers to biogas capacity development, the DoE has facilitated the establishment of a National Biogas Platform in 2013 and have collaborated with the industry association (SABIA) to host two biogas conferences in 2013 and 2015, respectively. The National Biogas Platform was established with the aim to support and stimulate the development of South Africa's fledgling biogas industry.

A national biogas strategy will be developed by the DoE in collaboration with GIZ and a draft is expected to be released by March 2016.

102 In terms of the Gas Act, 2001 (Act No. 48 of 2001)

Bio2Watt Bronkhorstspruit Biogas Plant, the first commercial scale biogas project in South Africa

Owner: Bronkhorstspruit Biogas Project (Pty) Ltd (BBP), currently majority owned by Bio2Watt.

Developer: Bio2Watt.

Location: Bronkhorstspruit, Tshwane Metropolitan Area, Gauteng.

Capacity and annual energy production: 4.4 MW; 36GWh per annum (actual).

Date project commissioned: 2015 (initiated 2007).

Commercial arrangement: Established as an IPP with a signed PPA with BMW SA. Power is connected to Eskom network and wheeled through the municipal grid to the industrial off-taker.

Description: Co-digestion biogas plant situated on a large feedlot east of Pretoria and making use of mixed waste, including primarily manure, paper sludge, fruit & vegetables plus abattoir waste streams. The Anaerobic Digestion technology is thermophilic and comes from Denmark.

Challenges: To bring the first commercial biogas plant to closure, Bio2Watt had to break new ground and convert a number of sceptical stakeholders. The complexity of the transaction and absence of a clear framework for small Independent Power Producers added to the challenges and legal costs. There were lengthy processes for licensing, permits and EIAs and alignment between governmental procedures. These were largely responsible for the project taking sever years to be developed compared with the short turnaround times which have become synonymous with the REIPPPP.

Highlights: Developing the wheeling agreement with the Tshwane Metropolitan Municipality, which, in its current form, had never been done before (finalised in 2013).

- Executing the first private deal (PPA signed with BMW in 2012), where a large industrial manufacturer demonstrates its commitment to sustainability by purchasing ±30% of its power from BBP rather than from the utility or a municipality.
- The first commercial/industrial scale biogas plant in South Africa.
- Successfully introducing the idea of waste use as a resource, where a culture of dumping at landfills has always been seen as the easiest way to dispose of waste.

International support: Development support was largely from the Dutch government (RVO) as well as the Norwegian Development Fund (Norfund). The REMT and Energy & Environment Partnership (EEP) funded by the Finish government also supported this initiative.

Biomass

Similar to biogas, commercial applications for biomass-to-energy have been limited in South Africa. Only two biomass IPPs have successfully participated in the first four bid windows of the REIPPPP.

It is anticipated that electricity production using biomass offers significant potential at competitive costs if utilised in cogeneration applications. Under the broader IPP procurement programme, 1,800MWs have been determined for the procurement of capacity from industrial cogenerating facilities utilising renewable fuel products.

Qualifying biomass cogeneration projects potentially include incineration of agricultural and forestry residues to generate electricity and supply heat to industrial processes. Such plants are expected to be generally small (less than 50MW with many below 20MW) and distributed across the industrial centres or in the sugar and forestry areas of South Africa.

In May 2015, the IPP office released a request for proposals for cogeneration projects and the announcement of preferred bidders is expected by the end of 2015.

Biofuels

Within the family of bioenergies, liquid biofuels have been most topical on South Africa's developmental agenda due to the inherent attributes, such as high labour intensity, potential balance of payments savings[103] and potential diversification of the country's transport fuel mix. In 2007 the South African government committed to a short-term goal in the production of biofuels amounting to 2% of the total road transport pool.

Worldwide, biofuels are primarily employed as an instrument for reducing carbon emissions. In South Africa, however, the main attraction of biofuels is centred on their potential to create jobs, support the agricultural industry and rural development.

Globally, the adoption of biofuels has soared in the last decade, but still makes a negligible contribution to the fossil fuel-dominated global market. Biofuels is most commonly used as transport fuel, but is more expensive to produce than conventional mineral fossil fuels. Its inclusion into the fuel mix cannot be left to market forces; it requires Government policy interventions, such as subsidies and mandatory use of biofuels, to stimulate the market. This will also be the case in South Africa.

While subsidies seek to level the playing field with conventional fossil fuels, the cost-effectiveness of achieving national goals under a subsidy scheme requires careful consideration. South Africa intends to address the market imbalance with the establishment of a fair and favourable regulatory environment, which includes:

1. Regulations regarding the mandatory blending of biofuels[104], expected to come into operation from 1 October 2015. These regulations make it mandatory for licensed manufacturers of petroleum products (petrol/diesel) to blend locally produced biofuels into their petrol or diesel.

2. Revised fuel specifications for the country, adjusted to allow for the changing fuel characteristics associated with blending.

103 With no domestically produced crude oils, South Africa is heavily reliant on oil imports at a scale that contributes negatively to the balance of payments
104 Gazetted August 2012. Refer Chapter 2 for further details

3. A commitment to consider a pricing and subsidy mechanism in support of the Biofuel industry.

The Biofuels Regulatory Framework is being developed by an inter-Departmental Biofuels Task Team (BTT), led by the DoE and comprising the Department of Agriculture, Forestry and Fisheries (DAFF), National Treasury, Department of Water and Sanitation (DWS), Department of Trade and Industry (**the dti**), NERSA Department of Science and Technology (DST), Department of Economic Development (EDD), Small Business Development, Presidency and the Department of Rural Development and Land Reform.

The BTT needs to address two important challenges in finalising the regulatory framework and the subsidy mechanism in particular:

- The biofuels subsidy will effectively be consumer funded, necessitating due scrutiny to ensure a fair and transparent process for selecting projects, maximising job creation and achieving the optimal socio-economic objectives.
- At the same time, it requires the impact on the consumer to be kept as low as possible.
- Ensuring value for money for subsidy paid to manufacturers of biofuels and the net benefit to the country with respect to its social development goals.

To meet these objectives, the current focus is on finalising details of the Biofuels Implementation Framework, which involves:

- Process for the selection of projects to be subsidised as part of the biofuels programme.
- Ensuring the intended support and benefits to agriculture are realised.
- Minimised impact on food security.

Based on the success of the REIPPPP, it is expected that project selection will follow a similar bidding process. Competitive bidding effectively supports the national objectives, allowing cost impacts to

be minimised, while incorporating the requirements for rural community involvement, job creation, equitable shareholding and the inclusion of previously disadvantaged people in the mainstream economy as bid conditions.

In addressing concerns relating to food security, a Biofuels Feedstock Protocol has been developed to safeguard the switching from production of food to Biofuels feedstock in the country. The protocol favours the use of fallow land that can produce commercial and small-scale crops under rain-fed conditions. Where irrigation is required, water use will be subject to a water use license from the DWS. In addition, the Protocol prohibits the use of staple food products like maize and potato for biofuel production and favours dual purpose crops. It also provides guidance with respect to preferred production areas in different regions with adequate rainfall.

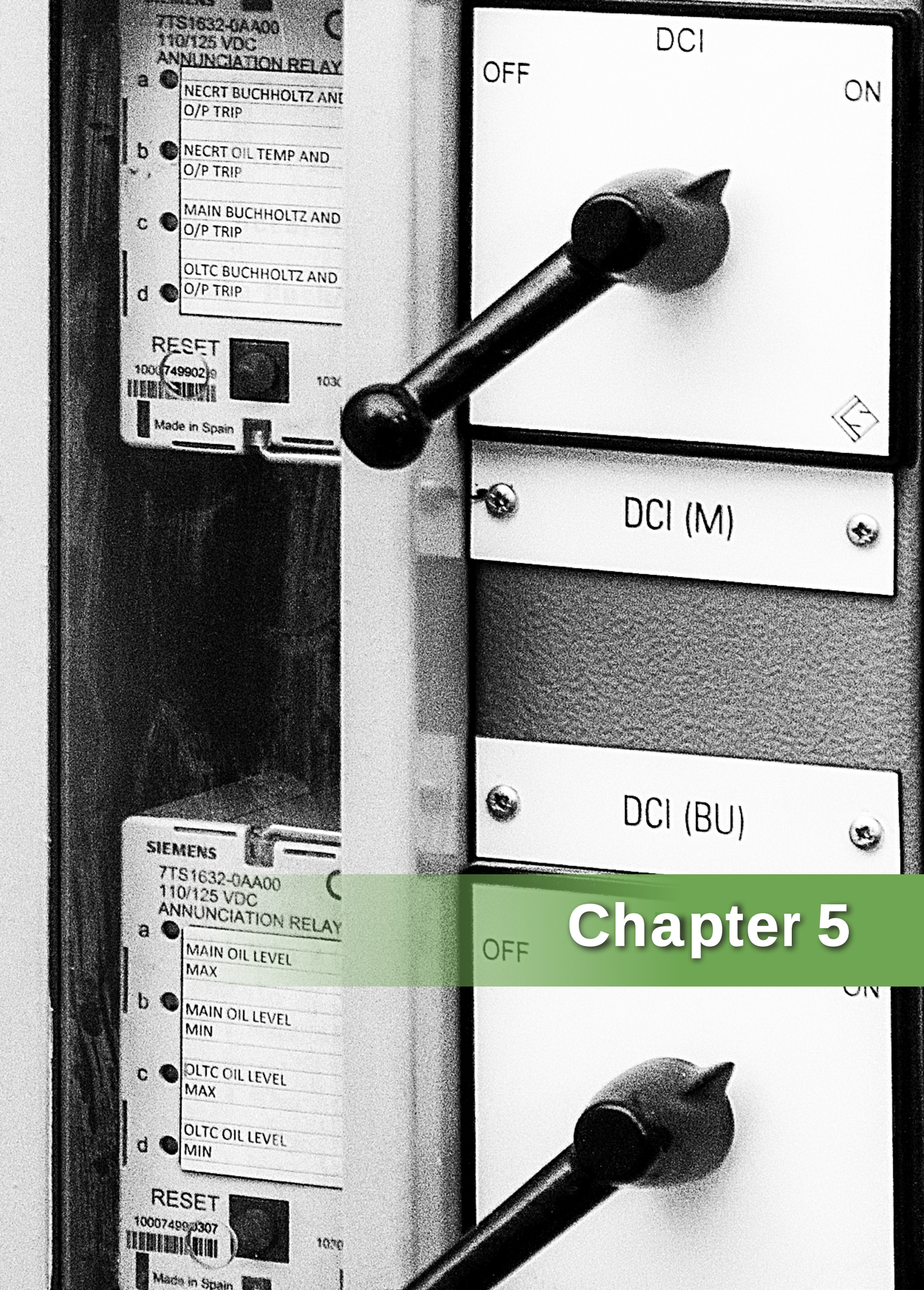
In order to limit the liability to the fiscus it has been proposed that the targeted 460 million litres be initiated with 230 million litres and to follow an open competitive bidding process.

The proposed regulatory framework with associated funding support mechanisms and potential benefits of promoting biofuels is under Cabinet consideration, with a Cabinet determination on biofuels expected before the end of 2015/16 financial year.

Collaboration delivering RE success

The REIPPPP has been the dominant force of the RE market growth since 2011. The success of utility scale power projects has cemented RE as an indispensable component of the country's electricity mix. Market trends suggest that rooftop Solar PV is set to make a significant contribution in the market, even though the exact scale and speed of market penetration will depend on how the policy environment is resolved. Alongside developments in the liquid fuels sector and the historic contribution from woody biomass, RE sources are emerging as a cornerstone of South Africa's energy sector. As such, it is contributing to the national aspirations of secure, affordable energy, lower carbon intensity and a transformed 'green' economy.

This scope and scale of RE development in South Africa, across the diverse range of energy sources, demonstrates what is possible when Government and private players share a strong commitment to implementing a RE programme. South Africans are collaborating to realise one of the world's most progressive alternative energy plans, effectively tapping into the immense RE potential offered by the country's natural resources while doing it cost effectively.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Chapter 5

CHAPTER 5

Investment Flows, Economic Development and Localisation under the REIPPPP

Energy infrastructure as basis for economic development

Infrastructure investment is a recognised priority in South Africa's economic development and planning frameworks. In a bid to transform the economy, stimulate national growth and drive job creation, Government initiated long-term infrastructure development programmes that leverage investment and participation by the private sector. Infrastructure investment in the energy sector has become a flagship programme of this development strategy.

Sustainable, clean, reliable and affordable energy supply is a critical component in economic and socio-economic growth and development. In 2008, in the face of severe electricity supply constraints, South Africa was confronted by the reality of prolonged underinvestment in the electricity sector, presenting significant risk to the stability of the economy and the developmental goals of the country. This prompted, among others, the prioritised introduction of the REIPPPP that unlocked rapid, large-scale development of energy generation infrastructure while serving as an attractive platform for investors to participate in energy infrastructure opportunities.

The design of the REIPPPP as a rolling, competitive procurement programme enabled continued refinement of the process and increased competitive pressure among bidders in each subsequent bid window, continually improving the cost effectiveness of the energy procured.

In delivering clean energy to the strained electricity network at competitive prices, the REIPPPP has contributed to improved security of electricity supply, economic stability, development and job creation.

The investment appeal of a well designed and executed programme

The REIPPPP is the fastest growing renewable energy programme in the world[105] and one of the largest programmes in the current infrastructure development portfolio of the country. With the announcement of the latest bid round, committed private sector investment in renewable energy generation reached R193bn; effectively realising investment at this scale within four years from the juncture when the first request for proposals went to market (Figure 48). The investment achieved in utility scale RE projects during 2014 placed South Africa among the top 10 investing countries in the world[106] for the year.

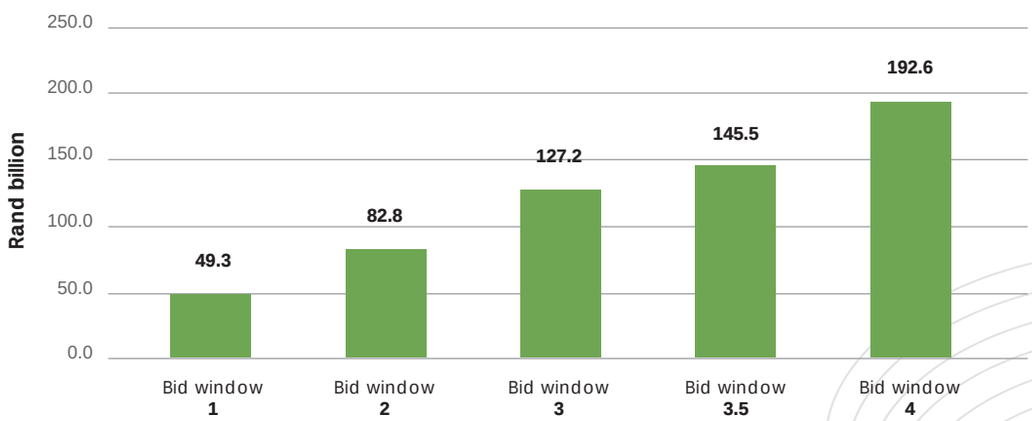


Figure 48: Cumulative REIPPPP investment across bid windows

While the focus of the procurement design has been largely on securing shareholding for South Africans in the REIPPPP, the programme has also attracted significant foreign investment into the country (see Figure 49), bucking the general foreign investor sentiment trend.[107,108]

Figure 49: Foreign and domestic share of investments in the REIPPPP

105 UCT Graduate School of Business. 9 July 2015. Managing Power Sector Reform and Regulation course media release: Power crisis offers investment opportunity in sub-Saharan Africa
106 UNEP. 2015. Global Trends In Renewable Energy Investment report
107 UNCTAD. 2015. 2014, Global foreign direct investment (FDI) inflows declined by 8% and inflows into Africa declined by 3%
108 Number of FDI projects in South Africa fell by 17.7% from 2013 to 2014. Ernst and Young. 2015. Africa attractiveness survey

The REIPPPP has to date attracted R53.2 billion in foreign investment and financing across all bid windows. Foreign equity in the REIPPPP (BW 1 - 4) is R35 billion, equivalent to 56.5% of the total foreign direct investment (FDI) attracted into South Africa during 2014 (i.e. $8.2 billion)[109,110]. Foreign equity and financing combined (R53.2 billion) was 85.8% of FDI in 2014.

This success is largely ascribed to the well-designed and transparent procurement process and an investment environment where key risks are mitigated by Government and transactions offer reasonable levels of profitability.

An analysis of the funding sources and shareholding (see Figure 50) demonstrates how diverse the investor interest is. Financing and investments (equity and debt), originate from a variety of countries across the globe, with Europe and the USA representing the largest sources of finance. The FDI analysis identified at least 19 different countries that have participated in providing financing and/or equity to IPPs.

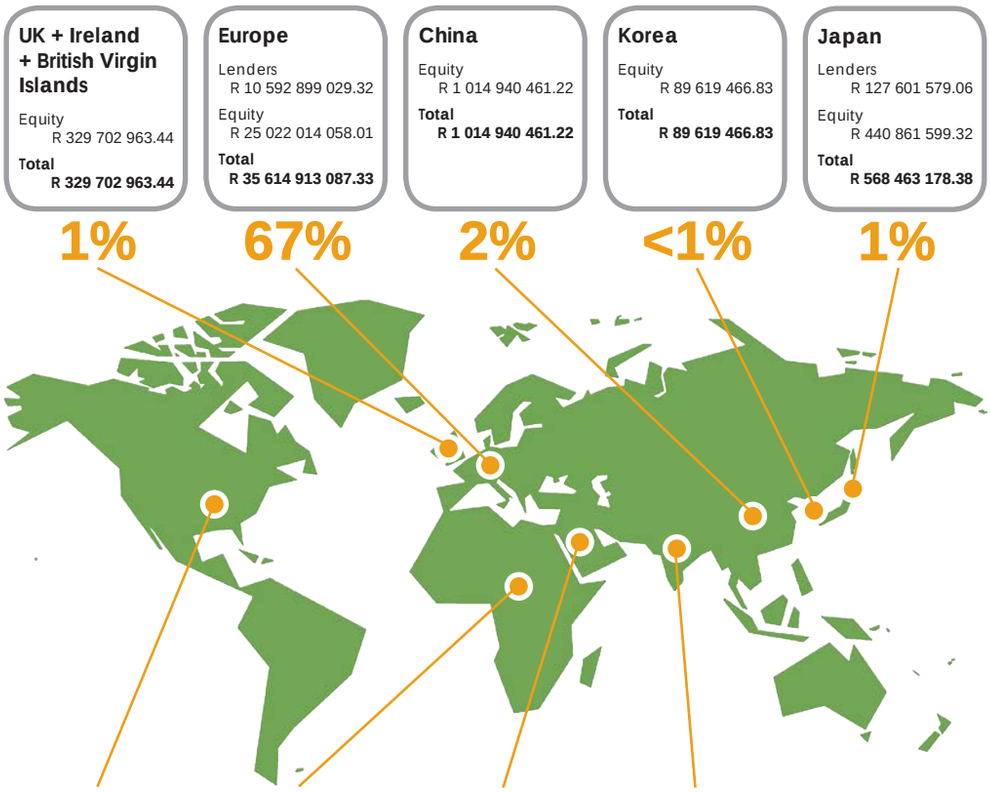


Figure 50: Funding sources and shareholding

109 South Africa Reserve Bank (SARB). 2015. Quarterly Bulletin. March 2015:45. Pretoria. SARB.
110 27 July 2015 exchange rate

The share of foreign investment and equity has stayed consistent and even showed an increase in the most recent three bid windows, suggesting that investor confidence in the REIPPPP continues to grow over time.

