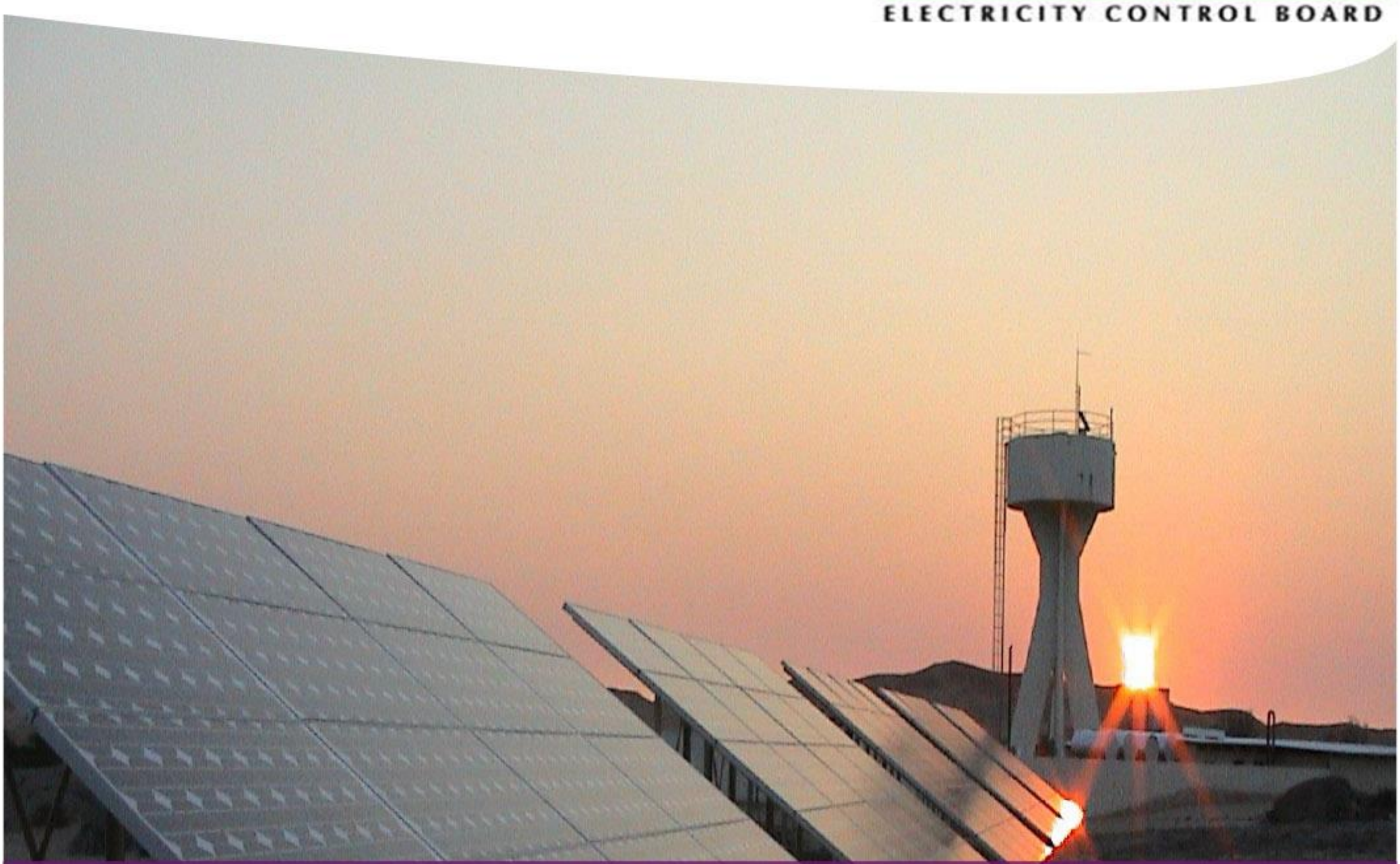


National Renewable Energy Policy for Namibia

Preliminary Draft

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

CSP	Concentrated Solar Power
DSM	Demand Side Management
ECB	Electricity Control Board of Namibia
FiT	Feed-in-Tariff
GCF	Green Climate Fund
GHG	Greenhouse Gas
HPP	Harambee Prosperity Plan
INDC	Intended Nationally Determined Contributions
KW	Kilowatt
Kwh	Kilowatt-hour
MME	Ministry of Mines and Energy
MW	Megawatt
Mwh	Megawatt-Hour
NIRP	National Integrated Resource Plan
PV	Photovoltaic
RE	Renewable Energy
REDZ	Renewable Energy Development Zones
SADC	Southern African Development Community
TJ	Terajoules
TW	Terawatt
UNFCCC	United Nations Framework Convention on Climate Change

Acknowledgements

The Ministry of Mines and Energy (MME) wishes to acknowledge the role of several key contributors to Namibia's National Renewable Energy Policy.