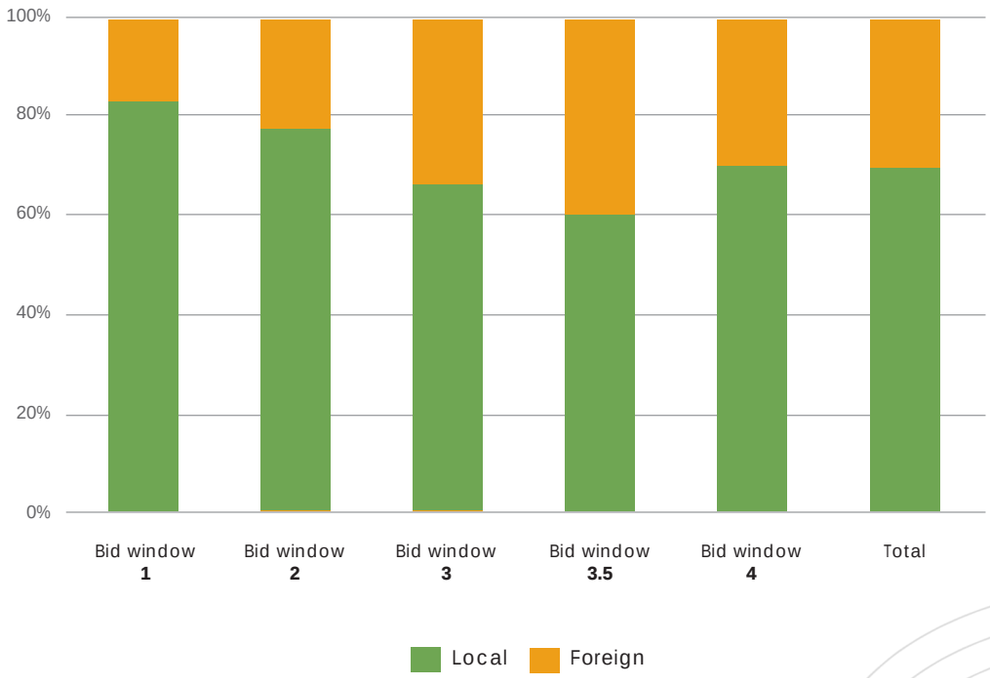


Figure 51: Share of foreign vs local investment (equity and debt)

Equity and innovative ownership models

An important focus of the REIPPPP is to secure sustainable benefits for the country and for local communities in proximity of the development. This is achieved through several mechanisms.

The requirement for shareholding in the IPPs to be retained locally was incorporated into the procurement conditions, requiring that at least 40% of each project be owned by South Africans with Level 5 contributor status. South African (local) equity shareholding across bid windows 1 to 4 equates to 47% (R30 billion) of total equity (R 65.8 billion), which is substantially more than the 40% requirement. Bid requirements have also secured shareholding by black South Africans across the value chain.

In addition, a minimum ownership of 2.5% by local communities is required as procurement condition. In this way a substantial portion of the investments have been structured and secured as local community equity. The actual shareholding held by local communities in participating IPPs is 10.5% across the procured portfolio; well in excess of the minimum requirement.

Community trusts have been the main vehicle for structuring of local community shareholding. Over the life of the IPPs, the benefits to the qualifying communities will be substantial. The aggregated impact (accrued over the 20-year project operational lives) of all bid window investments and earnings, as projected for local communities associated with the IPPs, amounts to R29.1 billion (net income). If the net projected income had to be structured as equal payments over time, it would represent annual net income of R1,46 billion. Under current financing structures, cash flows to communities will be limited until debt[7] has been fully serviced (Figure 52).

111 Finance for local communities have mostly been secured through Development Finance Institutions

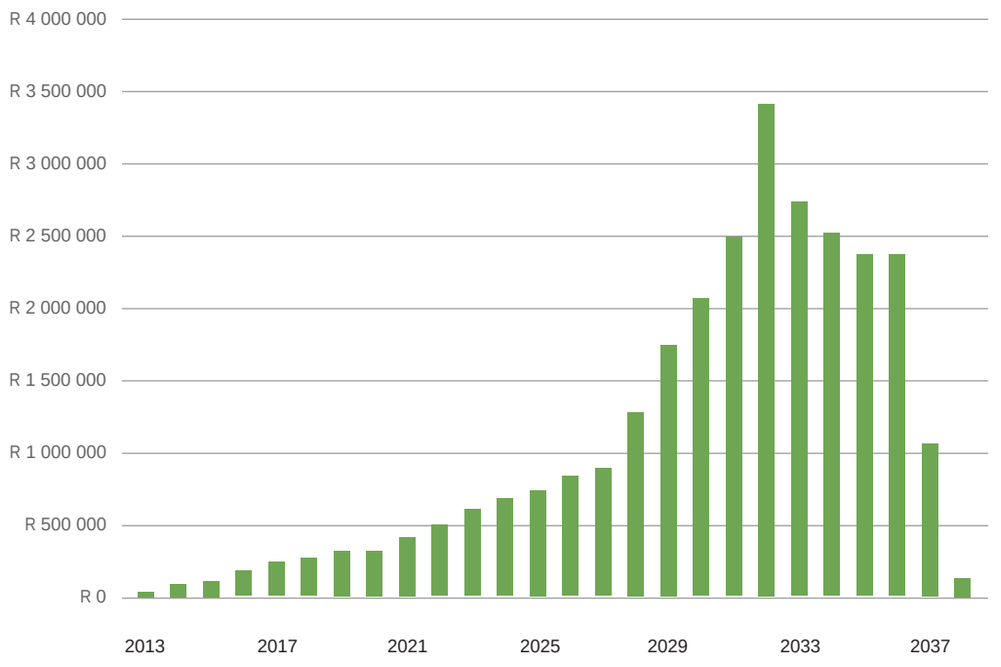


Figure 52: Community trusts cash flow projection

Opportunities and/or alternate vehicles are being investigated for subsequent bid windows that will enable a more even distribution of community trust cash flow and will realise community benefits sooner.

Investment by technology

Wind, Solar PV and CSP have attracted the most significant share of the investment across all bid windows (see Figure 53).

	Wind	Solar PV	CSP	Biomass	Small hydro	Landfill gas
R billion invested	73.4	62.4	53.3	2.3	1.0	0.3
Percentage share of investment	38%	32%	28%	1%	1%	0%
Capacity (MW)	3 357	2 292	600	42	19	18

Figure 53: Relative share of investment

The costs of CSP, Landfill Gas, Biomass and small-scale Hydro offer higher capacity factors and greater flexibility for the comparatively high capacity cost.

With the exception of bid window 3.5 that was dedicated to the procurement of CSP, Wind and Solar PV have dominated every round. Wind power is contributing a larger share of capacity in each bid window, corresponding to a larger share of investment. However, as the capacity cost for wind technology is becoming increasingly competitive, the investment spend per installed unit is delivering more.

	Wind		Solar PV		CSP		Other	
	MW	%	MW	%	MW	%	MW	%
BW 1	649	46%	627	44%	150	11%	-	0%
BW 2	559	54%	417	40%	50	5%	14	1%
BW 3	787	54%	435	30%	200	14%	35	2%
BW 3.5	-	0%	-	0%	200	100%	-	0%
BW 4	1 363	62%	813	37%	-	0%	30	1%

Figure 54: Technology share per bid window[112]

Leveraging broader developmental benefits (national objectives)

In addition to the financial investments in the economy and the favourable equity structures that had been secured, the REIPPPP is targeting broader economic and socio-economic developmental benefits for the country. Through the selected procurement approach, IPPs have been committed to economic and socio-economic development goals during both the project development phase and over the contracted 20-year period of plant operation. Bid obligations and minimum thresholds for preferential procurement, employment equity and socio-economic development contributions are utilised as mechanisms to capture a share of the value/prosperity from the programme for South Africans and local communities.

Broad-based economic development has been a particular focus in South Africa during the last two decades. In support of this goal, the development of black industrialists, youth employment and gender equity and empowerment are among some of the priority focus areas entrenched in the procurement requirements. The distribution of benefits arising from these obligations is expected to make a significant impact in the targeted sectors, when considering the scale of the procured portfolio. As an example, the total projected value of goods and services to be procured from BBBEE suppliers amounts to R101 billion, more than 50% of the total REIPPPP investment (R193 billion). By June 2015, R22 billion had reportedly already been spent in this category.

The programme is anticipated to contribute 109,443 employment opportunities for South African citizens[113] (Figure 55) during both the construction and operational phases. The actual employment reported on the programme to date is 19,033 job years.

112 Values for bid windows 1 and 2 and 15 of 17 projects under bid window 3 refer to contracted capacity at financial close. Values for the other bid windows reflect capacity values as per bid submissions.

113 In accordance with the definitions of the bid documentation, employment is measured in job years, which is the equivalent of a full time employment opportunity for one person for one year. This corresponds closely with the Department of Public Works definition of a job, measured in full time equivalents (FTE)

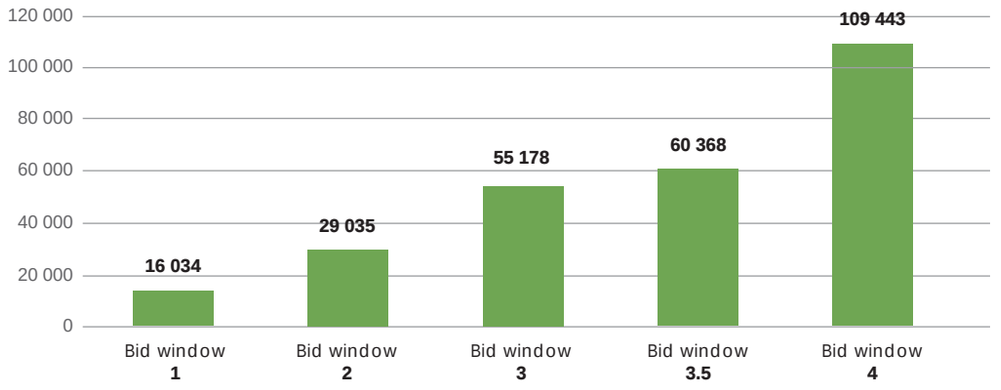


Figure 55: Cumulative employment opportunities[104] (job years[115])

South African citizens, local community members, women, youth and people with disabilities are given preference for employment, with minimum requirements and targets specified as bid criteria.

As part of the bid obligations, IPPs have committed to contribute to community needs: from housing and infrastructure to healthcare, education and skills development. Such commitments have further served to facilitate engagement with local communities, enhancing acceptance by local community members. Given the scale of the programme portfolio, these contributions will be significant:

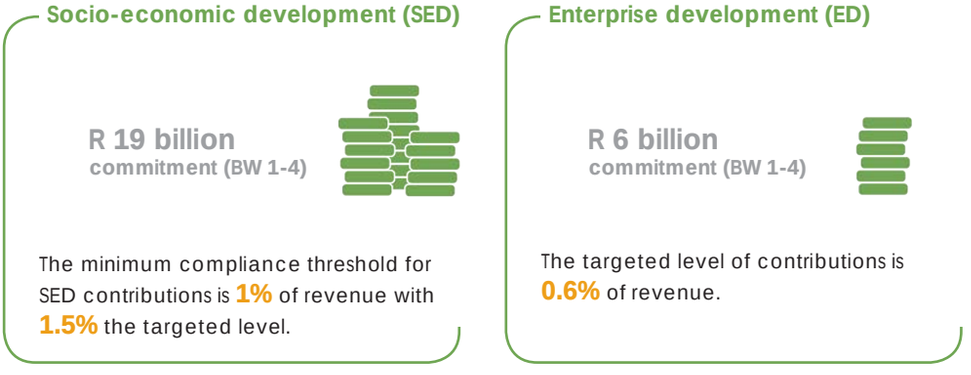


Figure 56: Committed SED and ED spend

These obligations become effective only when operations commence and revenue is generated as a percentage of revenue generated. Earmarked economic and socio-economic support will accrue over the lifespan of the respective plants, but will make comparatively small contributions during initial operation. Even in these early days communities in the vicinity of IPPs that have commenced commercial operation, have benefitted from developmental initiatives.

Contractually, a large share of the economic and socio-economic contributions have been confined to the 50km radius around the respective IPP locations. Clustering of IPP projects in specific geographic areas – rural locations that are generally sparsely populated – has, in some cases, led to an overconcentration of development funds to be spent in areas with limited absorption capacity (refer to Figure 44 on page 82). Consideration is therefore being given by Government to more appropriate and equitable allocations of revenue-related developmental contributions from IPPs. Alternative socio-economic development financing mechanisms are being investigated that would offer more immediate benefits to local communities, while simultaneously and equitably enhancing benefits to the broader South African economy.

114 The duration of the construction periods typically ranges from between two and four years, while the planned operation period of the plants is 20 years. Projected numbers are stated as cumulative over the total periods
115 Job creation is measured in job years (equivalent of a full time employment opportunity for one person for one year)

A monitoring and evaluation and contract management function has been established within the IPP Office to monitor progress and ensure the full benefits of the REIPPPP are realised and accrued to the relevant beneficiaries.

Growing the development footprint

Project distribution in the country (refer to Figure 45 on page 83) has led to investment and developmental contributions being clustered in the Northern Cape, Eastern Cape and Western Cape provinces.

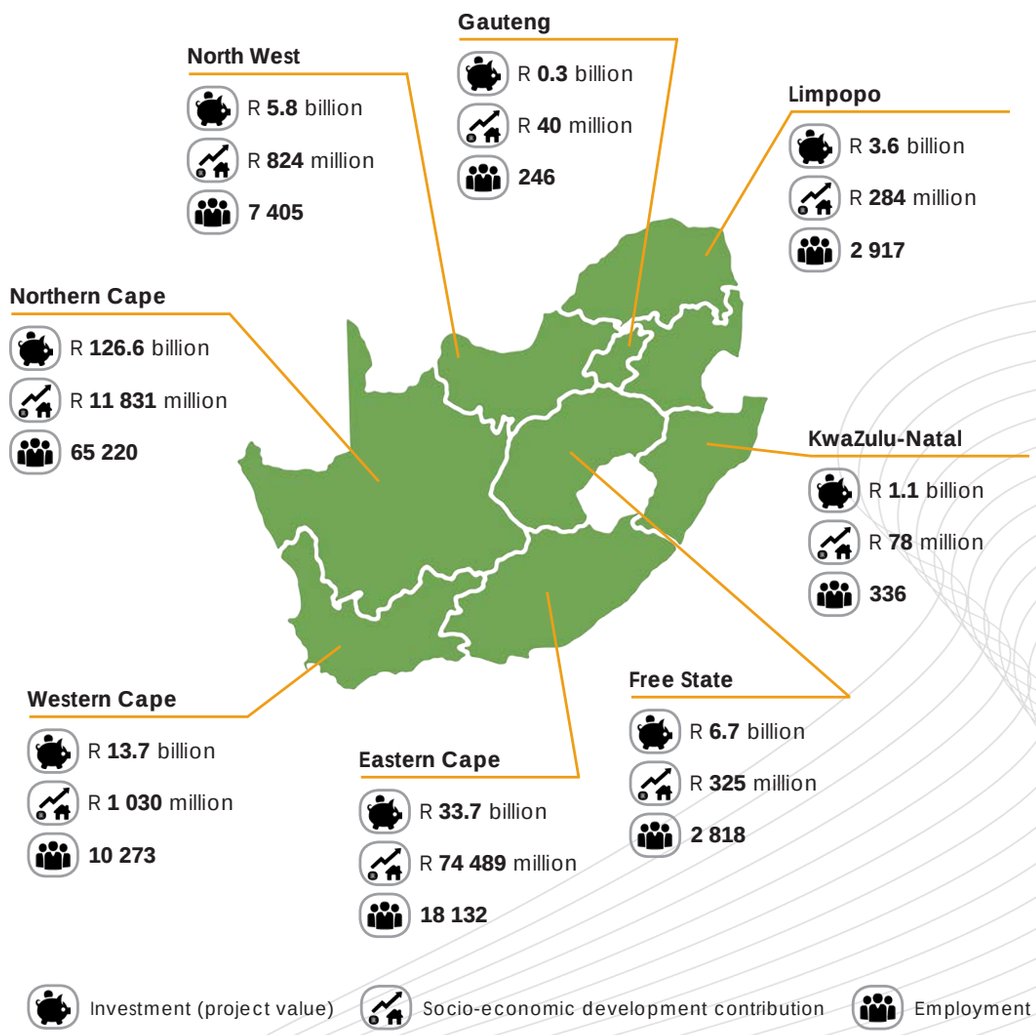


Figure 57: Committed investment and development contributions per province

Within the respective provinces, the need for closer collaboration and improved alignment with provincial Government energy strategies, spatial planning and development plans have been recognised as optimising the benefits of the REIPPPP to the province. Suitable forums are being identified or, if none is existing, created to facilitate improved interaction and alignment with the developmental priorities for the province, region and impacted communities.

Localisation strategies

Development of renewable energy and the associated green economy is identified as a priority sector in the national planning framework. In 2011, a Green Economy Accord was signed by organised labour, business representatives, community constituents, and Government containing 12 green economy commitments. One of these commitments relates to the rollout of renewable energy that is envisaged to be used as a vehicle to promote rural socio-economic development. The Green Economy Accord set a target to create 50,000 green economy-related jobs by 2020 and achieve "an industry-wide localisation of at least 35% by 2016 (or such higher figure as Government may mandate as a condition of any subsidy), and increase local content in the years to follow towards the aspirational target of 75%".

The REIPPPP has been designed to contribute to the country's objectives for developing a local green industry and creating green jobs. By introducing minimum participation requirements for local content (as a percentage of project value), a percentage of the project spend is retained for local suppliers, encouraging the growth of the local industry. The minimum thresholds and targets for local content have been set consistently higher with each successive bid window. This is the only bid obligation category for which increasingly stringent requirements have applied.

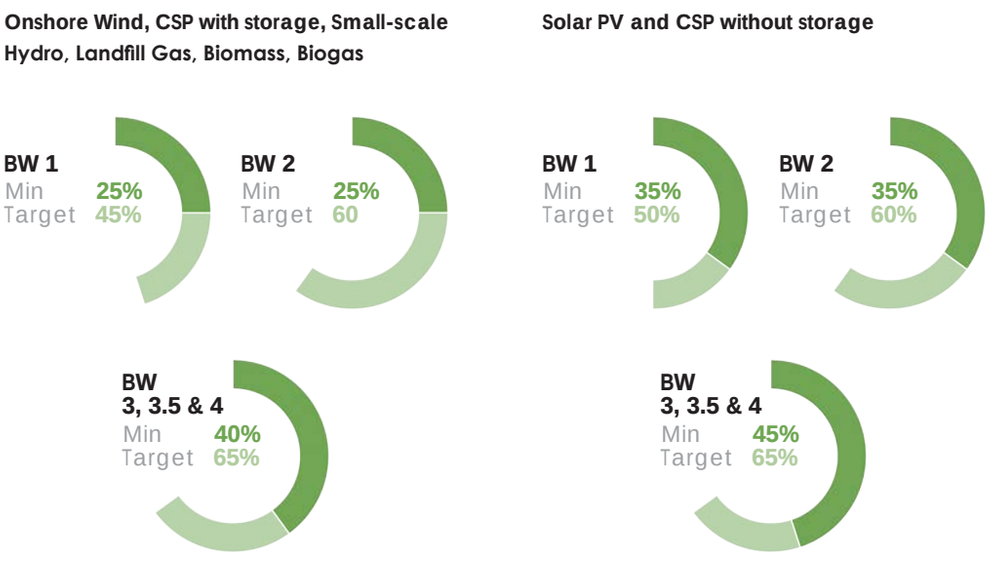


Figure 58: Comparison of local content minimum thresholds and targets across bid windows

For a programme of this magnitude, with the combined procurement spend projected to be R140.8 billion[116], the result is a substantial stimulus for local manufacturing and the green economy. Based on procurement projections, R65 billion is expected to be spent locally for the current portfolio of projects.

While local content requirements present opportunities for economic growth and employment, it obliges local industry to have the necessary capacity to support the desired scale of development. To assess industry status and identify priority areas for Government support and facilitation, **the dti**, in collaboration with industry partners and donors, commissioned three technology-specific studies to assess localisation potential, inform the development of localisation goals and roadmaps for Wind[117], Solar PV[118] and CSP[119] technologies and to identify appropriate Government support programmes that will enable the process.

116 of which R72.2 billion is projected during the construction phase and R68.6 billion during the operational period

117 The wind energy industry localisation roadmap in support of large scale roll-out in South Africa. Developed by the South African Department of Trade and Industry (**the dti**); supported by an industry representative project steering committee that included SANEDI, CSIR, the IPP Project Office, Eskom, SAWEA, DST, DoE and GreenCape. Available Online: www.wwf.org.za, 2013

118 Photovoltaic Electricity. The localisation potential of PV and a strategy to support large scale roll-out in South Africa. Developed by the South African Photovoltaic Industry Association (SAPVIA) in collaboration with South Africa's Department of Trade and Industry (**the dti**) and the World Wildlife Fund (WWF). Available Online: www.wwf.org.za, 2013

119 Assessment of the localisation, industrialisation and job creation potential of CSP infrastructure projects in South Africa - A 2030 vision for CSP. Developed by the Southern Africa Solar Thermal and Electrical Association (SASTELA), Department of Trade and Industry (**the dti**) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)Available Online: www.record.org.za, 2013

The studies have focused on developing an understanding of the respective markets, value chains, market potential and opportunities for localisation in the short-, medium- and long-term, identification of hurdles and recommendations that will facilitate the achievement of the desired level of localisation.