The policy was prepared under the able guidance and management of the Electricity Control Board (ECB) of Namibia, which shepherded the policy development process, balancing the need for a high quality, comprehensive guidance document with the imperative of expedited results which reflect the urgent need for this policy.

The policy received input from an impressive diversity of stakeholders, too numerous to name all individually. However, a special note is reserved for assistance from NamPower, the Namibia Energy Institute (NEI), the Ministry of Environment and Tourism, the Ministry of Poverty Eradication and Social Welfare, the Ministry of Land Reform, the Parliamentary Standing Committee on Natural Resources, and the SADC Centre for Renewable Energy and Energy Efficiency.

MME also expresses gratitude for the support and cooperation of stakeholders from the private sector, including (but not limited to) renewable energy project developers, financial institutions, consulting firms, and industry associations.

Finally, MME acknowledges Pegasys Strategy and Development, Blue Horizon Energy Consulting Services, 3E, and the Namibia Development Trust for their technical assistance to the ECB in terms of policy formulation, stakeholder engagement, and drafting support.

Foreword

(Placeholder Text, to be substituted by MME-endorsed language)

The Republic of Namibia can measure its wealth in many different ways: its richness of ethnicities, its linguistic diversity, its unique natural landscapes, its evolution into an upper middle-income country, its political stability, or its steady economic development. However, one key metric that should be added to these measures is Namibia's wealth in renewable energy resources.

Namibia boasts the world's second highest solar irradiation regime, with the entire country having radiation of more than 5.5 KWh/m^2/day, and sizeable regions having levels as high as 5.8 KWh/m^2/day or greater. It has high wind power potential, especially in coastal areas where wind speeds reach 10 metres/second or faster. Namibia is home to several hot springs, indicating the potential for geothermal energy development. Furthermore, Namibia is uniquely placed to transform the challenge of an invasive plant species (encroacher bush) into an opportunity for biomass-based energy, with large areas that have the potential to generate between 6-30 MWh/hectare from conversion of bush into bioenergy[i] (or up to 40 TWh/acre, according to some assessments).[ii] This is in addition to Namibia's hydropower potential on the Kunene, Kavango, and Orange Rivers, as noted in the Hydropower Master Plan.[iii]

Renewable energy thus represents a valuable economic resource for Namibia. In the past, while the country has made proactive efforts to develop this resource and develop its renewable energy industry, these initiatives have been stymied by the absence of a coherent, clearly pronounced policy. While 1998's Energy Policy White Paper provides unequivocal support for the growth of renewable energy in Namibia, it is time that renewable energy is not short-changed, and for the White Paper to be supplemented by a focused, dedicated renewable energy policy.

This document is intended, therefore, to provide the necessary boost to renewable energy development in Namibia, and to serve as a clear signal of the Government of Namibia's commitment to a clean energy future for its people, powered by renewables, and replete with economic opportunities created by the growth of the renewables sector. It is also a reaffirmation for the government itself that it must reach beyond the level of renewable energy development already taking place, and must take fresh steps to support renewables in a way that is unprecedented in Namibia. The government has taken a somewhat tentative approach in the past, and it must now be bolder as it explores promising new territory. As the old adage goes, nothing ventured, nothing gained.

This Renewable Energy policy will complement Namibia's new National Energy Policy, currently under development, and the guiding principles of the renewable energy policy will be further implemented through additional instruments such as the Independent Power Producers (IPP) Framework, a future Energy Efficiency Policy that covers buildings, industrial equipment, and appliances, and similar efforts to provide direction and clarity within Namibia's rapidly evolving energy landscape. Together, these policy initiatives are testament to the fact that Namibia is gearing up for a renewables revolution. Indeed, Namibia is ready to show the world what can be achieved through renewable energy development.

I welcome this important first step in making Namibia a leader in renewable energy.

[SIGNED, Hon'ble Minister of Mines and Energy, Namibia]

Executive Summary

[To be drafted after RE Policy Draft is revised and updated, incorporating a round of detailed comments, and all core policy statements are finalized.]

Introduction

Background and Problem Statement

At the time of the development of this policy, only a third of all Namibians had access to modern electricity.[iv] More than half the country continues to rely on traditional biomass for cooking, which perpetuates a disproportionate burden on women of fuelwood collection, preventing the inclusion of more women in productive economic activities or self-development. In addition, such reliance on solid biomass for cooking is associated with significant health problems and environmental degradation. Thus, there is a need for more widely accessible, cleaner energy.