All three studies identified significant potential for localisation. For Solar PV, as an example, the readily achievable local content share in 2013 ranged between 39% and 59%, increasing to 66% by end of 2015. The study further estimated that development of a local industry in the country could create up to 389,282 FTE jobs across the value chain between 2013 and 2035. This scale of employment would, however, be dependent on a high adoption rate in the non-utility scale, commercial-, industrial- and residential-market segments, which accounted for 53% of the projected employment opportunities.

While each sector identified unique characteristics, opportunities and challenges, a few shared requirements for enabling a greater localisation share were identified:

- Stable and sustained growth in the market beyond the scope of the REIPPPP and beyond the South African borders are critical for sustainable local industries.
- Greater visibility regarding long-term development commitments, allowing adequate time for capacity building, are key to market confidence and investment.
- The PV study in particular identified the significant opportunity for the local industry to support non-utility scale renewable energy solutions. The urgent resolution of policy direction and the regulatory environment would dictate the extent to which this market is developed.
- Reduced administrative requirements and streamlined processes for establishment of local manufacturing facilities[120].

The refinement and implementation of the identified strategies, roadmaps and recommendations are continuing in the respective industries, led by **the dti** in collaboration with industry partners.

The combined effect of REIPPPP infrastructure investments, local content bid requirements and technology localisation strategies is evident in the creation of several local manufacturing facilities across the country. Growing investor interest combined with provincial initiatives to create green manufacturing centres, suggest a positive shift towards greening the economy.

120 Such facilities already established in the Eastern and Western Cape provinces (refer to Chapter 2)

PV Module manufacturing – Pinetown, KwaZulu-Natal

ARTsolar was established in 2012 as a South African-owned (PV) module manufacturing plant. The facility has the capacity to produce 250,000 PV modules a year – enough to generate 75MW of electricity. These locally manufactured PV modules adhere to stringent International Electrotechnical Commission (IEC) specifications and have been certified by the TüV Rheinland, a leading global PV test institute. Quality standards are maintained by continuous training of production staff and regular test inspections.

Cognisant of national economic and socio-economic developmental priorities, the manufacturing process has been structured to maximise the local content of the modules, black economic empowerment and job creation. According to the company, ARTSolar maintains a 35% to 40% local content level and the facility employs approximately 160 people.

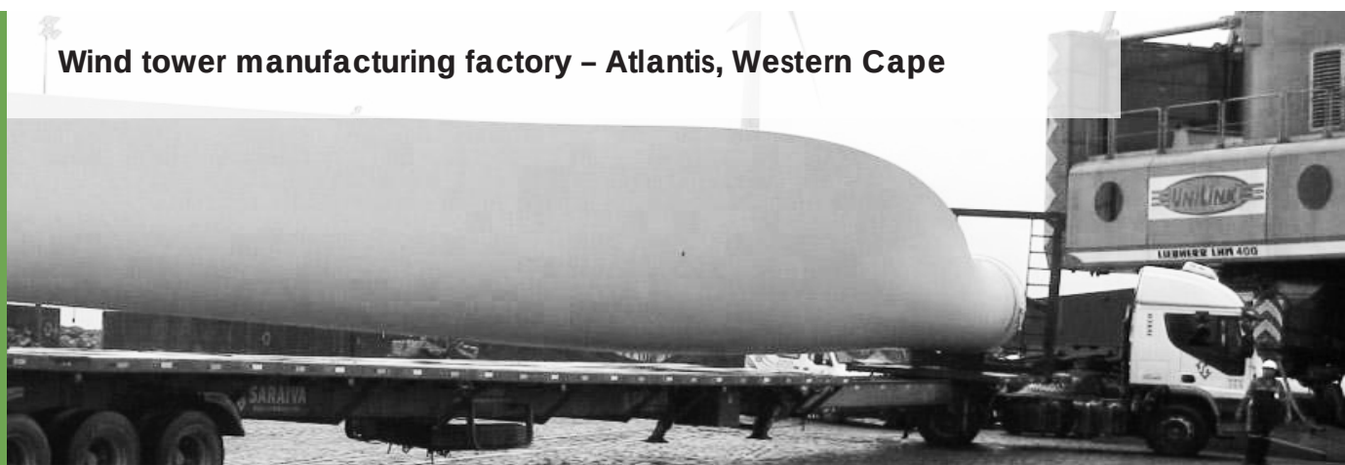
The company envisages playing a significant role in furthering the use of renewable energy throughout Africa. As a result, it has developed PV modules that are suited to local climate conditions, particularly exposure to elevated temperatures typical of the African continent.

Mounting system manufacturing – Port Elizabeth, Eastern Cape

PiA Solar was created as a direct result of the REIPPPP. Recognising a niche market for the design, manufacture and installation of solar mounting systems, PiA Solar was formed in 2011 as the first locally designed, supplied and installed mounting system solution in South Africa. The world standard fixed mounting system was developed in collaboration with Scatec Solar, a Norwegian-based developer & Engineering, Procurement and Construction (EPC) company that successfully participated in the first bid round of the REIPPPP. The design was certified and approved by Scatec for use, and the installation successfully delivered well ahead of time. In 2013 alone, PiA Solar installed more than 600,000 modules, 150MWp of structures and 200,000 foundations.

As a local manufacturing and installation company, the company maintains it is contributing significantly to local content, employment and equity. It offers a local content range in excess of 95 percent for all product and service offerings. It has created temporary employment in one year for more than 700 people from communities local to the specific installations. In addition, in excess of 70 permanent jobs were created for a variety of skilled supervision and management personnel. PiA Solar is also a BBBEE Level 4 contributor with 100% procurement level recognition.

Wind tower manufacturing factory – Atlantis, Western Cape



Spain's Gestamp Renewable Industries (GRI), develops, constructs and operates wind farms across the world. It is also a manufacturer of wind towers for major Original Equipment Manufacturers (OEMs) in the wind energy market, with 10 factories worldwide. One of these tower manufacturing facilities is situated in the Green Technology Industrial Park in Atlantis, about 40km from Cape Town. The location reflects the vibrant South African RE market and responds to the growing local content requirement specified in the REIPPPP. The factory officially started operation in November 2014.

The facility, which represents an investment of €22 million, can manufacture 150 wind towers annually and provides employment to more than 200 people. As such it contributes to key objectives of the REIPPPP programme, which are to establish local manufacturing facilities, job creation and transfer of skills in South Africa. The support of **the dti** through a development incentive grant was instrumental to realise the project.

Atlantis, a previously developed, but underutilised industrial centre, is earmarked as a new green economic hub to grow the Western Cape's green technology sector and the community's manufacturing potential. The Atlantis community has long struggled with a high unemployment rate. The location of the Gestamp manufacturing facility in Atlantis is therefore also supportive of the developmental objectives of provincial Government.

Becoming leaders in the global, green economy – Mr Pancho Ndebele, MD of Emvelo

Mr Pancho Ndebele has an interest in practical applications for sustainable development that tangibly improves the quality of living for the broader society. His journey started as an electrical and water engineer involved in the development of water and energy infrastructure. In 2008, he established Emvelo for the purpose of pursuing sustainable infrastructure development, a bold step that preceded most of the major development programmes in the country. Emvelo was uniquely positioned as a black-owned business

in this sector prior to partnering with global players in the development of large-scale projects. Emvelo has been at the forefront of Southern Africa's emerging clean energy sector and was instrumental in founding the Southern Africa Solar Thermal and Electricity Association (SASTELA).

Emvelo successfully participated as an IPP in the third REIPPPP bid window. The 100MW Karoshoek Solar One CSP plant, in which Emvelo is a shareholder, is being developed in Upington in the Northern Cape province. Karoshoek Solar One is part of the Karoshoek Solar Valley, 'a solar Silicon Valley' concept conceived by Emvelo for a 1.1GW cluster of CSP capacity that can be dispatched as required by the power system.

With the insight of their journey and participation in the policy discourse relating to renewable energy, Mr Ndebele believes that as a country, South Africa has taken enormous strides towards creating a sustainable framework for RE development. The current procurement approach successfully caters for competition, leveraging of international technology price trends, improved cost efficiencies, risk delegation and broader economic interest. In his words: "world class".

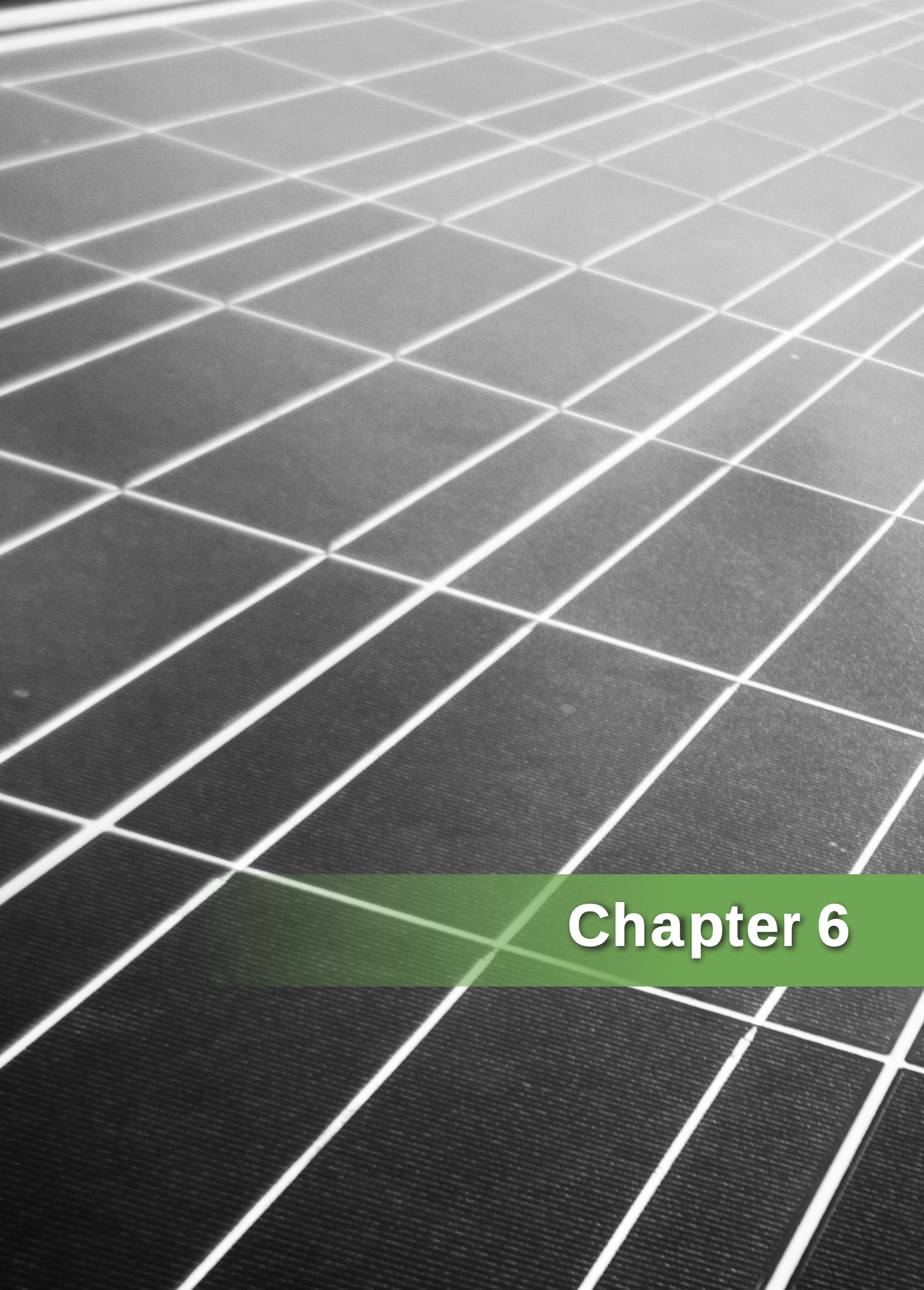
Mr Ndebele, however, believes this to be the first step of a much greater vision that will unlock the true economic potential of this sector; in the same manner that the European Union's RE framework catalysed the industrialisation of today's leading wind suppliers. Speaking as a participant in the CSP industry, but of equal relevance to other RE technologies, Mr Ndebele believes southern Africa has the potential to become a global leader in the manufacture and supply of CSP technology to the world.

The thermal storage offered by CSP contributes to the value of a RE portfolio, increasingly presenting a feasible alternative to conventional power sources and notably increasing the global market potential for RE technologies. Based on Emvelo's experience of Southern African Development Community (SADC) interest in RE development, he recognises the potential for regional collaboration to unlock the economies of scale for a lucrative, regional industry. Quoting the 'Airbus model' where components manufacturing is distributed across several European countries for assembly in France, he foresees the potential for a similar manufacturing hub that can stimulate the entire regional economy. This scale of development would, however, be dependent on clear strategic direction and development commitments to justify the necessary investment that will lead to meaningful industrialisation.

He believes southern Africa is perched at a threshold from where, if pursued collaboratively, it can position the region as a key player in the global green economy; enabling vital economic growth and long-term sustainable employment.

Building prosperity, one power plant at a time

The REIPPPP programme has successfully created an enabling framework for attracting substantial private sector expertise and investment for utility-scale renewable energy. It has delivered cost-effective, clean-energy infrastructure to the country and contributed to security of electricity supply that is expected to bring about a virtuous circle of investment and economic growth. The REIPPPP design continues to seek an effective balance between the seemingly competing national goals of accelerated procurement of cost-effective energy at the required scale while enabling and leveraging maximised developmental benefits for the country. In the meantime, efforts to identify and unlock opportunities for renewable energy investment and broader industry development continue outside the REIPPPP framework and across the continent.



Chapter 6

CHAPTER 6

Renewable Energy (RE) contribution towards sustainable energy for all

Challenges of energy poverty and electrification

Most recently, renewable energy in South Africa has become synonymous with large-scale, grid-connected projects as constructed under the REIPPPP. Renewable energy can, however, also be deployed on a smaller, stand-alone scale where it can directly benefit households, farmers, communities and businesses.

A considerable portion of South Africa's residents/population are classified as energy poor. Using different approaches to quantify the extent of the energy poverty challenge, it is estimated that between 40 and 49% of households are affected. Data[121] further suggests that the situation is deteriorating. In considering energy poverty, both non-electrified and electrified households are taken into account.

The South African government has, over an extended period of time and with broad international support, been involved in a number of initiatives and projects focused on the application of non-grid renewable energy and renewable energy alternatives in order to improve the quality of life of all citizens. Included among these initiatives are rural energisation, solar water heating systems and energy-efficient cooking programmes.

Rural energisation / Off-grid electrification

The 1998 White Paper on Energy Policy embedded Government and the DoE's commitment to universal access to electricity for all South African households. In 2001, a non-grid electrification programme was introduced as a complementary measure for addressing the electrification backlog in areas that could not be electrified within a period of three or more years. Most of these affected areas are in sparsely populated, remote rural areas of the country where a combination of low load demand, the dispersed nature of rural settlements, high fixed costs of grid extension and challenging geographical terrain, make it unlikely that the electricity grid will reach all areas in the medium term.

Non-grid electricity supply through the means of Solar PV systems was identified as the most suitable, temporary alternative to grid electricity[122]. This policy position and resulting solar home system (SHS) programme is built on extensive research and investigations that started at least two decades previously. The programme makes use of standalone SHS, where the size of the installed Solar PV systems range from 50 to 100W peak. The upgrade to larger systems of about 100W peak was introduced from 2012, targeting both existing and new installations. The service offering is currently limited to lighting and media access (it provides power for charging mobile phone batteries, radio and a monochrome or a 12V colour television). The non-grid service is offered on a fee-for-service basis, requiring customers to contribute a once-off connection fee (not exceeding R89) towards the installation followed by a small monthly payment thereafter. The monthly service fee covers lifetime running costs, including the operation, maintenance, replacement of batteries, fee collection, customer service, support and management of the system. Government subsidises about 80% of the capital costs of the systems and 100% for those households that are classified as indigent, using the free basic services grant.

The programme had to closely align with Eskom and municipal distribution development planning to delineate the areas that would receive SHS. As a measure with 'interim' or 'temporary' status, the programme faced many challenges, which included the coordination with network planners, alignment with distribution grid development plans and acceptance by the receiving households.

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121 DoE. 2012 and 2013. Household survey of energy related behaviour and perception in SA
122 Implemented as a temporary supply solution to provide rural communities access to limited electricity until grid connections become achievable

In June 2013, Cabinet adopted the New Household National Electrification Strategy, which targets 10% of the national backlog for off-grid electrification through SHS installations, or any other non-grid RE technology that is cost effective (e.g. mini-grid or hybrid systems). This Cabinet decision is significant in that it acknowledged it would take years before all households are electrified via the grid and that non-grid electrification would play a pivotal role in attaining universal access to modern energy services (current status illustrated in Figure 59). The New Household Electrification Strategy identified a target of 300,000[123] households for electrification with quality, non-grid solutions by 2025. In addition, the Strategy foresees universal energy access (97% of households) by 2030 – which aligns with the National Development Plan 2030 goal.

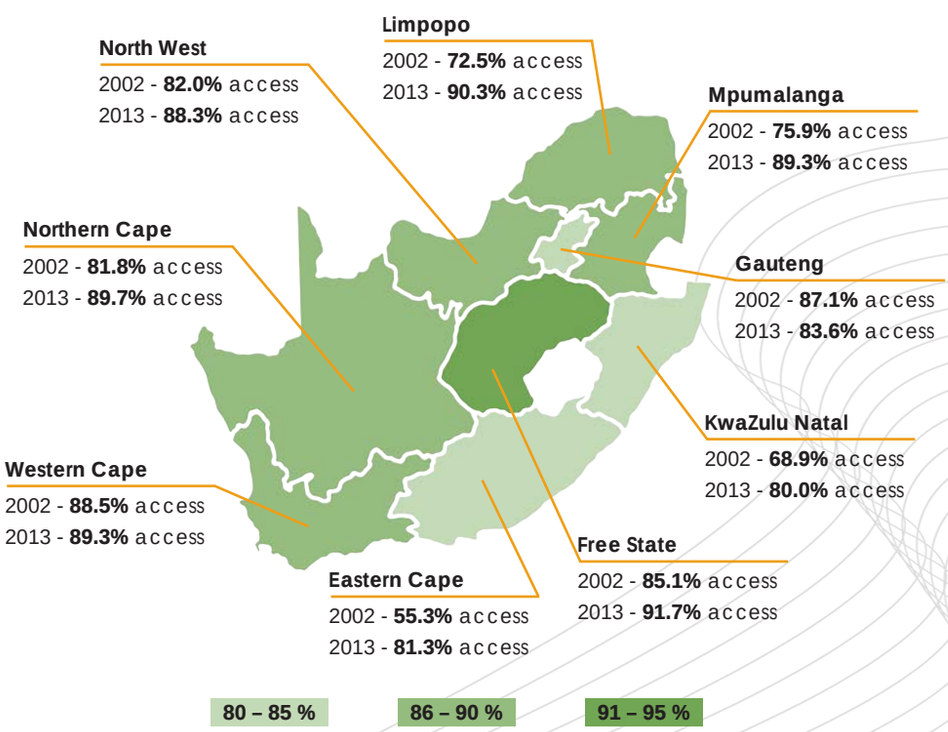


Figure 59: Electrification status for provinces, 2002 - 2013[124]

The Minister of Finance's 2015 budget speech reemphasised the national position that building inclusive economic growth and development is dependent on providing electricity to rural municipalities.

The off-grid electrification programme is effectively implemented as a collaboration between the DoE and the Department of Cooperative Governance and Traditional Affairs (COGTA), under whose auspices all municipalities function. While the non-grid programme is the responsibility of the DoE, collaboration with COGTA and municipalities are important because of coordinated planning and 'co-funding' from the Free Basic Energy (FBE) allocation. The FBE is managed by COGTA and administered by municipalities. For indigent households that qualify for a monthly FBE allocation, a share of the service costs should be contributed by their municipalities in lieu of the equivalent electricity supply.

123 Representing approximately 10% of the non-electrified housing stock in the country
124 Stats SA. 2014. General Household Survey dataset, 2002 -2013

Coordination of the FBE contribution has presented challenges, notably where indigent registries are outdated, preventing the municipal payments from being processed. Ideally, the registers are supposed to be updated annually.

The implementation of the non-grid programme is structured into concessions within predefined geographic locations, with a predetermined number of SHS allocated. A single service provider, or concessionaire, is appointed to a designated area within which it has the exclusive right to supply SHS services. Concessionaires that have successfully tendered for rendering these services, are appointed on a short-term contract that is evaluated in terms of performance and impact every two years, before provisional renewal. They are furthermore responsible to provide maintenance on the installed systems in terms of a 20-year contract. In line with this obligation, customers pay R90 per month for maintenance of the system. The DoE monitors the implementation to ensure the services are rendered in accordance with contractual obligations.

Since inception, the programme has been implemented in three provinces, namely Limpopo, KwaZulu-Natal and Eastern Cape. There is also a German (KfW), donor-funded non-grid project implemented in the Eastern Cape. From 2002 to date, approximately 96,000 households were supplied with non-

grid SHS technology. The focus has been on areas most affected by low levels of electricity access resulting in significant improvement in service levels (Figure 59). While the services are limited, most recipients have reported improved quality of life. Electronic devices can now be charged at home[125] and electric lighting[126] promotes learning and income generating opportunities while improving personal safety and security[127].

To date, it's estimated that the South African government has invested more than R350 million in the off-grid programme, in addition to other significant contributions from the concession companies themselves. The programme receives direct allocation from the national budget; in the current 2015/16 financial year, R101 million has been set aside.

Further refinements to the non-grid programme are being pursued in line with the new household electrification strategy. During the sixth South Africa-EU Summit held in July 2013, the European Union (EU) and South Africa agreed on the development of a joint cooperation programme with a focus on rural electrification through renewable energy solutions. The joint programme will focus on the 300,000 households identified by the New Household Electrification Strategy. Following the agreement, a concept for the implementation of the off-grid rural electrification management authority was developed with the support of the EU-SA Dialogue Facility. The concept has since been submitted to the European Commission headquarters to appeal for support from the EU Technical Assistance Facility (TAF) that is available under the Sustainable Energy for All Initiative (SE4All). This submission to the TAF was well received, with funding approved for implementation of the programme. As first implementation steps, a project manager was appointed and the technical assistance programme has been initiated.

With this support, the non-grid electrification programme will be redesigned to improve the quality of the service offering and strengthen institutional capacity, including the establishment of an off-grid electrification authority. The purpose of this proposed off-grid management authority is to ensure that the off-grid electrification programme is reinvigorated to ensure meaningful contribution to universal access as well as promoting off-grid energy access more generally. As such, the proposed enhancements to the programme include mini-grid/hybrid packages and biogas systems. The entity will, therefore, be focused on assisting with the transition from renewable energy 'concepts, ideas and pilots' into meaningful programme roll-out that improves access to modern energy services[128].

125. Previously, devices such as mobile phones and television batteries required traveling to an electrified area where devices could be charged, often at a cost to the user
126. Replacing paraffin lamps and candles as the main sources of lighting
127. PwC. July 2013. Socio-economic Impact Assessment of Rural Electrification
128. DoE. 2014. Off-grid management foundation document

The roll-out of solar water heating (SWH) systems

Solar water heating (SWH) in South Africa makes sense on many levels: the country has one of the best solar profiles in the world. There are also other factors at play: Eskom needs to alleviate electricity demand on the morning and evening peak periods; avoiding CO_2 emissions from coal- generated electricity through renewable energy technologies could also help Government achieve its climate protection targets. The rising cost of electricity makes investment in a solar water heater attractive; and, more recently, the industry offers opportunities for job creation and local industrialisation. From a consumer perspective, electric water heating accounts for 40-60% of an average home's electricity bill, and SWH can save 70% or more of the energy and costs to heat water. In cases where households are not connected to the electricity grid, the provision of a SWH system can provide hot water from a free energy source and avoid costly expenditure and negative health impacts associated with typical alternative fuels such as wood, paraffin and coal. In recognition, the 2003 RE White Paper identified SHW as a key contributor towards the 10,000GWh RE target set for 2013.

The South African government prioritised SWH both as a means to reduce electricity demand on the electricity system (thereby also saving energy), and to extend access to energy services for homes without adequate services. Inadequate services may be relevant to non-electrified and energy poor households. While the feasible scope for SWH applications within the commercial and industrial sectors is significant, Government's focus has been primarily on the residential market.

Initial groundwork came from the 2005 CEF 500 project, implemented by CEF, a state-owned enterprise (SOE) with support from the United Nations Development Programme (UNDP) grant funding program. In addition to supporting a pilot rollout of SWHs, the project served as a catalyst for the development of the first industry standards for SWHs and the establishment of a local testing facility at the SABS. South African standards and testing had to specially provide for the harshness of local conditions.

The CEF continued investigating suitable options to promote SWH in municipal areas and launched the 'Switch to Solar' project in 2008. It was designed to address identified market barriers, which included prohibitive initial system costs, low levels of awareness about SWH performance and durability and delays in installation associated with the greater complexity of SWH sizing and location. The initiative therefore offered a database of reputable SWH manufacturers and installers, post-installation inspections by certified plumbers and, most importantly, financing. The programme covered the full initial cost of supply and installation, processed any incentive claims on behalf of the homeowner and then allowed the consumer to repay the balance over a six-year period. 'Switch to Solar' replaced 258 SWHs in Ekurhuleni and Nelson Mandela Bay Metropolitan Municipalities, which were both partners to the programme.

In 2008, the national utility, Eskom, introduced a national SWH incentive programme under a broader demand-side management programme. This incentive programme was made possible by the newly introduced industry structures (including industry standards and testing facilities) that created confidence in the performance and quality of the products being supported.

The national drive for SWH was given impetus with the announcement by the former Minister of Energy, Ms Dipuo Peters, in May 2009[129] that the DoE will install one million SWHs within five years. Building on this short-term target, the National Development Plan has consequently set a long-term target of 5 million SWH installations by 2030. These ambitious targets necessitated the development of a coordinated national SWH strategy.

Through the Renewable Energy Market Transformation (REMT) Programme, the DoE commissioned Integrated Energy Solutions to develop a National SWH Framework. The main aim of the framework was to identify and develop solutions for the largest obstacles to large-scale adoption of SWHs in the country. The 2009 study identified high costs, supply chain constraints and limited local supply capacity[130] as the main market barriers preventing economies of scale.

129 Budget speech, May 2009
130 REMT and DoE. 2009. Report on the National Solar Water Heating Conference: Building Consensus on accelerating the rollout of Solar Water Heaters in South Africa

In developing an action plan, the framework distinguished between an industrial/commercial market segment and the residential market. Based on the AMPS 2009 household database survey, it dissected the residential sector into five distinct market segments (Figure 60).

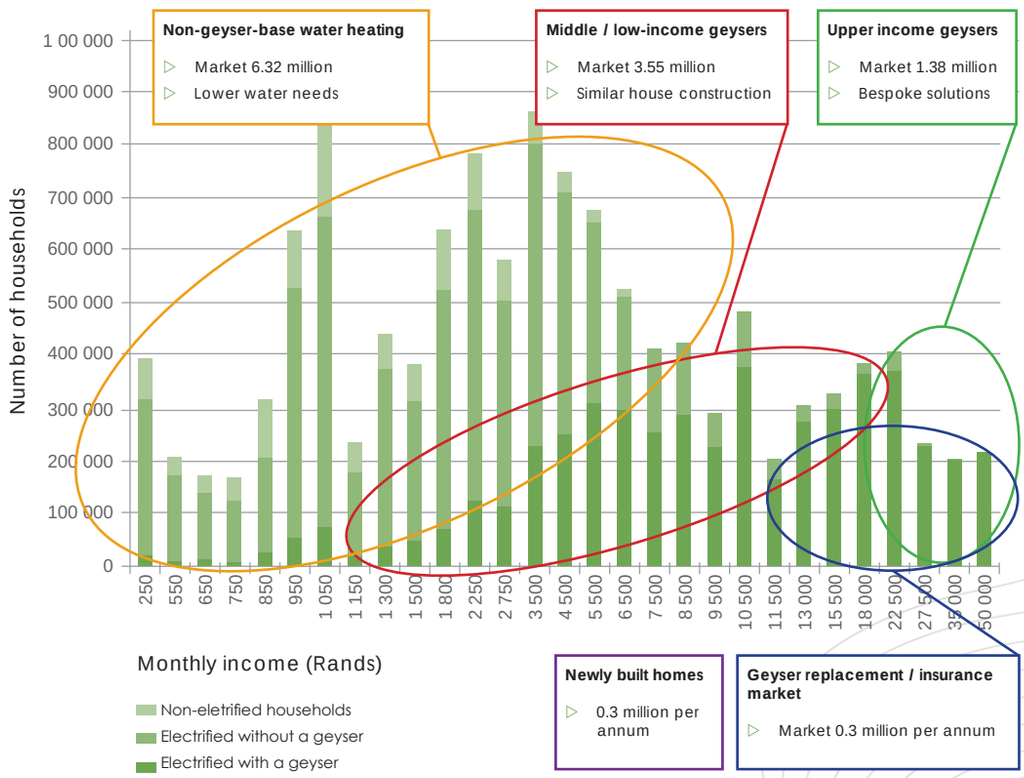


Figure 60: Residential sector segmentation for the National SWH Framework, 2009

Market segmentation informed three clear implementation strategies. The first, targeting the estimated five million high income households to encourage fuel switching from electric to solar technology, would be focused on realising energy savings. The insurance industry was identified as a potential vehicle to facilitate a geyser[131] replacement programme for this market segment as they were already processing 300,000 insurance claim replacements[132] per year.

The second would focus on electrified and non-electrified households without an electric geyser. The objective would be to provide modern energy services to some of the six million homes that were identified in this segment. Preference was given to a mass rollout approach installing SWHs at no cost to the consumer. Although the focus was not on energy savings, the availability of hot water was expected to reduce the use of electric powered kettles and stoves to boil large amounts of water. This would help save the household costs or enable available energy to be used for alternate applications.

The last strategy was to focus on newly built homes, ensuring informed decision-making when selecting water heating options at the time of construction. The requirement for efficient water heating in new developments has since been incorporated into national building standards[133] and also municipal bylaws.

In 2012, Government consolidated existing efforts into a National SWH Programme with an allocation of R4.7 billion in the 2012/13 budget. At the time Eskom was appointed implementing agent for the SWH rollout to both the high- and low-income market segments. Under this arrangement, the existing

131 Colloquial term for an electric water heater in South Africa
132 Estimated number of insurance claims for the replacement of failed electric heaters and associated water damages
133 SANS 10400X and XA; http://sans10400.co.za/energy-usage

incentive programme continued as before and a mass rollout programme was introduced for the free installation of SWH systems to under-privileged communities.

As of February 2015, a total of 407,463 SWHs had been installed (Figure 61). The vast majority of installations were done in Gauteng (35%), followed by KwaZulu-Natal (17%).

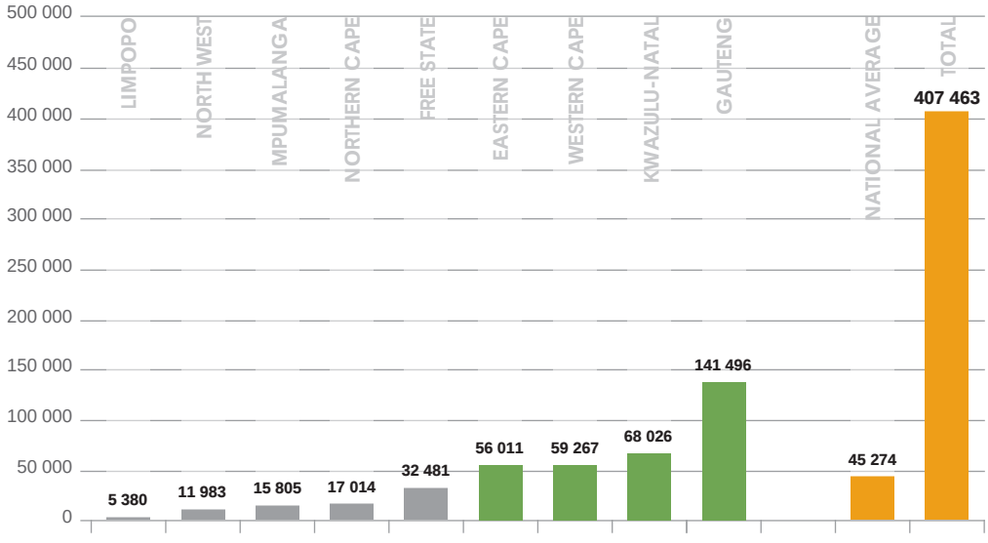


Figure 61: SWH installations as of Feb 2015

In spite of the coordinated effort and the introduction of the mass rollout, implementation progress has been slower than anticipated, preventing the target of one million SWHs by 2015 being met. Implementation has been hampered by expected and unexpected challenges. A significant challenge has been the cost. To meet the target would require an estimated total cost of R12.9 billion[134]. An amount of this magnitude could not be sustainably funded by the fiscus[135]. Funding, however, was not the main hurdle. Poor quality installations, use of cheap imports and access to good quality, reticulated water supply in many of the provinces presented greater challenges to accelerated implementation.

134 Assuming 70% of the targeted installations in high-income households with a contribution of R15,000 per unit and 30% in low-income households at a total installed cost of R8,000 per unit

135 DoE Deputy Director General, Ompi Aphane. Report on the National Solar Water Heating Conference: Building Consensus on accelerating the rollout of Solar Water Heaters in South Africa hosted by the Department of Energy and the Renewable Energy Market Transformation (REMT) Unit, Johannesburg on 5 November 2009

Drawing on the lessons learned, the National SWH Programme has been comprehensively reviewed, with a revised strategy presented to Cabinet on 24 June 2015. Details of the new direction are still being finalised, though the following principles are important:

- Participation in the programme will require compliance with the SWH industry designation requirements[136] in terms of the Preferential Procurement Policy Framework Act, which calls for a minimum local content threshold of 70%;
- Manufacturing contracts will be adjudicated in terms of local content and awarded according to guidelines based on the highest local content achieved in the shortest possible time; and
- Manufacturing contracts are to be separated from installation.
- In line with the REMT recommendation, cooperation with the insurance industry will be pursued to replace failed electric water heaters with solar water heaters.
- In addition, bulk procurement from manufacturers will also be adopted.
- The SABS has been designated to carry out local content verification on behalf of government.

SWH offers a suitable, renewable energy alternative for water heating in South Africa. Government will continue its support of this technology as a more efficient energy alternative and for delivering expanded and affordable services to all households. The future emphasis will be on establishing quality, local manufacturing capacity and unlocking a broader economic and socio-economic development potential.

Turning houses into homes – Kuyasa Project, Western Cape

SouthSouthNorth Projects Africa (SSNA), a section 21 organisation based in Cape Town, set up a project called Kuyasa in collaboration with the City of Cape Town and with funding from the former Department of Environmental Affairs and Tourism. Kuyasa, the first registered CDM Gold Standard project in the world, included the installation of solar water heaters, ceilings and low energy lighting in 2,309[137] RDP houses in Khayelitsha. This project aimed to improve thermal efficiency of houses, decrease emissions, and lower monthly fuel bills to create a better living environment, improve indoor air quality and therefore minimising health problems.

The project opted for a locally manufactured solar water heater that is suitable for South African conditions, such as chlorination and high heating temperatures. Combined cost savings through the energy-efficient interventions amounted up to R300 per month per household. Other benefits included direct income generation, improved living conditions, skills transfer and a significant lowering of the area's carbon emissions.

136 The designation policy instrument is one of a suite of policy levers designed to maximise support for domestic manufacturing, implemented by **the dti**
137 Global Infrastructure Basel. July 2012. Case study. http://www.gib-foundation.org/projects/kuyasa-low-income-energy-efficiency-housing-project/

The Kuyasa project was launched in 2009 and concluded in 2010. The CDM monitoring and verification results from November 2010 reported annual reductions of 7.40 million kWh (34%) in energy consumed and 6,437 tons (33%) in CO_2 emissions for the 2,309 households. The project created 87 job opportunities locally at Kuyasa, offering in-service training in carpentry, plumbing and electrical skills. Results revealed that almost half of Kuyasa residents that received training on this project now have fulltime jobs and/or business opportunities outside the community.

Sustainability in housing – Cosmo City Climate Proofing Project, Gauteng[138,139]

The Cosmo City Climate Proofing Project was officially launched on 9 June 2010 by the City of Johannesburg's Environmental Management Department in partnership with Johannesburg City Parks. The Climate Proofing project involves the rollout of low-pressure Solar Water Heater (SWH) units, as well as the installation of insulated Isoboard ceilings and distribution of Compact fluorescent lamps (CFL) to 700 low-income households in Cosmo City. Cosmo City is a mixed-income housing project created to provide accommodation for informal settlers from the area.

The project was funded by the Danish International Development Agency (DANIDA) under the auspices of the embassy as part of a R15 million climate change mini-programme for Johannesburg. The main objective of the project was to promote renewable energy, energy efficiency and greening in low-income houses and contribute towards building a liveable human settlement that promotes energy conservation, alleviates energy poverty and demonstrates the performance and efficiency of renewable energy and energy efficiency technologies. This project is an extension of the first phase of installation consisting of 170 SWH in 2007 and contributes to the DoE's target of implementing one million SWH units in the country.

Results reported for the period August 2009 to October 2011, reflected annual carbon emission reductions of 1,258 tons of CO_2 and annual cost savings, at that juncture, of R1,154.94 per household. One hundred and eighteen job opportunities were also created during the implementation.

138 Onatu, G. O. Ogra, A. and Okafor, J. 2012. Energy efficiency improvement strategy in mixed income housing development: A case study of Cosmo City Johannesburg
139 C40 Cities case study. November 2011. City of Joburg launches its 'Climate proofing of urban communities' project

An unexpected adventure in renewable energy – Mr Anton-Louis Olivier and Mrs Marlett Balmer

Mr Anton-Louis Olivier is currently the Managing Director of NuPlanet (Pty) Ltd, developers and operators of the Bethlehem Hydro IPP (see case study on page 64). Mr Olivier joined the then Department of Minerals and Energy Affairs (DMEA) as a Junior Energy Specialist in the Energy for Development Directorate in 1993 after graduating as a mechanical engineer. The position was intended as a stepping stone, but the energy sector and this transition period from apartheid-era energy policy, presented an expected, yet enjoyable challenge. A few highlights from this period:

The Energy for Development group consisted of Dr Izak Kotze, Mr Tony Golding and Mrs Marlett Balmer. Navigating the bureaucratic system of that time required critical survival tips for which newcomers, like himself, relied heavily on the guidance of their colleagues. These included addressing all staff members more senior as Meneer and Mevrou (Sir and Madam) and regular drinks after work as a coping strategy reminiscent of Government jobs the world over.

A notable event during that period was the introduction of the Reconstruction and Development Programme (RDP) as policy framework in Government. Under this new programme, approximately 20,000 schools and 5,000 clinics were identified as being not electrified. Most of these were not within reach of the electricity grid and would need to be electrified using Solar PV. The PV industry in South Africa in 1993 was miniscule and a very small focus of the DMEA at the time. As Mr Olivier had the dubious honour in the DMEA to deal with PV, this project landed on his desk. Soon he was attending RDP meetings at the Union Buildings as DMEA representative and making calls on a programme that even then had a price tag in the region of R1.5 billion. "Needless to say, the moment DMEA management realised there was this much at stake and a junior official with only six months experience was running with it, I was bumped back to doing field surveys of biogas plants." He further recalls his biggest disappointment as being unsuccessful in introducing the concept of energy efficiency and passive design into the huge RDP low-cost housing programme.

In Mr Olivier's recollection, the RE industry then consisted of a couple of companies in the off-grid sector, supplying PV systems and SWH for farms and remote locations. The only industry body was the Sustainable Energy Society of Southern Africa (SESSA), a meeting place of a handful of retailers and other RE enthusiasts. As there was little activity in the sector, the SESSA meetings themselves fulfilled a strong social function for the industry.