Rural areas in particular are heavily underserved, lacking essential energy services. Despite Namibia being regarded as an upper middle-income country, over a million of its citizens are deprived of access to reliable and affordable electricity. As Namibia moves towards its goal of providing near-universal electricity access by 2030, it needs to find and harness new sources of energy.

A related reason that calls for adequate, viable, and affordable energy options in rural areas is the level of rural-urban migration, particularly to Windhoek. The city of Windhoek is an already water-stressed region, facing ever greater resource constraints due to the pressures of in-migration. Assuring energy in more remote areas and secondary cities of towns could help create productive economic activities in a more dispersed manner, reducing the rapid rate of urbanization and the related water stress.

Namibia is heavily susceptible to the vagaries of nature, suffering prolonged droughts, floods, heat waves, bush fires, and other extreme events. Climate change is expected to exacerbate natural climate variability, unleashing greater extremes and creating more unpredictability in Namibia's already-fragile hydrological regime. With higher temperatures and higher rates of evaporation, future low-season flows in Namibia may take an already water-stressed nation into the realm of water scarcity. This has serious implications for the reliability of Namibia's existing and planned hydropower generation facilities, and for the nation's future energy security. Moreover, climate change is also likely to create additional demand for electricity, in the form of demand for cooling to cope with soaring temperatures in coming decades.

Energy security challenges came into sharp relief for Namibia recently when the Southern African Power Pool (SAPP) faced the prospect of power shortages, arising from South Africa's inability to meet its own domestic demand, and its diminished capacity to export power to the rest of the region. Currently, Namibia's installed generation capacity is in the order of 400 MW, while its demand is approximately 600 MW. The gap is made up by electricity imports. In order to be truly energy-secure, Namibia needs to be energy-independent, given the risks in power supply within the SADC region. This requires Namibia's bolstering its own energy generation capacity with hitherto untapped domestic sources.

Thus, Namibia must address the problem of inadequate access to electricity (especially in rural areas), the challenge of extending affordable energy services to underserved populations, the need for self-sufficiency and energy independence, while at the same time ensuring that energy sector development is climate-resilient and able to assure energy access even in a non-stationary natural environment.

Renewable energy holds the solution to all these challenges, if developed strategically and with foresight. This policy responds to this problem statement, and will better equip Namibia to prevail over these difficulties.

Rationale for a Renewable Energy Policy in Namibia

A National Renewable Energy Policy for Namibia is required to provide guidance to the government on how to develop the renewable energy sector and scale-up the contribution of power from renewable sources in the country's electricity mix.

Such a policy acts as a compass for the government, to help direct its actions in a manner that serves the objectives, goals, and targets articulated in the policy. It is the foundation upon which formal, legally binding mandates can be built, in the form of a National Renewable Energy Act for Namibia or other legislative enactments to support the development of renewable energy.

The policy is also a touchstone for entities beyond the government that are interested in the growth of the renewable energy sector, such as prospective investors trying to gauge market-readiness, donor governments planning to invest in renewable energy abroad, multilateral development partners exploring opportunities to support, Namibian citizens eager to utilize clean energy, civil society organizations and non-governmental organizations (NGOs) wishing to harness renewable energy to extend energy access to communities, and for international institutions working with nations to combat climate change and promote low-carbon development.

While it is possible to develop the renewable energy sector in the absence of a policy, the lack of formal directive statements to guide the government and a clear roadmap hinders timeous and measurable progress. Development takes place in less cohesive, less strategic, ways that are not as closely tied to national developmental priorities. Moreover, in the absence of a recognized and publically available policy document, the government is less accountable for its actions to scale up renewable energy, or its failure to adequately do so.

A policy is necessary to both recognize major barriers that stand in the way or constrain the development of renewable energy, and to create an enabling environment that reduces or eliminates such barriers, and fosters accelerated development of renewable energy.

In light of this, a formal, written policy is called for that is endorsed by Parliament and officially adopted by the Government of Namibia.

Alignment with Existing Policies and Frameworks

The complexity of Namibia's energy sector – and the central role of energy in supporting broader national development – manifests in a multiplicity of policy documents and frameworks that touch on themes relevant to the National Renewable Energy Policy. The government views alignment between the different instruments as critical. Thus, this policy has been drafted after a review of numerous such policies, strategies, vision documents, and frameworks, and is (at present) consistent with what they articulate. These include, but are not limited to:

- The Harambee Prosperity Plan, 2016
- Namibia Vision 2030
- Namibia's Fourth National Development Plan (NDP-4), 2012/13 – 2016/17