For RE and energy development work, DMEA collaborated with academic institutions. Prof Anton Eberhard's group at EDRC at the University of Cape Town were the main partners for policy development. The development and publication of the county's first Wind Atlas, a project lead by Mr Olivier, was based on work done by Prof Roseanne Diab at the University of Natal.

For Mr Olivier his adventure with RE continued after he left the DMEA; he continues to develop and operate hydro power plants.

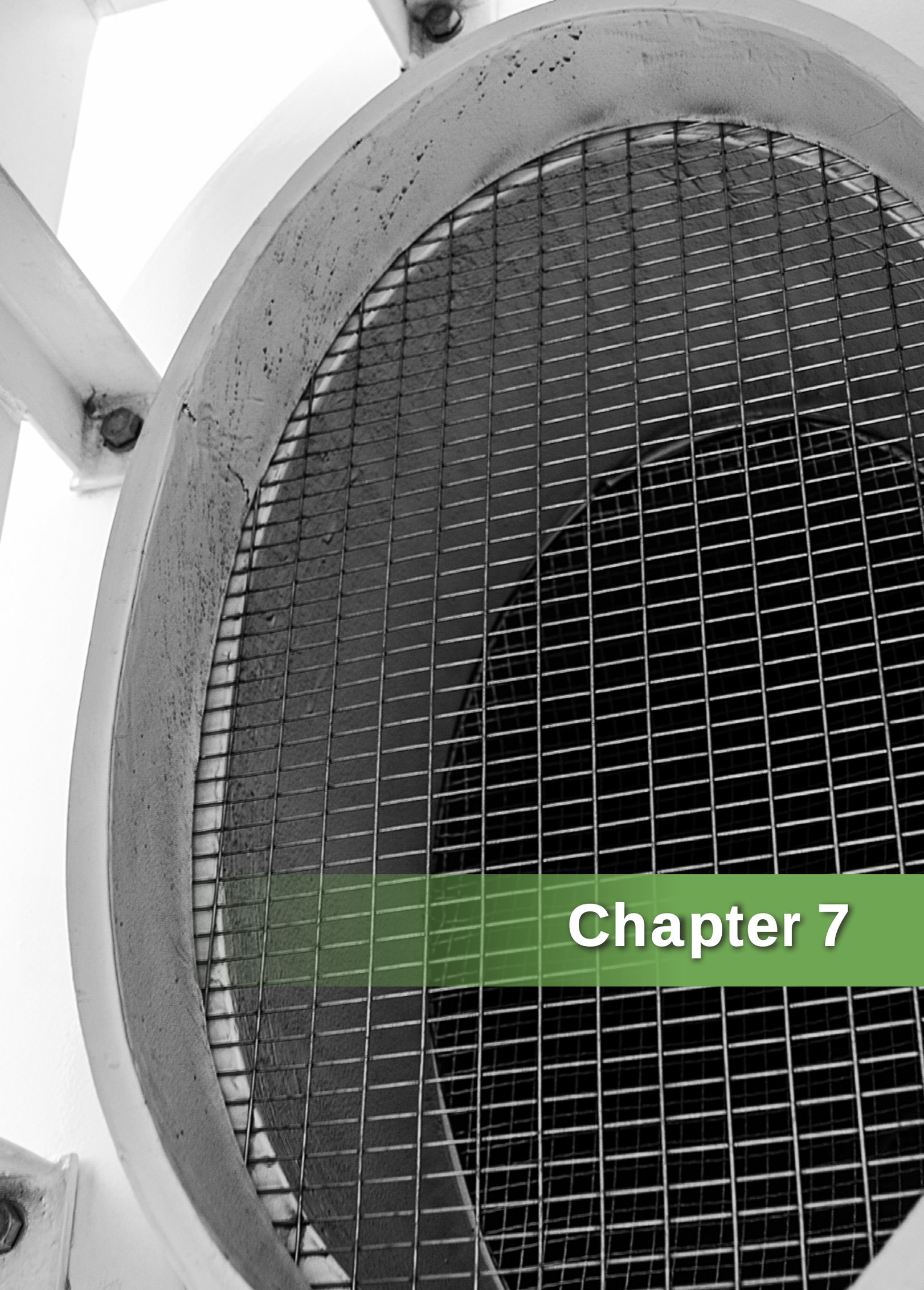
Mrs Balmer, one of the aforementioned helpful colleagues, is currently senior energy advisor for the South African German Energy Programme (SAGEN). She started her career with the then National Energy Council (NEC) in the 'Energy for Development' department. She recalls it as having been a "brilliant time" with everybody working in

RE considered weird and wonderful, looking like hippies and wanting to save the world. She soon learned to distinguish delegates at energy conferences by their footwear, with anyone in 'Jesus' leather sandals from the RE sector while "properly shoed people" were from the petroleum or coal sectors. "The lunatic fringe ruled!"

In 1993, the NEC was absorbed by the DMEA. Being part of the dismantling of apartheid structures and the development of brave new energy policies for the new South Africa presented an exciting time. She identifies the people with the biggest impact on her career to have been Dr Izak Kotze, Reinhold Viljoen as well as Prof Eberhard. They served as inspiration and mentors and seminal thinkers in the RE and energy development arena.

Mrs Balmer remembers the White Paper formulation process, and especially the stakeholder consultation process they engaged in, as a particular highlight of this period. She recalls the privilege to work with several noteworthy individuals in the sector such as Dr Wendy Annecke, Sarah Ward, Wrenelle Stander, Dr Rod Crompton and the researchers at EDRC such as Dr Douglas Banks, Anthony Williams and Bill Cowan. Many of the most influential individuals in the energy sector today were part of the significant work that helped shape the energy landscape in South Africa. The fact that the White Paper is still the official policy document of the energy sector is testimony to the quality of their work.

Two further projects stand out as highlights. The early promotion of energy efficiency in low-income housing as well as the investigation into the use of solar cookers and potential local manufacturing of the technology. After seeing projects through the challenges that confronted RE as the "step-child in the energy sector", Mrs Balmer is delighted by the breakthrough presented by the REIPPPP programme.



Chapter 7

CHAPTER 7

Managing the development of the grid infrastructure to support renewable energy deployment

The changing face of transmission planning

A reliable power supply is not only dependent on adequate generation capacity, but also the grid network infrastructure to deliver electricity to consumers (loads). Accordingly, the successful development of both utility-scale renewable energy resources and traditional thermal power plant, as prescribed in the Integrated Resource Plan (IRP) 2010, is critically dependent on adequate network infrastructure for the generated power to be connected to, and transmitted through the national electricity grid.

The Electricity Regulation Act[140], read in combination with the South African Grid Code and NERSA Licencing requirements, provides for generators to have the same non-discriminatory rights of access to the power network as electricity consumers. The national transmission network is centrally owned and managed by Eskom, the national power utility, which is mandated to support grid access for all interested generators. Transmission network planning and development is an Eskom Transmission licence condition. The process and criteria for planning is specified by the South Africa Grid Code, which is a NERSA technical standard. Planning for the network consists of a:

- Strategic grid plan (SGP), which takes a long-term view (in excess of 10 years) and is updated approximately every three years.
- Transmission development plan (TDP) that focuses on the next 10 years and is updated annually. This informs the basis of the capital funding requirements for the Eskom Transmission Division.

140 Act No 4 of 2006

Historically, limited requirements were imposed on network planning due to the Electricity Supply Industry structure:

- Planning was conducted in a vertically integrated and regulated utility environment in accordance with the Grid Code. The grid connection for committed generation typically included Eskom's own-build power stations with known spatial locations.
- Eskom's own-build power stations were typically a few large generators, with long lead times. This allowed sufficient time to establish the grid connection and shared network upgrades in alignment with the project development timelines of the generator. The grid connection generally only involved Eskom Transmission infrastructure that matched the capacity of the planned generators.
- The Grid Code was primarily focused on cost minimisation, demanding meticulous optimisation, and leaving minimal spare grid capacity in areas with limited consumption or growth potential.

The increasing complexity and changing needs of the diversified power system triggered by the IRP, dictate a drastically new approach to network planning. Private market participation in the energy sector with the introduction of IPPs has triggered changes to the Electricity Supply Industry in terms of:

- The spatial locations of the generators are determined by the IPPs and are only known to Eskom upon application for a grid connection to participate in the bidding programme.
- Distributed IPP plants have a two- to three-year construction period, whereas long transmission line projects have a six- to eight-year project life cycle. These differences in timeline need to be proactively managed so that grid is available timeously in alignment with the completion times for new power plants.
- The future generation projects are determined by a competitive bidding process, which is assessed on an individual project basis. Economies of scale are therefore difficult to obtain and to integrate with network plans.
- The prime development locations for renewable energy, corresponding with high renewable energy resource potential, available land and low population densities, coincide with those areas where limited spare network capacity had been created due to the historical cost minimisation approach stated above.
- REIPPPP bid windows 1 to 4 have utilised much of the available grid capacity in areas of RE IPP interest such as the Northern Cape, Eastern Cape and Western Cape provinces. Network upgrades will be required if RE development is to continue in certain areas, as driven by the need to procure cost-efficient electricity generation.
- Individual RE IPP generators are typically significantly smaller than the incremental grid capacity expansion. The cost and project life cycle duration of grid expansion can be prohibitive for an individual RE IPP project. If the shared grid (grid that supplies more than one customer) is planned strategically to accommodate the cumulative RE IPP capacity, then the relative cost and project duration will significantly reduce – and, in so doing, help lower electricity tariffs.

These planning challenges associated with the partial privatisation of new generation are, however, not unique to South Africa – nor are they overly complex. They do, however, necessitate a transition to a new planning paradigm. Shared grid upgrades need to be proactively planned and developed to accommodate cumulative IPP requirements, with an equitable recovery of costs once these plans are implemented.

Grid Connection Capacity Assessment

The Generation Connection Capacity Assessment (GCCA) provides direction with regards to the available grid capacity to connect IPP generation. It also provides an understanding of the timelines and additional capacity that may be created via proposed future grid upgrade projects.

Generation developers need to have an understanding of the existing and future grid capacities in different geographic areas so that grid dependencies can be assessed and managed when establishing optimal sites for new power plants.

In order to communicate and give direction to the market as regards the short- to medium-term available transmission capacity for connecting new generation plant, Eskom Transmission published the Generation Connection Capacity Assessment for the 2016 Transmission Network (GCCA-2016), which has been recently updated (July 2015) to provide a 2022 view (GCCA-2022).

The assessments have indicated a predominantly constrained transmission network, particularly in the Northern Cape, Eastern Cape and Western Cape provinces, where most of the successful REIPP projects are located. Consideration of the REIPPPP bid window 4 submissions suggested that the available grid capacity will be further reduced. A lack of grid reinforcement may curtail the procurement of the most cost effective generation due to the impact of increased transmission grid constraints.

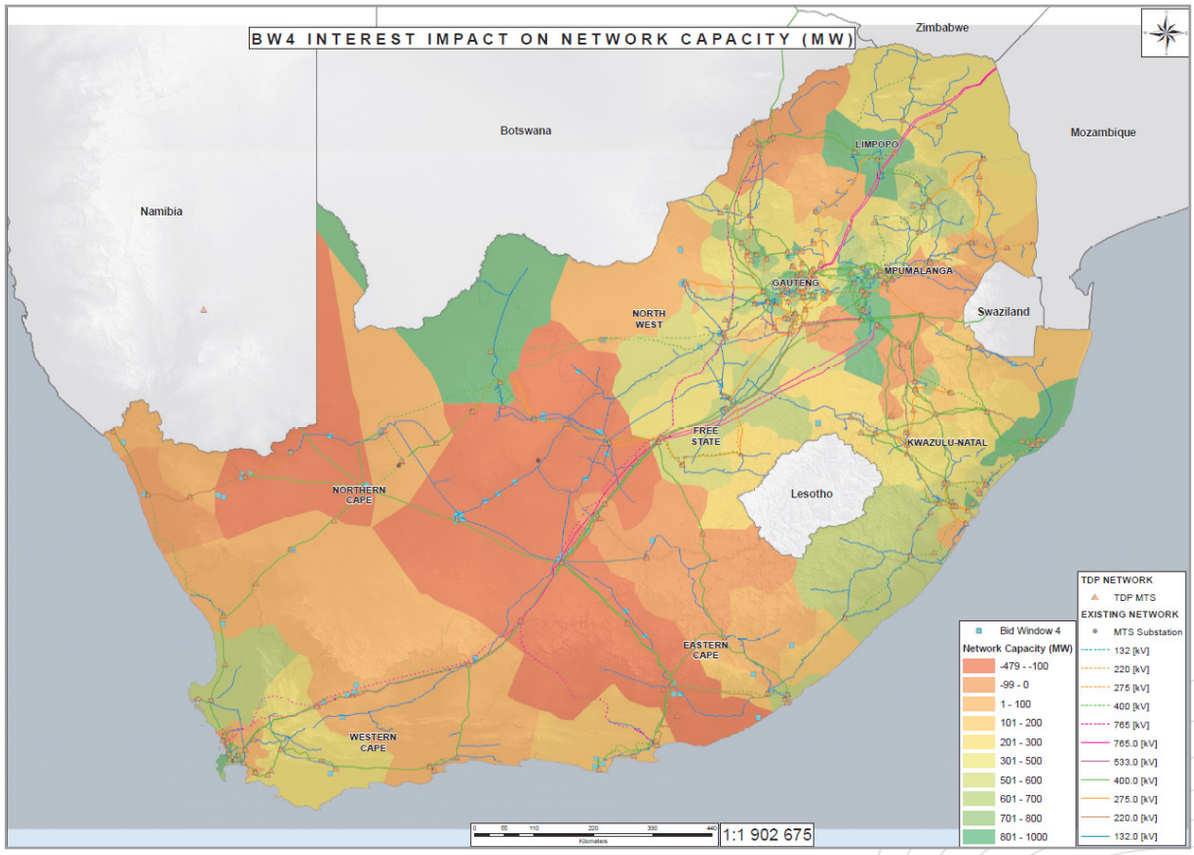
Renewable Energy Development Zones (REDZ)

In support of Strategic Infrastructure Project 8 (SIP 8; Green Energy in support of the South African Economy) and to facilitate infrastructure development in the country, the Department of Environmental Affairs (DEA) introduced a Wind and Solar PV Strategic Environmental Assessment (SEA). The primary objective of the SEA is to streamline regulatory processes for new RE power plants in line with the REIPPPP and without compromising the environment.

Based on the SEA, eight Renewable Energy Development Zones (REDZ) (Figure 62) were identified. These areas were selected through integrated spatial analyses and wide stakeholder consultation, and as geographical areas in which development is considered most appropriate from a national strategic perspective. Factors taken into consideration include energy resource potentials, infrastructure availability, stakeholder and local authority support, environmental suitability and socio-economic need.

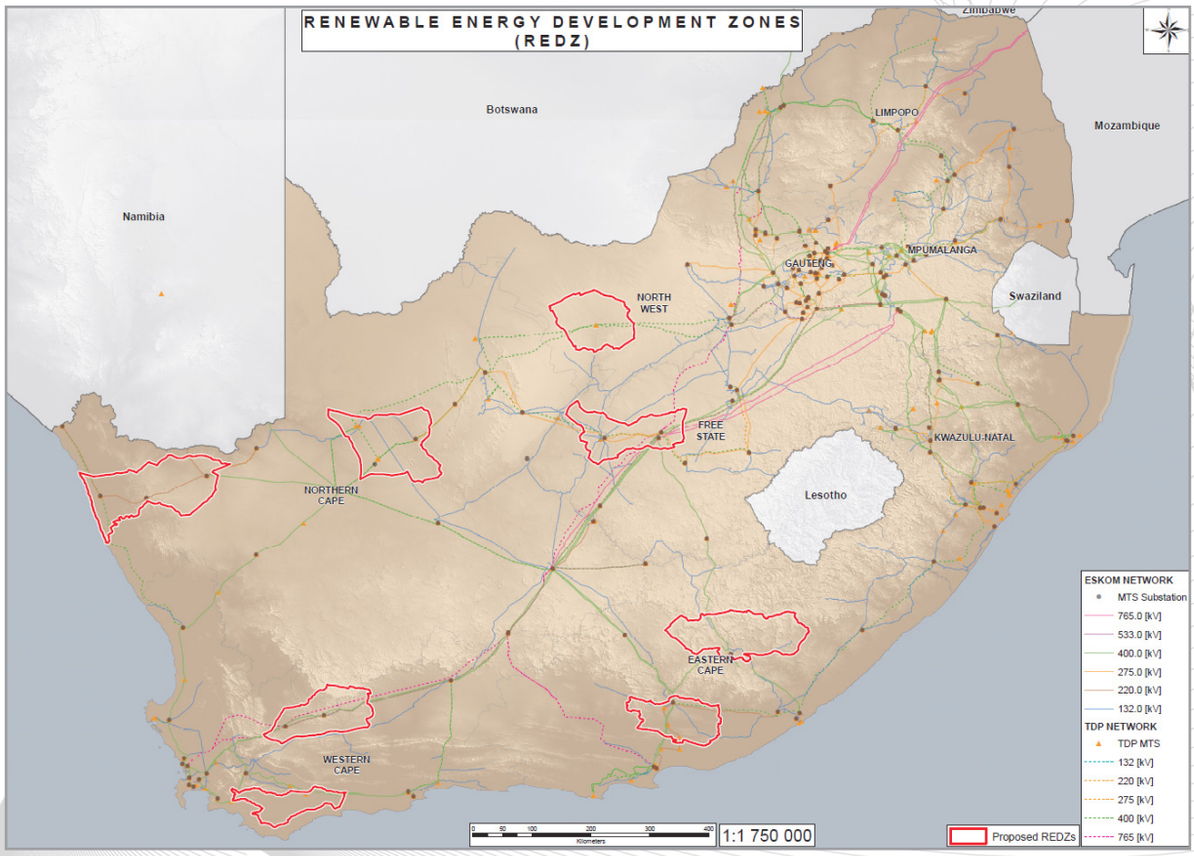
Although the REDZ identified priority areas for development, they do not preclude development of renewable energy projects in the numerous suitable areas with exceptional wind and/or solar resource that exist outside the REDZs.

The location of the REDZ further serves to inform the grid connection planning, identifying and confirming the areas where grid capacity will be required to support the targeted development zones (Figure 63). The REDZ will be formally gazetted.



Grid capacity (post BW 4)

Figure 62: Spatial comparison of grid capacity with the identified REDZ



REDZ

Figure 63: The final focus areas for the REDZs

Transmission Development Planning (TDP) amid uncertainty as to the Generation Spatial Locations

The IRP provides the national plan for generation capacity at an aggregated country level but does not incorporate geographically-specific, spatial information that can be utilised in transmission grid planning. Consequently, proactive scenario-based network planning is required to inform the development of grid capacity in advance and in alignment with anticipated spatial generation locations for the country. For this purpose, a TDP Generation-based Scenario Forecast was drafted by the DoE's IPP Office in cooperation with key stakeholders (including Eskom).

This forecast will be used to provide a more robust set of assumptions to the currently uncertain location of generation plants in relation to the grid. The ultimate objective is for the TDP to identify the alternative network expansions per scenario to enable the smooth deployment of envisaged capacity under the IRP 2010. These network expansions have associated development costs and lead times, necessitating urgent investment in order for these grid projects to be able to provide an adequate response subsequent to an implementation decision.

This TDP Generation-based Scenario Forecast has been informed by several key considerations:

- Spatial resource distribution (Wind, Solar PV, Coal, Gas).
- Renewable Energy Development Zones (REDZ).
- Information from the REIPPPP bid windows.
- Information from IPP Office Requests for Information (RFIs).
- Eskom grid access applications.
- EIA applications.
- Tacit knowledge from the industry.

The Generation-based Scenario Forecast will integrate with the Transmission Development Plan and Distributor sub-transmission Network Development Plans in order to support a sustainable integration of IPPs. To this end, a short- to medium-term shared grid planning approach has been developed, which takes a staged prioritisation methodology as follows:

Stage 1

Short-term projects (three to four years lead time) to provide capacity in the areas where connection applications are clustered, factoring in the Eskom grid access applications and EIA applications.

Stage 2

Medium-term projects (maximum lead time of eight years) to further increase capacity in the areas where expressions of interest are clustered, factoring in the REDZ and the additional engagements with stakeholders via renewable energy industry associations.

As can be seen above, the prioritisation of the plans into the various stages is defined by the lead times, which is predominately determined by the Transmission Planning scope. The Sub-Transmission Planning approach integrate into these Transmission Plans and the location of the future energy projects is clearly defined in the following section.

Sub-transmission planning

The sub-transmission planning approach is to utilise the concept of collector and satellite stations (illustrated in Figure 64 below) to optimise the network and environmental impacts in connecting relatively small spatially distributed generation plants to the Transmission grid.

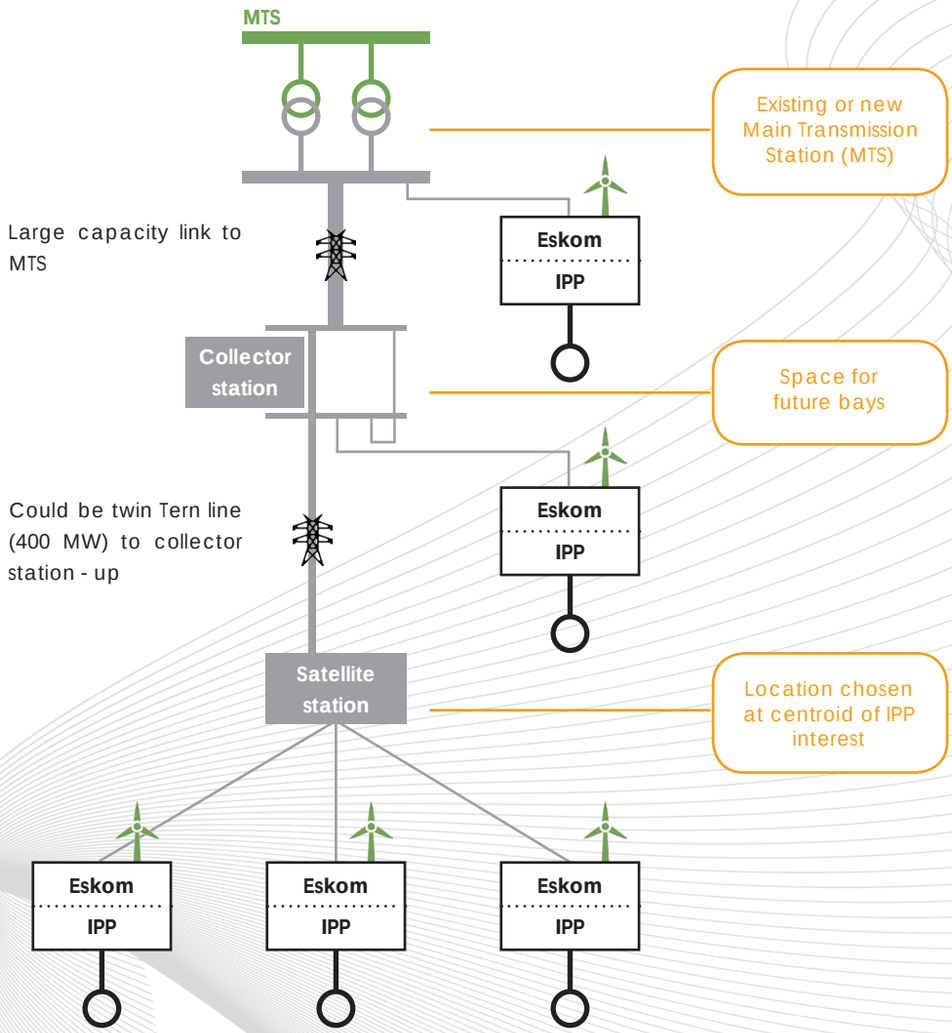


Figure 64: Basic graphical representation of the IPP Cluster concept for sub-transmission grid

Further analysis is underway to develop an implementation plan whereby the project phasing, dependencies, development costs and execution costs can be optimised in support of the present and anticipated Ministerial determinations for generation procurement. This necessitates integration of the IPP grid integration requirements in the Transmission Development Plan (TDP) and the distributor Network Development Plans (NDPs[141]), as well as inclusion of such considerations in the design of the IPP procurement programmes and associated treatment of the grid.

Looking ahead

The spatially distributed REIPPPP development and the introduction of the non-renewable IPPs increase the complexity of the grid planning environment. In this context, future grid connection planning will be developed around a number of feasible and reasonable generation scenarios to accommodate the spatial location uncertainty associated with the implementation of the IRP 2010 generation plan.

With the ever-increasing concentration of solar PV and wind in localised areas there is a potential risk to the grid that will need to be assessed in future. A loss of generation impact scenario may need to be performed to determine how a sudden loss of that generation capacity will impact on the grid stability and mitigation thereof if required.

This process has been initiated with a generation spatial forecast scenario as input to the 2015 TDP update. In addition, Transmission and Distribution planning will depend on greater collaboration, incorporating extensive consultation to develop an informed understanding of the future generation footprint in terms of size, spatial location and fuel sources, and the grid required to support such. It is proposed by the DoE IPP Office that future consultation should be introduced into the development of the assumptions informing the planning of the grid, including Government departments, Eskom departments, renewable energy industry associations, developers, universities and other parties.

The expectation is for an increasingly more robust and effective planning of network expansion to support optimal infrastructure development delivery in the country.

141 Including both Municipal and Eskom distribution plans.

Chapter 8

CHAPTER 8

Renewable Energy Research and Training in South Africa

Renewable energy research and development, skills development and training support the implementation of renewable energy projects in South Africa and create the enabling environment to foster growth in the sector as well as in the broader economy. With South Africa's recent foray into renewable energy deployment, local institutions are stepping up to the challenge to supply not only innovative technologies, but also the trained and skilled workforce required to exploit technological advances to the benefit of the country.

Research and Development (R&D)

R&D is important for stimulating innovation as well as enhancing absorptive capacity[142] for new ideas and technologies. Absorptive capacity refers to the ability to assimilate new information and thereby enhance technology transfer. R&D is, therefore, not only important for new inventions in the field, but for countries to adopt new technologies successfully in the shortest period of time.

South Africa has a rich legacy in energy research that supported the country's national objectives from an early stage. At least five distinct but overlapping periods of organised R&D in South Africa's modern history can be identified[143].

The first period (1820 – 1900) was driven by the interests of European scientists, based on the twin benefits of a southern scientific location and a relatively developed local society and economy.

The second period (1910 – 1930), utilised research and scientific knowledge to unlock southern Africa's natural resource potential in minerals and agriculture. This period also saw the establishment of Eskom, Iscor, and the Industrial Development Corporation (IDC).

The three pillars of energy security, food security and military dominance of the subcontinent commanded investment into the research and innovation sector during the third period (the 1960s), which aimed to support and consolidate apartheid South Africa.

142 Griffith, R.; Redding, S. and Van Reenen, J. 2001. Mapping the two faces of R&D: Productivity growth in a panel of OECD industries. The Institute of Fiscal Studies. IFS working papers no W00/02
143 Academy of Science of South Africa. 2014. The State of Energy Research in South Africa. ASSAF:Pretoria

The fourth period (1960 – 1990) saw broader energy research conducted at the CSIR and funded by means of a coal levy, while Eskom also established their own research capability focused on electricity generation, transmission and distribution. The latter period was characterised by high investment in scientific research and technological development, which rapidly accelerated innovation in South Africa.

The challenge of the fifth and current period since 1994, was to move smoothly into a globalising world from a position of severe isolation; the focus shifted towards research that paid a higher social dividend as well as addressed environmental challenges brought on by climate change[143].

For energy R&D to serve South Africa, it should support important policy and strategic objectives, seek to build a competitive advantage for the country and ensure a sustainable energy future for all.

Early research of renewable energy solutions for rural areas - Mr Bill Cowan, former EDRC researcher

From 1990, Bill Cowan was a senior researcher with the Energy for Development Research Centre (EDRC) and later the Energy Research Centre (ERC) at the University of Cape Town; his experience spans approximately 20 years. During the 90s, him and his team were focused on providing electricity and finding other improved energy solutions for non-electrified areas, particularly in remote rural locations where the national grid could not be rolled out quickly and cost effectively. Mr Cowan was involved in several studies and programmes, including optimised remote area power supplies, industry standards and support, and subsequent integrated energy provision for low income rural and peri-urban communities. This substantial portfolio of work has contributed some of the earliest investigations into the appropriate employment of renewable energy solutions in the country as well as the southern African region. Below are some of his valuable recollections from this pioneering period:

The EDRC was established in 1989, initially within the Energy Research Institute (ERI) at the University of Cape Town. It was first named CRAET (Centre for Research in Appropriate Energy Technologies). This reflected a major line of thought in the 1980s: that new implementations of appropriate technology should be employed to foster socio-economic development, particularly in rural areas of developing countries.

With funding from the National Energy Council, which lasted until 1992, EDRC continued to carry out research and helped build expertise in renewable energy fields judged important for rural development in South and southern Africa. This carried on from pioneering work led by Prof Anton Eberhard, who had joined the ERI in 1983, and a remarkable team of researchers and postgraduate students over several years.

The EDRC worked in collaboration with Eskom, the Independent Development Trust, industry organisations, the South African Bureau of Standards (and other international standards and research organisations) in these early years, where a primary focus was on ways to improve 'Remote Area Power Supply', i.e. electricity for communities not reached by the national grid.

An accelerated national electrification programme, reaching through many rural areas, altered the scope and requirements for Remote Area Power Supply. One of the major scoping and strategy studies, carried out by the EDRC researchers and joint European partners, was titled 'Scheme for Large-Scale Implementation of Solar Home Systems in South Africa'. It laid a basis for possible ways to provide off-grid power in portions of the country where grid connection would be too expensive in the medium term.

Structure of the South African renewable energy research landscape

Typically, the value chain of R&D progresses from basic research to applied research; pre-commercial incubation to demonstration; and from niche market to full scale commercialisation. Different actors and role players are active during the various stages. The research value chain, with the typical division between public and private sector involvement, is illustrated in Figure 65, below:

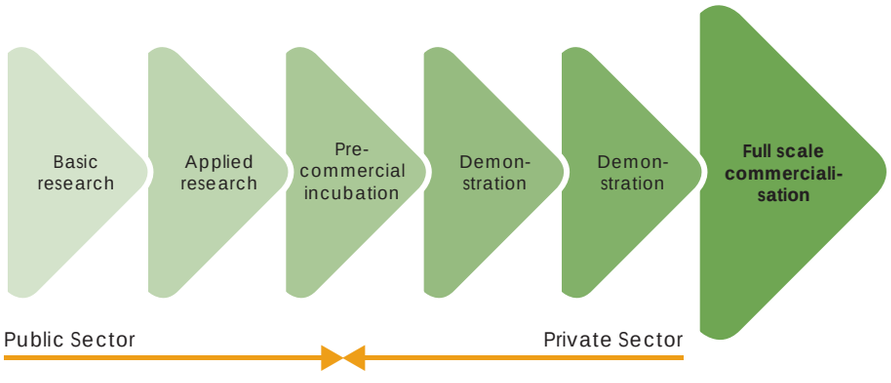


Figure 65: R&D value chain (after ASSAF, 2014)

Typically, the public sector supports investment in research and development with a broader time horizon and a less predictable outcome, while the private sector is more likely to invest in research and development with a shorter time frame and a clearer return on investment. Both sectors, however, pursue benefits that will ensure energy security, social equity and environmental sustainability. The 2010/11 National Survey of Research and Experimental Development shows the South African public sector spent R898.2 million as gross expenditure of R&D (GERD) on energy, which amounts to 4.4% of the total GERD of R22.4 billion[143]. There has been a decline of about 5.2% (equivalent to R49.4 million) in expenditure from a total of R947.5 million of 2009/10. From the 2011/12 budget allocation an estimated R73.618 million[144] was allocated to renewable energy. When this figure is compared, for example, with the allocation of R642.3 million to the nuclear energy programme in 2011/12, it is clear that there is room for improvement on research expenditure towards renewable energy R&D.

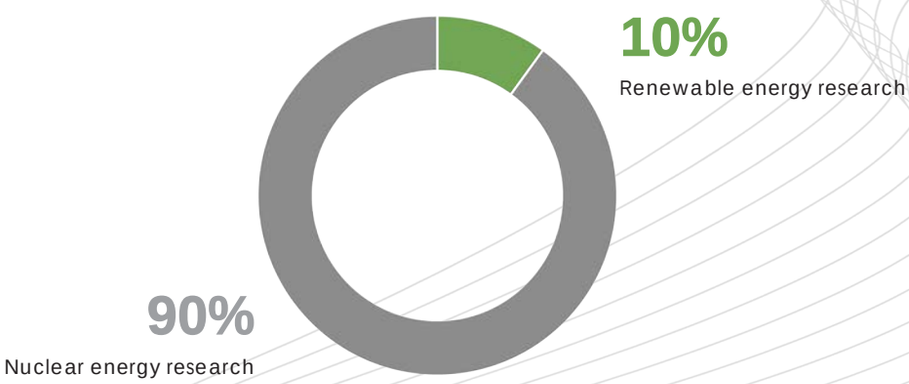


Figure 66: Comparing research funding allocations for renewable energy and nuclear energy (based on data from ASSAF, 2014)

In the public sector, the main entity responsible for research in South Africa is the Department of Science and Technology (DST), which oversees the management of the country's science system. DST promotes South African science and innovation by developing science, technology and innovation policies, and funding R&D at public research institutes. It also partners with other government departments, in particular those having oversight responsibilities over science performing agencies such as the DoE and South African National Energy Development Institute (SANEDI). In the 2012/13 DST budget, R39 million was allocated to support R&D in the renewable energy sector.

144 Combined R&D budget allocation across all government departments

Funding for research carried out at higher education institutions is provided by DST through the National Research Foundation (NRF). The NRF promotes and supports research with funding, human resource development and the provision of National Research Facilities in all fields of natural and social sciences, humanities and technology. The following important renewable energy related R&D Centres/Institutes have been established at Higher Education Institutions (HEIs)[143].

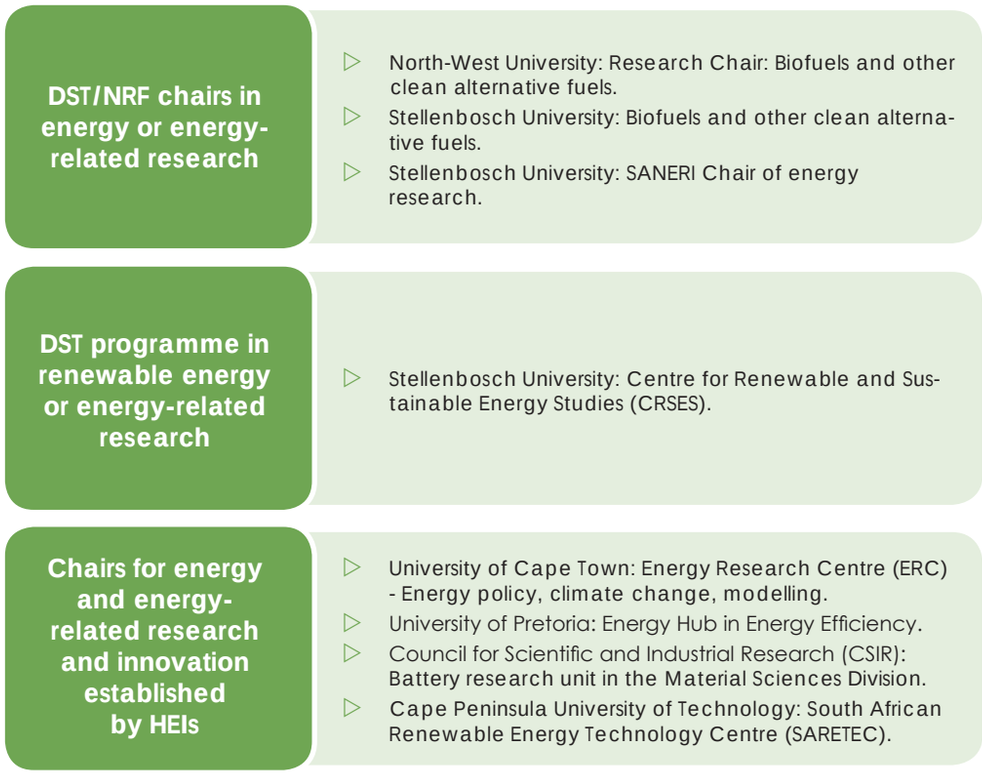


Figure 67: Renewable energy-related research chairs and institutions (based on information from ASSAF, 2014)

Linked to DST, an important additional stakeholder is the Technology Innovation Agency (TIA). The TIA was established in terms of the TIA Act, 2008 (Act No 26 of 2008) with the objective to support the development and commercialisation of competitive technology-based services and products. In terms of energy, TIA's Energy Business Unit aims to pursue investments that are aligned with Government plans to promote renewable and sustainable energy technologies. During 2012/13, TIA supported the development of 55 products, processes and services of which 10% fell within the energy sector. The TIA's research expenditure on renewable energy totalled R20.7 million in 2013, with an additional R5.5 million allocated to bioenergy (microalgae-to-energy, biodiesel and waste-to-energy).

In a concerted effort to support energy research and development, Government established the South African National Energy Research Institute (SANERI) in 2007. The SANERI was launched as a wholly owned subsidiary of the Central Energy Fund (Pty) Ltd (CEF) and resided under two government departments, Minerals and Energy[145], and Science and Technology. On 1 April 2011, SANERI was officially operationalised as the South African National Energy Development Institute (SANEDI), established by the National Energy Act, 2008 (No 34)[146]. Its mandate is to serve as a catalyst for sustainable energy innovation, transformation and technology diffusion in support of South Africa's sustainable development. Transfer payments from the DoE to SANEDI were initiated in 2011/12, with an initial allocation of R20.1 million increasing to R56.1 million in 2012/13. The 'Working for Energy' programme received a direct allocation from National Treasury of R134.3 million[147] in 2013/14, while research into carbon capture and

145 Established in 2008 as two new departments dedicated to Energy and Minerals and Resource
146 Department of Energy (DoE). 2008. National Energy Act, No 34, 2008. DoE: Pretoria
147 Academy of Science of South Africa. 2014. The State of Energy Research in South Africa. ASSAF:Pretoria

storage received an additional R217 million. Apart from these two programmes, direct support of R&D to renewable energy research is limited and the bulk of the work has been undertaken through donor funding, for example the development of the Wind Atlas and general support to the Renewable Energy Centre of Research and Development (RECORD) at SANEDI (through Danish and German assistance, respectively) as well as the establishment of a photovoltaic (PV) yield, training and integrity testing facility through RECORD at Nelson Mandela Metropolitan University (NMMU).

The Renewable Energy Centre for Research and Development (RECORD)

The mandate of the South African National Energy Development Institute (SANEDI) is to serve as a catalyst for sustainable energy innovation, transformation and technology diffusion in support of South Africa's sustainable development. RECORD supports the mandate of SANEDI within the Renewables Programme.

RECORD Mission
To be recognised as the foremost institution for renewable energy research coordination and collaboration in SA.

RECORD Vision
To facilitate renewable energy research coordination, collaboration and dissemination of national and international renewable energy knowledge contributing towards a sustainable low carbon energy future.

RECORD Core Activities
1. Co-ordinate renewable energy research in SA.
2. Facilitate renewable energy research collaboration.
3. Contribute to renewable energy skills development and support renewable energy business development.
4. Renewable energy awareness creation.

In 2014, RECORD concluded a year of successful projects and collaborations in the renewable energy sector. Some of these include the launch of the first ground verified high-accuracy solar resource map for South Africa, the recognition of renewable energy research excellence through the RECORD RERE awards (in partnership with the SA National Energy Association (SANEA), the launch of the State of Energy Research in South Africa report, the launch of the RECORD waste-to-energy platform and its associated state of research scan, as well as various formalised collaborations with state-owned enterprises (SOEs), academic institutions, non-governmental organisations (NGOs) and government departments. RECORD has been instrumental in renewable energy industry knowledge sharing, advising on the identification of Renewable Energy Development Zones (REDZ) through the DEA and energy standards through the SABS, and participating in initiatives such as the SOLTRAIN programme (training for solar water heating), the SASTTP (South African Solar Thermal Technology Platform), and the SETRM (Solar Energy Technology Road Map for South Africa). In addition to this, the renewables programme at SANEDI has supported the South African Renewable Energy Technology Centre (SARETEC) through funding of and expert advisor, student bursaries and leveraging support to infrastructure and development for this national centre that is now ready for launch at the Cape Peninsula University of Technology (CPUT).