- The White Paper on Energy Policy 1998
- National Integrated Resource Plan, 2016
- The Electricity Act, 2007
- Rural Electricity Distribution Master Plan, 2010
- Off-Grid Energization Master Plan, 2007
- National Connection Charge Policy, 2015
- National Policy on Climate Change, 2011
- Namibia's Intended Nationally Determined Contribution to the UNFCCC, 2015

In addition, the policy has also been drafted after taking cognizance of policies and legal instruments that are currently under development, such as:

- Draft Electricity Bill
- Draft Namibia Energy Regulatory Authority Bill
- Draft Independent Power Producer (IPP) Framework, 2016

Vision Statement and Mission

The National Renewable Energy Policy aims to enable access to modern, clean and affordable energy services for all Namibian inhabitants. Modern energy is defined as the level of energy and energy services required to meet people's needs. In some locations this means access energy from centralized sources, while in other locations it means access to off-grid or distributed energy solutions that don't compromise quality or reliability required to meet people's needs.

The National Renewable Energy Policy aims to make renewable energy a powerful tool for the Government of Namibia to meet its short-term and long-term national development goals, and to assist Namibians climb the development ladder, empowered by access to energy at levels that facilitate engagement in productive activity.

The National Renewable Energy Policy's Vision is for Namibia to become a regional leader in the development and deployment of Renewable Energy within the Southern African Development Community (SADC).

Objectives

The Government of Namibia recognizes the following objectives of this National Renewable Energy Policy:

I. Making Renewable Energy a Vehicle for Expanded Access to Affordable Electricity in Namibia

At present, only a third of all Namibians have access to modern electricity. There is even more troubling disparity between rural and urban electrification rates, with an estimated 78% of urban residents having access to electricity but only 34% with access in rural areas.[v] The Government of Namibia is responsible for extending affordable, modern energy services to a greater percentage of Namibia's population. One of the objectives of the National

Renewable Energy Policy is to make renewable energy a means of accelerating expanded energy access providing assurance of adequate and affordable energy services to the vast majority of Namibians, aiming for no less than 70% coverage by 2020 and near-universal coverage by 2030.

II. Assuring the Commitment of Namibia's Government to Renewable Energy

The National Renewable Energy Policy is testament to the Namibian Government's commitment to growing the renewable energy sector. Through this policy, the Government is elevating renewable energy development as a national priority. This support to renewables expansion should be taken cognizance of by those within and outside Namibia who have an interest in renewable energy growth. This policy should also be viewed as a demonstration of Namibia's commitment to global, multilateral objectives such as combating climate change, in furtherance of its obligations under the United Nations Framework Convention on Climate Change (UNFCCC).

III. Boosting Confidence in Investors about the Growth of Renewable Energy in Namibia

The National Renewable Energy Policy is intended as a signal to national, regional, and global markets regarding renewable energy sector growth in Namibia. The Government of Namibia is committed to making Namibia an attractive investment destination for renewable energy, and to reducing or eliminating barriers to investment.

IV. Creating an Enabling Environment for Renewable Energy Project Development in Namibia

Beyond the removal or reduction of obstacles, i.e. the mitigation of negative factors that impede renewable energy development, the Government of Namibia is also committed to undertaking positive, supportive approaches to spur the growth of renewables, i.e. putting in place incentives or enabling mechanisms that catalyse renewable energy development.

V. Accelerating Renewable Energy Sector Growth

The Renewable Energy sector in Namibia is already expanding. Several factors make Namibia an attractive location for siting renewable energy projects (including high resource potential for solar and relatively good potential for wind in many areas; low population density; and few competing land uses), and as a result this sector is poised for robust growth. However, for investor interest to translate into significant new generation capacity, measures have to be put in place to help accelerate renewable energy investment, procurement, project development, and project completion. The National Renewable Energy Policy points the Government of Namibia in this direction.

VI. Enabling Greater Participation of Namibians in the Renewable Energy Sector

Namibia's significant renewable energy potential is an economic opportunity for Namibians. The Government of Namibia is committed to ensuring that growth in this sector will be leveraged to benefit Namibians. The benefits include job creation for Namibians in this sector, as well as investment opportunities for Namibian nationals. This National Renewable Energy Policy directs the government to manage the fine balance between creating and assuring preferential opportunities for Namibian participation in the industry and ensuring the sector is attractive for foreign investment. The government should proactively extend project preparation and due diligence support, lending support (such as preferential lending rates), and devise potential tax support to Namibians participating in the development of RE project. Similarly, it should prioritize the training and capacity building of Namibians in this sector, and seek out Namibian projects and technologies to include in Renewable Energy Development Zones (REDZ), for pilot or demonstration projects. However, the government must do so without falling foul of international trade rules (as some countries' domestic content clauses in the RE sector have), and without stifling competitive opportunities for foreign investors.

Goals and Targets of the National Renewable Energy Policy

The National Renewable Energy Policy is intended to be a living document that will continue to guide Namibia's government for an indefinite period of time. Since the policy will endure for several years, it should be complemented with an Implementation Plan, designed for a specific timeframe (such as three to five years), which would be revised periodically. Prescriptive targets should be found in the Implementation Plan. However, the goals of the National Renewable Energy Policy, below, are accompanied by targets where appropriate, to ensure that this policy is clear about the direction of growth in renewable energy, the pace of development, and the scale of expansion of the renewable energy sector in Namibia.

I. Namibia Should Aim to Become Energy-Independent, and also become a Net Electricity Exporter by 2030, By Leveraging its Renewable Resources

The Government of Namibia aims to achieve energy independence and energy security for Namibia through increased use of renewable energy. Currently, Namibia imports over 2 billion Namibia dollars' worth of electricity every year in foreign exchange, which could have been avoided if Namibia could meet demand through its own generation. This money has significant opportunity costs, and could be used instead to help Namibia meet its socio-economic development goals, if it remained in the country.

Thus, In the period up to 2030, Namibia should seek to bridge the gap between domestic generation and total consumption by expanding renewable energy generation to cover the deficit where it makes economic sense. Renewable energy development should help to first reduce and potentially eliminate the need for imports. When the government considers options to reduce imports and increase domestic generation, it should first prioritize power generation from clean and renewable sources when cost competitive with other options (such as conventional power generation from fossil fuels).

II. 70% or more of Electricity Installed Capacity in Namibia Should be from Renewable Sources by 2030

By the year 2030, 70% or more of installed capacity in Namibia should be from renewable energy sources. The above target relates to renewable installed capacity divided by the total installed capacity available in Namibia, taking into account import/export installed capacity of the country, and the installed capacity of all the other conventional technologies (coal, gas, etc.). Renewables installed capacity currently represents 27% of electricity installed capacity in Namibia (2015).

III. Renewable Energy Should be a driver of Income-Generating Opportunities, and Poverty Alleviation through Increased Access to Affordable Energy Services

The Government of Namibia has made poverty eradication and alleviation a national priority. Renewable Energy can enable the government to meet its poverty reduction targets. The government should use the development of renewable energy to combat poverty. This can be achieved by increasing access to adequate energy services that support more productive activity; creating new jobs across the renewable energy value chain; and improving socio-economic welfare as a whole by enabling resource-poor households to invest more time in education and household health.

IV. Namibia Should Assure Transparency of Regulatory Mechanisms and Governance Related to Renewable Energy

The Government of Namibia should demonstrate utmost transparency in the development of renewable energy, particularly in terms of project procurement. The Renewable Energy Policy directs the government to exhibit greater transparency through the following actions (this list should be treated as illustrative, not exhaustive):

(1) Public announcements of opportunities in reasonable timeframes in advance of tendering;
(2) Widespread dissemination of calls for proposals, including guaranteed availability of all tender materials on relevant government websites and at relevant department offices;
(3) Pre-tendering briefings, wherever applicable;
(4) Creation of a streamlined dispute-redressal mechanism (such as an ombudsman or an arbitration facility) related to renewable energy procurement.

VI. Namibia Should Balance Grid-Connected Renewable Energy Development with Off-Grid Development

The Government of Namibia should accord importance to grid-based renewable electricity as well as off-grid renewable electricity applications, and balance the development of both types of renewable power while also encouraging energy efficiency. While some regions of Namibia are most optimally served through grid-connected, utility-scale renewables, other locations are well-suited to being powered by off-grid applications. Both approaches are complementary in nature and neither grid extension (with renewables integration) nor off-grid systems by themselves can provide a solution in isolation.

The Government of Namibia should undertake periodic evaluations of the suitability of its 121 constituencies within 14 administrative regions for grid-extension and grid-based renewable projects, and similarly it should regularly identify locations where off-grid technologies are more cost-effective or reliable. It should prepare these periodic evaluations in an evidence-based and consultative manner, including through public participation of local communities. Where needed, it should provide additional support to small-scale, rural, off-grid solutions in case such support is needed for such applications to be viable (in comparison to grid-based projects which would largely be guided by the principle of cost-reflective tariff and competitiveness).