Eskom supports renewable energy research through its Research and Innovation Centre, although the bulk of its research funding is allocated to coal combustion and electricity-related research topics. Despite the main focus of Eskom's research being on electricity-related fields, Eskom still emerged as one of the biggest funders in the renewable energy R&D space with an estimated R55 million allocated between 2000 and 2014. Eskom's field of activity in the renewable energy research area includes Solar PV systems, ocean energy, solar thermal energy, wind energy and biomass. Eskom's ongoing support to renewable energy R&D, even in times of excess supply capacity, contributed positively to the organisation's success in building wind and solar projects.

From research to reality and beyond – Ayanda Nakedi, Eskom Senior General Manager, Renewable Energy Unit

Ms. Ayanda Nakedi holds the position of Senior General Manager of Eskom's Renewable Energy Unit, responsible for the development of a portfolio of RE projects for the organisation. Prior to this she served, among others, as General Manager responsible for strategy, technology and assurance within the Generation Division and as Chief Executive Officer of Eskom's Development Foundation. She has a long and distinguished career with the Eskom Group. In 2013 she was awarded the prestigious Boss of the Year™ leadership award by an independent organisation dedicated to seeking out the leaders of the South African workplace. She is inspired by new adventures and innovation, qualities that are perfectly suited to heading up the RE Unit in Eskom.

Eskom has a history of RE research and innovation that includes the first wind turbine and CSP dish installations as demonstration projects in the country. In April 2011, in response to the clear direction given by the IRP 2010, Eskom established the Renewables Business Unit. This signified the formal transition of RE from a research focus into a fully fledged operational unit in the organisation. It further reinforced Eskom's commitment to move towards a cleaner energy future.

Ms Nakedi was tasked with establishing, resourcing, integrating and leading the new unit; an exciting and daunting undertaking.

The RE sector is characterised by an extremely competitive private sector, technology innovation and short delivery lead times. It demands agility and a finger on the pulse at all times – in stark contrast with the lengthy development cycle of large-scale, capital intensive projects that the organisation is more familiar with. Effective delivery in this fast-moving environment required a significant paradigm shift. Ms Nakedi recognised that successful participation would depend on close collaboration: a competent, dedicated core team, solid internal and industry relationships and strong support from all business areas within the organisation (including procurement, engineering and group capital). To facilitate this, the RE unit was established as a single point of accountability for the complete project cycle: from concept development, through construction and commercial operation, to close.

The 100MW Sere Wind Farm was delivered on time and on budget (first turbine installed in December 2013; first power onto the grid in October 2014 and final handover by the EPC contractor on 31 March 2015) and on par with the average construction lead times of the current REIPPPP portfolio. Even with the successful completion of Sere and a 100MW CSP project recently initiated, RE constitutes only a small drop in Eskom's total energy portfolio (~45GW). Even so, Ms Nakedi believes it is only the start of great things to come because Eskom has recognised RE as a key component of its future energy portfolio and business.

She believes RE is set to transform the energy landscape irrevocably. Utilities across the globe are already seeing the impacts on traditional business models. Having observed international trends and best practice, she says South Africa can't afford to have the national utility confined to conventional energy sources or country borders. Eskom currently remains responsible for 45% of the power supply for the continent. She hopes that, through partnerships, Eskom can also be part of a clean energy revolution in the region.

The Central Energy Fund (CEF) is a state-owned company involved in the search for appropriate energy solutions to meet the energy needs of South Africa, the Southern African Development Community (SADC) and the sub-Saharan African region, including Oil, Gas, Electrical power, Solar energy, low-smoke Fuels, Biomass, Wind and other Renewable Energy sources. The Clean Energy Division (CED) of CEF invests in renewable energy projects that fall into the demonstration or niche market areas on the research value chain. Examples of investments include an R82 million investment in the Cape Cleaner Energy Solutions (Pty) Ltd (CCE) 8.8MW biomass electricity project, a R1.4 million investment into the Methcap waste-to-energy project at PetroSA and an initial investment in the Darling wind farm. CED invested R37.6 million to acquire a 29% shareholding in ENER-G Systems Joburg, an 18MW landfill gas-to-electricity project at five landfill sites within the City of Johannesburg, which was successful in round three of the REIPPPP. CED also coordinates activities related to the proposed 5GW solar park development[148] in the Northern Cape, for which the feasibility study has been completed.

148 A Solar Park is a concentrated zone of solar development that includes thousands of megawatts (MW) of generation capacity. One or more pieces of land in close proximity are designated and pre-permitted as a Solar Park. It also has the potential of decreasing the cost of solar power significantly due to economies of scale and use of locally manufactured components

A remarkable journey in clean energy research and development
- Dr Thembakazi Mali, SANEDI, Clean Energy

Dr. Thembakazi Mali holds a PhD in Chemistry and a Graduate Diploma in Environmental Engineering from the University of the Witwatersrand. Her career spans more than a decade in the chemical and petrochemical fields before it shifted into the renewable energy (RE) sector. Presently, she is the Senior Manager: Renewable Energy Programme, at the South African National Energy Development Institute (SANEDI).

Her first formal opportunity to work on clean energy came with an investigation into biofuels. This work coincided with an opportunity to be in Parliament when the then Deputy Minister of Science and Technology spoke about the establishment of a National Energy Research Institute. This sparked an instant interest and certainty that she would be part of this initiative. Indeed, with the establishment of the South African National Energy Research Institute (SANERI), Dr Mali joined SANERI immediately after it was established to manage the Clean Energy Solutions portfolio. These presented the first formal steps in a newly formed organisation that held the excitement of all start-ups – full of promise, but tinged with fear of the unknown.

SANERI was predominantly established to build capacity in the broader energy R&D environment, as most companies at the time were focused on their own, in-house R&D. At the start, the priority was to identify the R&D gaps and, of course, to address the skills shortage in order to revitalise and grow the energy sector. The huge interest in this work at the time strongly suggested that renewables had the potential to grow in the country. South Africa had existing pockets of excellence where good research was being done, but the R&D focus needed to shift towards assisting in solving some societal challenges. It was about the same period when the Biofuels Industrial Strategy (BIS) was being formulated, with some of its drivers being job creation and local economic development. This was followed by a number of Biomass, Solar (mostly PV) and Wind R&D projects. As the renewable energy research and development portfolio broadened, so did the number of postgraduates working with the various universities in association with SANERI, which was incorporated into the South African National Development Institute (SANEDI) in 2010.

In South Africa, the energy development focus has been weighted towards large grid-tied projects. While this is important, of equal significance are distributed, decentralised projects as solutions to some of the energy challenges faced by the country. The development of models and systems that can deliver those solutions are still much needed. Some of the research has been done and now await the innovation that will tailor it to suit our country's needs.

Dr Mali highlights two areas of research and development she believes South Africa should be involved in: energy storage and marine energy. Both areas have been locally explored in the past, though due to inadequate funding, momentum was lost and research discontinued, with some of the slack being taken up by international research institutions.

The promise of marine energy is enormous; given our extensive shoreline, it would be a shame if we do not attempt to harness all that energy. Energy storage remains prohibitively expensive, but R&D could help lower the costs. Decentralised systems could become affordable even in the far-flung areas of our country, where there is no hope of

a grid extension. Affordable energy storage would give communities the freedom to use RE in their homes.

She also believes the development of a coherent energy R&D strategy will direct the overall focus, prioritise areas that will grow the economy and give South Africa the competitive edge. Delivering on these goals will rely greatly on adequately funded energy R&D and suitable institutions to commercialise technologies and get them to market.

Job creation and skills development for the renewable energy sector

Job creation remains one of the most important priorities of the South African government to address high unemployment rates, poverty and inequality. The green economy – and more specifically, the renewable energy sector – has been identified as a sphere that could generate significant jobs. Estimates for job creation through the renewable energy sector vary from 36,400 new direct jobs[149] to 78,000[150] – and up to 462,000,[151] depending on the time frame and level of renewable energy and energy-efficient technology penetration. The renewable energy sector is already important to the South African economy, as illustrated below:

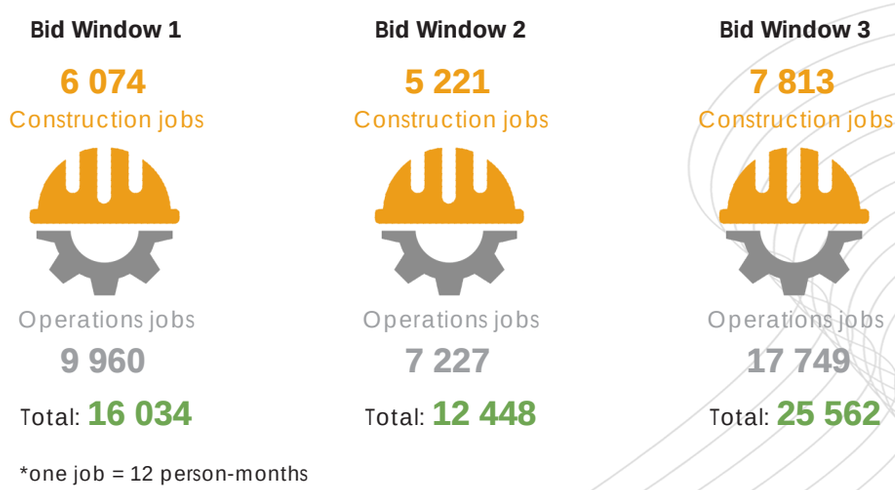


Figure 68: Local jobs created by renewable energy projects from Bid Windows 1 – 3[152]

However, according to the International Labour Office (ILO)[153], South Africa is short of approximately 12,600 industrial and mechanical engineers and technologists; 5,000 electricians; and 7,000 specialist managers (including environmental, arts and culture, office and quality managers) as well as professionals in the training and development, and human resources sectors. Many of these skills are particularly pertinent to the renewable energy and associated industries. In order to realise the potential of the sector, sufficient skilled workers are required to service the growing industry and skills development has to be addressed by the relevant public and private sector role players in South Africa.

149 AGAMA Energy. 2003. Employment potential of renewable energy in South Africa
150 Rutovitz, J. 2010. South African energy sector jobs to 2030. Prepared for Greenpeace Africa by the Institute for Sustainable Futures, University of Technology, Sydney, Australia
151 Maia, J et al. 2011. Green jobs: An estimate of the direct employment potential of a greening South African economy. IDC
152 Electricity Governance Initiative of South Africa. 2014. Renewable Energy Independent Power Producers Programme. 2014 Review
153 International Labour Organisation. 2010. skills for Green Jobs in South Africa. Unedited background country study. ILO: Geneva

South African framework for skills development

To understand the skills development framework in South Africa, it is important to grasp the different building blocks of the system, the role players and the underlying principles informing the framework. Some important principles are that training and skills development should be demand-driven, standardised and quality assured. South Africans are encouraged to view education and training as a life-long journey – and delivery as a partnership between Government, learners and business.

The South African national skills development framework is integral to a suite of complementary labour, equity and skills development policy and regulations that is considered to be one of the most sophisticated in the world in terms of design[151]. This suite drives ambitious strategies and targets and includes the Employment Equity Act (Act No. 55 of 1998 as amended 2014), the Labour Relations Act (Act No. 66 of 1995 as amended 2014) and the National Skills Development Strategy III (2011).

The National Training Board (established in 1994) investigated a number of factors influencing the South African training landscape, such as low levels of education, unemployment, the supply and demand of labour, and technological acceleration. In order to address identified problems, a National Qualifications Framework (NQF) was developed and implemented in 1995. The aim of the NQF is to specify learning in terms of outputs that are recognised both nationally and internationally. The NQF is the set of principles and guidelines by which records of learner achievement are registered to enable national recognition of acquired skills and knowledge, thereby ensuring an integrated system that encourages life-long learning. The NQF outlines 10 levels for education in South Africa and these are determined and overseen by three Quality Councils:

The NQF is overseen by the South African Qualifications Authority (SAQA). SAQAs function is to set up processes, structures, standards and qualification criteria for the NQF. The qualifications criteria are developed, approved, registered and published. This process ensures that education and training is of a high standard.

During 2003, the Department of Labour concluded that skills development would only be meaningful if labour market needs were accurately defined, there was alignment between National Growth Strategies and the Skills Development Strategies required to support it, and if a common language to define occupations was in existence. In 2000, the Organising Framework for Occupations (OFO) was established. The OFO is a skills-based, coded occupational classification system that organises jobs into occupations, and these in turn into occupational groups. The OFO distinguishes between the kind of work performed (a job) and the skills required to perform the job. Two dimensions of skill are used to organise occupations into groups, namely the skill level and the skill specialisation. Lastly, the OFO

identifies scarce and critical skills and provides the basis for any new qualification that needs to be developed. The OFO is managed by the QCTO, which coordinates qualifications in the OFO.

The development of a new occupational qualification follows a specific process and a number of role players are involved. Explained in a simplified manner, the process would develop as follows – industry recognises a need, the OFO is checked to determine if a relevant occupation exists and, if not, the Sector Education and Training Authority (SETA) is approached to assist in the development of a new qualification for the new occupation. The process requires a Development Quality Partner (DQP) to manage the development process and the DQP is often the relevant SETA. An occupational profile is developed, then a qualification to train for the new occupation is developed. Qualifications have three components (theoretical, practical and workplace experience) and include internal and external assessment specifications. An Assessment Quality Partner (AQP) is responsible for external summative assessment and the recommendation of the certification of the qualification to the QCTO. The AQP is often an industry body or could also be the relevant SETA. After the qualification has been registered by the QCTO and issued with a SAQA Qualification ID number, training service providers can apply to become registered training centres to deliver the qualification. They would need appropriate learning materials, qualified trainers and the correct equipment. The process is visually depicted below:

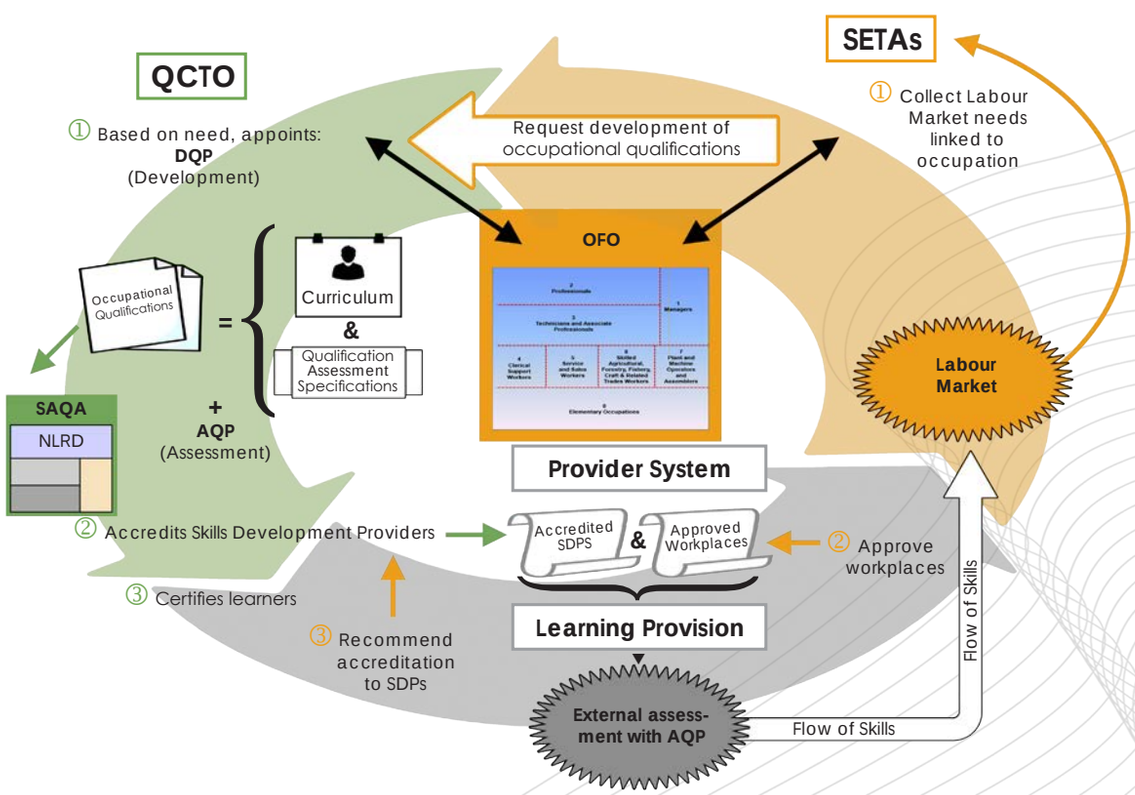


Figure 69: Role-players within the demand led occupational learning system

The process needs to be followed by the RE industry for qualification development.

Renewable energy skills requirement

Within the formal skills framework, the following renewable energy qualifications are either under development or have been registered. In response to identified sector requirements, a variety of technical qualifications are being developed. Qualifications are structured around different levels to provide the full scope of skills necessary to service RE projects.

In recognition of this growing field of study, universities in South Africa are introducing programmes at tertiary level focused on renewable energy research and innovation. Where possible, such programmes are implemented in close collaboration with industry partners to facilitate integration of cutting edge developments with private sector interests. Innovation programmes include:

Nelson Mandela Metro University (NMMU) Centre for Energy Research (CER)

- The NMMU CER identified 'Strategic Energy Technologies' as a research theme incorporating sub-themes in energy storage and renewable energy, among others.
- It offers a wide range of related study opportunities and provides a comprehensive platform to support specialised, multi-disciplinary training in strategic energy fields, and engages with Government, industry and other stakeholders for maximum impact.
- An advanced diploma in Renewable Energy is being developed with associated short learning programmes in various renewable energy technology areas.
- The CER is becoming known for world acclaimed innovations and sustainable energy projects in response to industry-identified needs and priorities, which include Electroluminescence (EL) imaging equipment that enables solar panel testing in the field, a patent for hybrid Concentrator Photovoltaics (CPV) systems and the TwerlyTM, an innovative 'off-the-grid' street light that harvests both sun and wind energy.
- The CER has established a PV testing lab and an outdoor research facility powered by renewables.

Renewable Energy Research and Development at the Faculty of Engineering, North-West University (NWU)

- The research programme at NWU includes cutting edge technology innovation and developments in the renewable energy sector. Among the extensive range of research initiatives only a few are highlighted:
- It hosts the Hydrogen South Africa (HySA) Infrastructure Centre of Competence that is developing applications and solutions for hydrogen production, storage and use in an African context.
- The NWU Solar Team has developed an internationally competitive Challenger/ Olympia class solar car that competed successfully in the 2012 and 2014 South African Sasol Solar Challenges, won the Federation International d'Automobile (FIA) award for research groups in alternative energies and will compete in the 2015 World Solar Challenge in October this year.
- NWU has initiated research on providing clean energy solutions in rural areas.

NRF Research Chair in Biofuels, School of Chemical and Minerals Engineering at the Faculty of Engineering, North-West University.

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

- The Chair was awarded on 1 July 2007 as a start-up SANERI Research Chair in Biofuels.
- Established as an internationally recognised research group with two fully equipped research laboratories as well as a state-of-the-art analysis laboratory.
- Consists of a unique combination of biochemists, microbiologists, chemists and chemical engineers.
- Research within the group is focused on the development of technology for affordable biofuels and biochemical production.
- This is being done in partnership with the Agriculture Research Council, Department of Agriculture, other university departments and industry.
- The group has established a Taught Master's programme and introduced a community renewable energy awareness programme to contribute to the renewable energy skills need.

Stellenbosch University Centre for Renewable and Sustainable Energy Studies (CRSES) at the Faculty of Engineering, Stellenbosch University

CENTRE FOR RENEWABLE & SUSTAINABLE ENERGY STUDIES

- The centre's main research areas in renewable energy spans a wide spectrum, including solar thermal energy, wind energy, ocean energy photovoltaic systems and bioenergy including biofuels.
- Appointed Specialisation Centre for Renewable Energy Technology for the Eskom Power Plant Engineering Institute with a focus on concentrated solar power (CSP) and wind energy.
- Hosts the Scatec Solar Chair in Photovoltaic (PV) Systems, supported by the Norwegian solar technology provider, Scatec Solar.
- Hosts a Senior Chair of Energy Research in Biofuels and Other Alternative Clean Fuels.
- The centre facilitates two coursework masters programmes with a focus on renewable and sustainable energy.
- Commercial activities span a number of new technologies and business opportunities developed with strong support from the Technology Innovation Agency (TIA).