VI. Namibia Should Prioritize Renewable Energy Development Beyond just the Electricity Sector

The Government of Namibia should also prioritize the use of non-electricity sector renewable energy and efficiency where these options are financially competitive with alternatives. This includes renewables for thermal energy and for domestic, industrial, and transportation fuels. In this context, the RE Policy supports the Solar Thermal Technology Roadmap for Namibia and its goal to achieve wide-scale adoption of solar water heating solutions. The policy also recognizes that the achievement of near term goals of the Harambee Prosperity Plan as well as the Namibia Vision 2030 and UN's SE4ALL goal of universal access to modern energy services by 2030 requires the extension of clean energy services (such as cooking fuel) that range beyond electricity, and recommends that the government leverage renewables to achieve these objectives.

VII. Namibia Should Pursue Climate-Resilient Energy Sector Development Through Renewables

The impacts of climate change are being felt the world over, including Namibia. Existing climate variability is being exacerbated by climate change. With climate change expected to bring greater variability in climatic patterns and weather systems, and more extremes (including more natural hazards such as drought, heat waves, floods, bush fires etc.), energy infrastructure around in Namibia is going to contend increasingly with a non-stationary environment. The Government of Namibia must prepare for more climate disruptions of its current primary power source – hydropower. Even if future hydropower projects are designed taking climate change projections into account, this may be insufficient to assure uninterrupted, constant generation. To build resilience against climate change variability, Namibia would be well served to adopt a more diverse energy mix.

The Government of Namibia should strengthen the country's climate resilience by diversifying the energy mix with more non-hydro renewable energy. Renewable power offers abundant fuel sources (be it solar, wind, or invader-bush based bioenergy), a negligible carbon footprint, and is less prone to inter-annual or seasonal variability than hydropower.

The added benefit of renewable energy is that it contributes to greenhouse gas (GHG) mitigation, and thus actively helps combat climate change. In light of this, as the Government of Namibia expands renewable energy, it should position the country as a strong candidate for international climate finance and grants that target GHG abatement or mitigation. In its Intended Nationally Determined Contribution (INDC) submission to the UNFCCC, Namibia committed to reducing its GHG emissions by 89% in 2030, relative to a Business-as-Usual projection for 2030. While Namibia's contribution to global GHGs is currently negligible, the emissions intensity of its economy increased (between 2000 and 2010) from NAM$ 200 per ton to NAM$300 per ton emitted. To manage this increase, it is important to increase the share of renewables in Namibia's electricity mix. Namibia's current emission factor for grid-based electricity is 0.413302564 kilograms of carbon dioxide per kilowatt-hour generated.

VIII. Namibia Should Accelerate Development and Deployment of Energy Storage to Facilitate Renewable Energy Expansion

The full scale of potential renewable energy development cannot be achieved without significant improvements in storage capacity. In recognition of the critical role of energy storage for growth of renewable energy, the Government of Namibia should invest in and promote the building of a range of storage infrastructure, and actively support research and development on storage options.

In this case, energy storage by utilizing compressed air, pumped hydro, batteries, or thermal storage (e.g. hot water units becomes indispensable.

IX. Namibia Should Ensure Renewable Energy Supports Accelerated Industrial Growth and Competitiveness

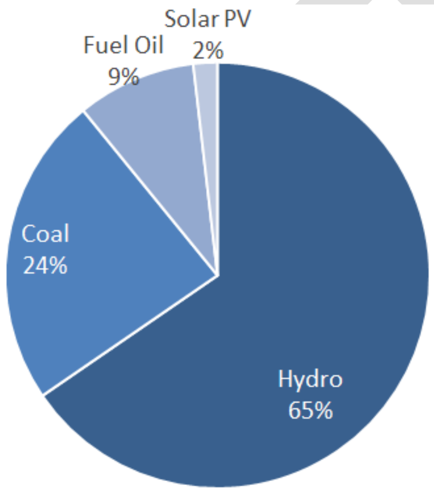
Namibia is aiming for economic transformation (as articulated in the Harambee Prosperity Plan), primarily in the manufacturing and industrial sectors. Namibia also aims to increase its economic competitiveness, including its aspiration to be rated the most competitive economy in Africa by 2020. The RE policy affirmatively directs the government of Namibia to make renewable energy a critical component of such competitiveness, both by ensuring competitiveness within the RE sector, and by enabling greater use of affordable and reliable renewable power in Namibia's growing industrial base.

Namibia’s Renewable Energy Sector - Background

Renewable Electricity in Namibia

Namibia has an abundance of renewable energy resources (e.g. solar, wind, and biomass) and a well-established electricity supply industry. Renewable energy (other than large hydro), however, only accounts for small amount of the installed capacity in the country to date. Figure 1 provides a high-level summary of the installed capacity in the country.

Figure 1: Namibia’s Installed Capacity as of January 2016 (~500MW)



Source: (ECB, 2016)

In addition, imports account for over half of Namibia’s energy supply as depicted in Table 1. The weighted tariffs for these imports depend on the contract terms, but tend be fairly expensive compared to the cost of existing and new generation options.

Table 1 Summary of Namibia’s Power Import

Import Source	Max Supply Capacity (MW)	Capacity Factor (%)	Net Supply	Weighted Average Tariff (N$/MWh)
South Africa (Eskom supplemental)	200	20%	40	2,782
South Africa (Eskom off-peak)	300	50%	150	627
Zimbabwe (ZPC)	80	50%	40	2,224
Zambia (ZESCO)	50	100%	50	713
Total	**630**		**280**	

Source: (ECB, 2016)

A number of new power projects are at various stages of development including several renewable energy projects, some of which have faced challenges to date. Examples of these recent challenges include:

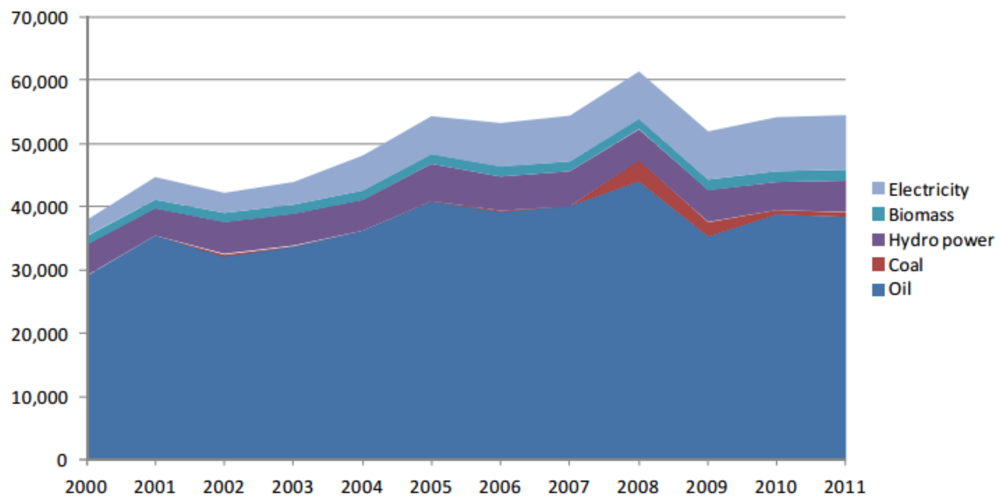
- While the 70MW REFiT worked for solar PV, the fixed tariff and recent currency devaluation resulted in a low success rate for non-solar PV projects reaching financial close
- Changes to procurement rules during bidding process lead to judicial review causing further delays of the 35 MW ECB/NP Solar PV; A 37MW tender has recently been issued to replace this project
- Unclear procurement rules for unsolicited projects still remains a challenge (e.g. 44MW Diaz Wind and 20MW GreeNam Solar PV)

These challenges, however, create opportunity for this RE Policy to provide more direction for the renewable energy sector and support an enabling environment to take advantage Namibia's abundant renewable energy resources.

Non-Electricity Renewables in Namibia

Primary energy consumption in Namibia has been growing at a rate of 3.5% annually, on average. During the 2000-2010 period the total growth rate for primary energy was 38% over the decade. The composition of Namibia's Total Primary Energy Supply demonstrates the predominance of energy from oil. Overall, primary energy in Namibia is derived from liquid fossil fuels (petroleum, diesel, paraffin, and liquefied petroleum gas), biomass (charcoal, wood, and processed wood products), and coal.

Figure 2: Namibia's total primary energy supply 2000-2011 (in TeraJoules – TJ)



Source: (VTT, 2013)

At present, renewables play a very small role in the non-electricity energy sector. However, there is potential for renewables to scale up in providing non-electricity energy (primarily thermal energy for heating and cooking, if Namibia's ample biomass resource is utilized effectively, sustainably, and combusted in cleaner ways.

Currently, over half of all Namibian households (approximately 54%) rely on wood or wood products for cooking. This translates to around 86% of rural households and roughly 20% of urban households. An estimated 46% of the population uses wood products for space heating, which is further disaggregated into about 75% of rural households and 17% of urban households.[vi]

Biomass in Namibia is most prevalent in the form of "encroacher bush." Approximately 30% of Namibia is covered by encroacher bush. The energy content of this resource has been estimated to be 1000 Twh.[vii]

Biomass for fuel use can take many forms, including wood chips, briquettes, and pellets. A recent profitability analysis indicates that the Windhoek region is most optimally served by wood chips, while more far flung areas are better served by pellets.[viii]

Some industrial and commercial applications are also well suited to the use of biomass as combustion fuel. A local Cement factory is already using encroacher bush. Thus there is potential to grow biomass use for combustion, pyrolysis, or even direct gasification. Existing applications of biomass in Namibia use only 600000 tw/a, which amounts to only 3% of total potential.[ix]