Comprehensive frameworks and foundations have been established in South Africa to support renewable energy deployment, both in terms of research and development and skills development. The development of training courses and material and the focus of research are effectively demand driven. How well these structures serve the growing green sector will greatly depend on how well the existing frameworks can be utilised. Industry players and associations have an opportunity to leverage and influence the structures to support their needs.

The national South African Renewable Energy Technology Centre (SARETEC) at the Cape Peninsula University of Technology (CPUT)

In 2013, Government and private sector decided to support skills development for the renewable energy sector through the establishment of the South African Renewable Energy Technology Centre (SARETEC) at the Cape Peninsula University of Technology. The purpose of the centre is to train technicians to service the growing number of renewable energy projects in the country. Funding of R105 million was secured from the Department of Higher Education and Training (DHET) via the National Skills Fund. The bulk of the funding has been utilised in the construction of a state-of-the-art centre with a turbine hall, auditorium, laboratories, workshops, lecture theatres and offices.

Construction was completed in March 2015 and the centre will be fully operational by July 2015. Through a public-private partnership with Nordex, a 2.5MW wind turbine (worth $5 million) was donated to the centre and delivered on 23 June 2014.

The Manufacturing, Engineering and Related Services Sector Education and Training Authority (MERSETA) announced the support of a pilot implementation project during 2015 through which the newly developed wind energy technician qualification will be offered at SARETEC.

Leading the curve on alternate energy studies – Professor Wikus van Niekerk, director for the Centre for Renewable and Sustainable Energy Studies (CRSES) at the Stellenbosch University

During a fuel stop on Isla del Sol while flying to the United States in 1993, Professor Van Niekerk and his wife noticed an unaccompanied (i.e. unprotected) Mr Nelson Mandela stretching his legs. Recognising it as a once-in-a-lifetime opportunity, the Van Niekerks introduced themselves. In the short conversation that followed, they were told by Madiba not to leave the country, but to stay and work in South Africa. And so it was. Born in Bloemfontein, qualified as a mechanical engineer at the University of Pretoria and completing his PhD in active noise control at Berkeley University in California, Prof Van Niekerk is now the director for the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University.

While acknowledging that he was in the right place at the right time, in equal measure Prof Van Niekerk has had to put in a tremendous effort to develop and make a success of the CRSES. Responding to a 2005 joint request for a proposal from the DoE and the Department of Science and Technology for a national hub for RE, he personally wrote and delivered it by hand to meet the deadline after internal bureaucracy almost resulted in no submission. One of the first orders of business of the newly formed South African National Energy Research Institute (now SANEDI) on 3 August 2006 was to sign a funding agreement to create CRSES. Leveraging from more than 30 years of experience in alternate energy technologies across the various faculties, allowed CRSES to hit the ground running.

The fast moving and dynamic nature of RE is not limited to technology, and CRSES has had to adapt to changing circumstances to remain both relevant and solvent. Currently it receives some funding from DST (20%), Eskom's Power Plant Engineering Institute for RE (20%) and the balance is raised from other sources, such as international agencies and the private sector. For example, Soitec Solar sponsors a chair at CRSES and the centre is working hard to secure long-term funding from other RE companies, many of whom have employed and are benefitting from CRSES graduates.The Centre has eight academic positions in 2015 under the programme and works closely with fellow universities, such as Fort Hare and Venda, to transfer skills and share knowledge in line with the philosophy of cooperation rather than competition.

Some of the centre's major achievements to date include being one of the founding members, with GIZ and GreenCape, of the South African Renewable Energy Technology Centre (SARETEC) and developing, with the assistance of GIZ, detailed solar maps. Its objectives for the immediate future are to start a national solar research centre and a national energy modelling centre.

Commenting on the REIPPPP programme, Prof Van Niekerk commends a well-executed programme; what has impressed him is the innovation that has pushed project owners to go beyond 'business as usual'. Offering a premium (2.7 times) the agreed tariff for CSP during peak hours has resulted in energy storage and counters the argument that RE gives you energy when you don't need it, and no energy when you do. In his view RE and gas will revolutionise and dominate the energy sector in South Africa in the near future, not by design but by necessity. The centre is ready and able to play a role in this transition.

Looking forward

Research and development of technologies and applications with the accompanying development of suitable skills will become increasingly important in the rapidly evolving energy landscape. Going forward, it is expected that research efforts will be focused on achieving increased penetration of renewable energy in South Africa. Small-scale, off-grid renewable energy systems, especially for rural areas, has been identified as a priority area as this is one sector where South Africa needs to make significant progress. Research into areas that will give South Africa a competitive advantage in the production and commercialisation of renewable energy technologies is also required to assist the country to become a market leader in the supply of renewable energy technologies. As grid-connected renewable energy projects increase, solutions for energy storage will also become more important. In addition, research and development into storage solutions will become increasingly significant.

Substantial investment will be needed to enable the required levels of R&D to support national objectives and research targets for the energy sector.

Chapter 9

CHAPTER 9

The foundation for a promising future

During the last decade South Africa has achieved a momentous shift in the way she thinks about and produces electricity. Historically, the coal-dominated energy sector provided for inexpensive electricity, supporting an energy-intensive economy. Price escalations, severe electricity supply constraints and environmental considerations have necessitated a radical transformation. Renewable energy is a critical part of this transition towards a more diversified, cleaner energy system.

With the introduction of the ground-breaking REIPPPP in 2011, South Africa emerged as a major hub for RE in the world. This programme delivered a rapid ramp-up in the development of RE resources, growing the share of RE from being negligible to 4% within four years. This rate of growth is set to continue, both as the procured portfolio becomes fully operational and newly announced procurement rounds are rolled out.

In addition, the RE portfolio is being realised at cost-effective prices while accomplishing broad benefits to the economy and people of South Africa. The development approach in the sector is continually refined to unlock inclusive economic growth and development and wealth creation within the

Early exploration

1980 - 1994

A time of visionaries and innovators

> Prior to 1994 elections a few young SA women-engineers in the energy sector started participating in the Energy Forums' discussions.
> ...it became necessary to form a pressure group to change attitudes and formulate gender-sensitive policies within the new government.
>
> – RITA MFENYANA

> ...a new area of research - then called appropriate energy technology – effectively looking at small-scale and renewable energy technologies that could promote social development and reduce poverty.
>
> – PROF ANTON EBERHARD

Sustainable development for all

1994 - 1997

Building inclusive partnerships

> ...encouraging the development of renewable energy technologies which are more affordable, accessible to our poor, safe, and which contribute towards sustainable development.
>
> – SUSAN SHABANGU
> Deputy Minister: Minerals and Energy (1996 - 2004)

A new policy context taking shape

1998 - 2003 - 2007

Taking a new direction

> ...the biggest breakthrough at a national level has been commitments and processes that have been established which paved the way for the growth of the broader sector.
>
> – OSMAN ASMAL
> City of Cape Town

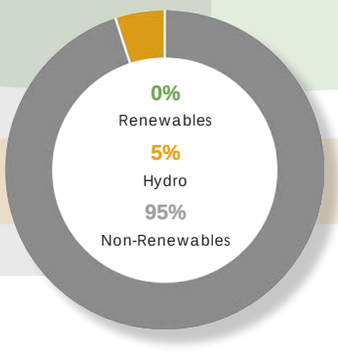
Changing gears

2008 - 2014

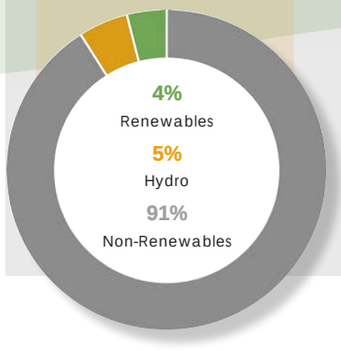
From REFIT to REBID

> the ongoing success of the country's flagship renewables procurement program and the growing interest of international developers and funders is a strong sign that South Africa is blazing a trail across the global renewables sector.
>
> – the Ernst & Young Renewable Energy Country Attractiveness Index (RECAI) report, February 2014

Low energy mix – demonstrated by IRP 2010 electricity mix



Achieved change as installed RE capacity by June 2015 shows



country. Towards this end, a comprehensive enabling platform is being created in a concerted effort to build a green economy incorporating skills development, technology research and development, infrastructure development, encouraging local manufacturing and securing participation for South Africans (individuals and businesses).

In reviewing the progress made, it is also recognised that there are remaining areas requiring additional support to catalyse development and/or unlock the full spectrum of potential benefits. Initiatives such as biofuels, biogas, solar home systems (SHS) and distributed RE generation will be important focus points in the continuing journey.

At this point, it is good to look back at where the country came from and how far it has come. With this perspective, South Africa can celebrate the significance of the RE contribution to the power system as well as the economy, society and environment. We have truly created a sound foundation for a promising future.

Celebrating how far we have come

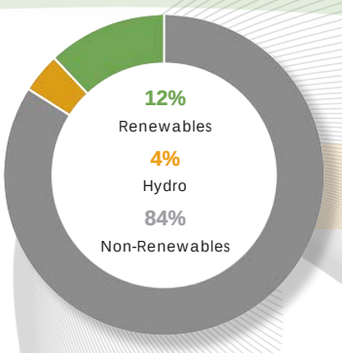
2015

South Africa at the right place at the right time; Showing the way to the world

> The South African Renewable Energy Independent Power Producer Programme is world class. Who would have thought, even a few years ago, that wind energy would now be the cheapest source of grid-connected energy.
>
> – PROF ANTON EBERHARD

> South Africa has been quietly creating one of the world's most progressive alternative energy plans. Solar, biomass and wind energy systems are popping up all over the country and feeding clean energy into the strained electrical grid.
>
> – Engineering News

> It is set to completely transform these deep rural communities in terms of healthcare, education, job creation and a raft of other interventions. All this while putting green electricity on the grid at affordable prices.
>
> – JOHAN VAN DEN BERG
> director of the South African Wind Energy Association



Achieved change as procured by June 2015

The future of RE

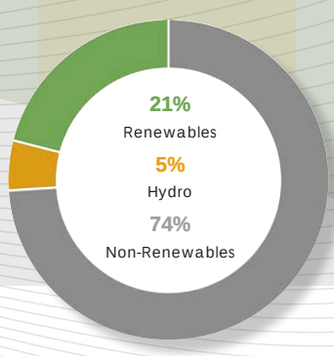
2015 - ▷▶▷

Building an asset base for the youth of South Africa to build on

Moving boundaries into Africa

> ...the mainstreaming of embedded generation and SWHs/efficient water heating for all sectors is imminent, from low income energy services through to commercial solutions.
>
> – ANDREW JANISCH
> City of Cape Town

2030 target of IRP



Bibliography

1 www.sauran.net

2 Frankfurt School of Finance and Management. 2014. Global Trends in Renewable Energy Investment. Frankfurt School-UNEP Centre BNEF: Frankfurt.

3 www.wiki-solar.org

5 Department of Minerals and Energy. 1998. White Paper on the Energy Policy of the Republic of South Africa. DME: Pretoria.

6 British Petroleum. 2014. BP Statistical Review of World Energy.

7 Government Gazette of South Africa. Electricity Act No 42 of 1922. https://www.greengazette.co.za/acts/electricity-act_1922-042)

8 www.heritage.eskom.co.za

9 National Energy Regulator. 2011. Lighting up South Africa. NER: Pretoria.

10 Steyn, G. Undated. Administered Prices. A report for National Treasury. NT: Pretoria.

11 Steyn, G. 2006. Investment and uncertainty: Historical experience with power sector investment in South Africa and its implications for current challenges. UCT: Cape Town.

14 www.sustainable.org.za

15 Sebitosi, A.B. and Pillay, P. 2008. Renewable Energy and the environment in South Africa: A way forward. Energy Research Centre, UCT: Cape Town.

16 Mwakasonda, S.A.J. 2004. Policies and Measures for Renewable Energy and Energy Efficiency in South Africa. Energy Research Centre, UCT: Cape Town.

18 Eberhard, A., Kolker, J. and Leigland, J. 2014. South Africa's Renewable Energy IPP Procurement Programme: Success Factors and Lessons. PPIAF and World Bank: Washington.

20 www.publications.gc.ca

21 Department of Environment Affairs and Tourism. 2007. Long Term Mitigation Scenarios. Strategic Options for South Africa. UCT: Cape Town.

25 Walwyn, D.R. and Brent. A. 2015. Renewable Energy gathers steam in South Africa. Renewable and Sustainable Energy Reviews. 41: 390 – 401. Elsevier

28 www.nersa.org.za

29 www.gsb.uct.ac.za

30 Edkins, M. Marquard, A. Winkler, H. 2010. Assessing the effectiveness of national solar and wind energy policies in South Africa. ERC, UCT: Cape Town.

31 Government Gazette. National Energy Act: 2012. Integrated Energy Planning Report (Act No 34 of 2008).

32 Palmer Development Group. 2012. Mapping of authorisation processes of renewable energy projects. GIZ: Pretoria.

37 Covary, T. and van der Walt, M.L. 2013. Renewable Energy Policy Mapping Study of RSA. Unlimited Energy: Johannesburg.

39 Montmasson Clair, G., Moilwa, K. and Ryan, G. 2014. Review of Regulation in Renewable Energy. TIPS: Pretoria.

40 www.greenenergy-ec.co.za

41 www.greencape.co.za

42 www.ewseta.org.za

43 www.ndwc.co.za

44 www.kznenergy.org.za

45 Statistics South Africa. 2013. Energy Accounts for South Africa. StatSA: Pretoria.

48 www.wasa.csir.co.za

52 International Energy Agency. 2010. Energy Technology Roadmaps. A guide to develop and implement. IEA: Paris.

50 Modise. M. 2013. Renewable Energy Resource Assessment in South Africa. Africa CEC session 3.

56 Klunne, W. J. 2013. Small hydropower in Southern Africa – an overview of five countries in the region. CSIR: Pretoria.

57 Barta, B. 2002. Capacity building in energy efficiency and renewable energy. Baseline study on Hydropower in South Africa. In Micro Perspectives for Decentralised Energy Supply. Proceedings of the International Conference, Berlin.

58 Department of Water Affairs. 2011. Appraisal of feasibility of retrofitting mini-hydro plants on Department of Water Affair Dams. DWA: Pretoria.

59 Holm, D. 2005. Market Survey of Solar Water Heating in South Africa. Energy Development Corporation (EDC), CEF: Johannesburg.

60 www.theguardian.com

63 Holm, D. Banks, D., Schäffler, J. Worthington, R., and Afrane-Okese, Y. 2008. Potential of RE to contribute to national electricity emergency response and sustainable development. Renewable Energy Briefing Paper for the Trade and Industry Policy Studies (TIPS).

66 Minister of Energy speech at the launch of the PetroSA Biogas-to-electricity project.

70 Energy Information Admininstration Country Report, 2014.

76 World Wild Life Fund (WWF). 2014. Enabling renewable energy in South Africa. Assessing the REIPPPP. WWF: Cape Town.

78 The CIA World Factbook. 2013. www.cia.gov

83 CSIR. 2015. Financial costs and benefits of renewable energy in South Africa in 2014. CSIR: Pretoria.

85 Karin Kritzinger, senior researcher at the Centre for Renewable and Sustainable Energy Studies, Stellenbosch University. 8 June, 2015.

95 Energy Research Centre. 2011. Socio-economic implications of mitigation in the power sector including carbon taxes in South Africa Working paper for CDKN project on Linking sectoral and economy-wide models. ERC, UCT: Cape Town.

97 http://energy.gov/articles/energy-department-announces-102-million-tackle-solar-challenges-expand-access-clean

99 Maphelele, T., Standord, R., Kooverji, B. May. 2013. Solar PV baseline report. SAPVIA: Cape Town.

100 Unverified industry project database: http://pqrs.co.za/s-a-solar-pv-list-2/as published 21 June 2015

102 Government Gazette. 2001. Gas Act of 2001. (Act No 48 of 2001).

105 UCT Graduate School of Business. 2015. Managing Power Sector Reform and Regulation course media release: Power crisis offers investment opportunity in sub-Saharan Africa.

107 UNCTAD. 2015. Global investment trends monitor. No. 18. January 2015.

108 Ernst and Young. 2015. EY's attractiveness survey Africa. Making choices. EY: Johannesburg.

109 South African Reserve Bank (SARB). 2015. Quarterly Bulletin. March 2015:45. Pretoria. SARB.

117 **the dti**. 2015. The Wind Energy Industry Localisation Roadmap in Support of Large-Scale Roll-Out in South Africa. **the dti**: Pretoria.

118 SAPVIA, WWF and the dti. 2013. The Localisation Potential Of Photovoltaics (Pv) And A Strategy To Support Large Scale Roll-Out In South Africa. **the dti**: Pretoria.

119 GIZ, SASTELA and **the dti**. 2013. Assessment of the localisation, industrialisation and job creation potential of CSP infrastructure projects in South Africa - A 2030 vision for CSP. GIZ: Pretoria.

121 Department of Energy. 2013 and 2014. A Survey of Energy Related Behaviour and Perceptions in South Africa. DoE: Pretoria.

124 Stats SA. 2014. General Household Survey dataset, 2002 -2013. StatSA: Pretoria.

127 PWC. 2013. Foundation Rural Energy Services. Socio-economic Impact Assessment of Rural Electrification. PWC: Amsterdam.

128 http://www.adf.gov

130 REMT 2009. Report on the National Solar Water Heating Conference: Building Consensus on accelerating the rollout of Solar Water Heaters in South Africa hosted by the Department of Energy and the Renewable Energy Market Transformation (REMT) Unit, Johannesburg on 5 November 2009.

133 http://sans10400.co.za/energy-usage

135 Aphane, O. 2009. Report on the National Solar Water Heating Conference: Building Consensus on accelerating the rollout of Solar Water Heaters in South Africa hosted by the Department of Energy and the Renewable Energy Market Transformation (REMT) Unit, Johannesburg on 5 November 2009.

137 http://www.gib-foundation.org/projects/kuyasa low-income-energy-efficiency housing project

138 Onatu, G. O. Ogra, A. and Okafor, J. 2012. Energy efficiency improvement strategy in mixed income housing development: A case study of Cosmo City Johannesburg. University of Johannesburg: Johannesburg.

139 http://www.c40.org

142 Griffith, R.; Redding, S. and Van Reenen, J. 2001. Mapping the two faces of R&D: Productivity growth in a panel of OECD industries. The Institute of Fiscal Studies. IFS working papers no W00/02.

143 Academy of Science of South Africa. 2014. The State of Energy Research in South Africa. ASSAF: Pretoria.

146 AGAMA Energy. 2003. Employment potential of renewable energy in South Africa. AGAMA Energy: Cape Town.

150 Rutovitz, J. 2010. South African energy sector jobs to 2030. Prepared for Greenpeace Africa by the Institute for Sustainable Futures, University of Technology, Sydney, Australia.

151 Maia, J et al. 2011. Green jobs: An estimate of the direct employment potential of a greening South African economy. IDC: Johannesburg.

152 Electricity Governance Initiative of South Africa. 2014. Renewable Energy Independent Power Producers Procurement Programme. 2014 Review.

153 International Labour Organisation. 2010. skills for Green Jobs in South Africa. Unedited background country study. ILO: Geneva.

List of Interviews

Person interviewed	Interviewed by	Date of interview
Dr Rod Crompton	Mari-Louise van der Walt and Theo Covary	1-Jul-15
Thembani Bukula	Mari-Louise van der Walt	22-Jul-15
Dr Thembakazi Mali	Mari-Louise van der Walt	3-Aug-15
Dr Wikus van Niekerk	Theo Covary	8-Jul-15
Mark Borchers	Theo Covary	22-Jul-15
Johan van der Berg	Theo Covary	29-Jul-15
Moeketsi Thobela	Theo Covary	29-Jul-15
Pancho Ndebele	Mari-Louise van der Walt	7-Aug-15
Ayanda Nakedi	Mari-Louise van der Walt	17-Aug-15
Mark Tanton	Mari-Louise van der Walt	5-Aug-15