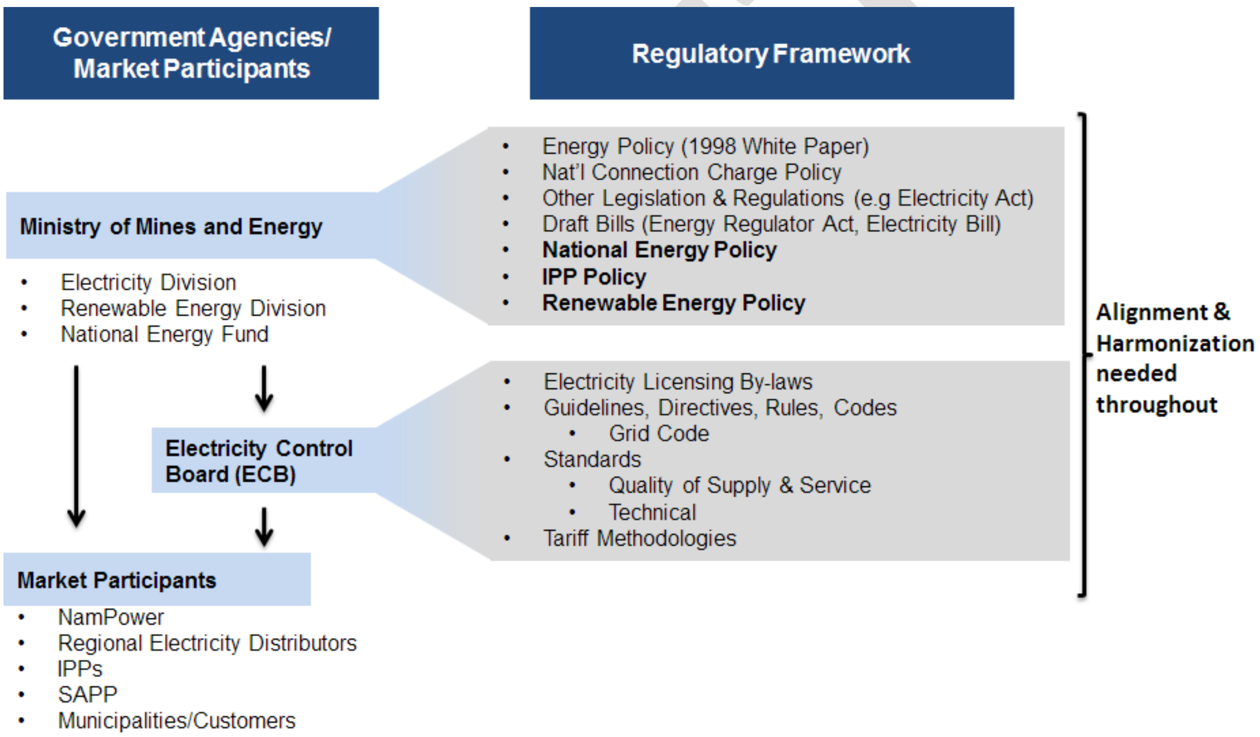
While several methodologically robust and credible studies have been conducted in Namibia regarding the economics and cost-effectiveness of encroacher bush use, the economics of de-bushing, and the economic plus environmental impacts of bush encroachment,[x] a gap appears to exist in terms of research that studies the environmental impacts of an energy production business model that requires recurrent harvesting of encroacher bush and continued coverage of land by such bush species. If bioenergy based on encroacher bush is turned into a viable industry with new value chains, it is plausible that farmers may find it profitable to allow encroacher bush to encroach on even more land. Instead of completely de-bushing, there could be an incentive to allow this fuel source to thrive. The potential ecological impacts of this model should be further explored, including through pilot studies that involve actual supply chains.

Renewable Energy Sector Strategy and Key Components

Enabling Institutional and Regulatory Framework

The RE Policy factors in the context of the institutional and regulatory backdrop of the energy sector. Additional regulations and amendments will be required to ensure alignment with the RE Policy as well as other draft policies and bills once these are finalized. Figure 3 provides a visual representation of the institutional framework for Namibia's power sector and highlights several draft policies and bills that still need finalized and aligned with this RE Policy.

Figure 3: The institutional and regulatory framework of Namibia's energy sector



As per the existing Renewable Energy Procurement Mechanism, Namibia differentiates renewable energy procurement based on system size as follows:

- Net metering rules for installations ≤500 kW for all renewable energy technologies (not to exceed the main electricity supply circuit breaker current rating)
- A renewable energy feed-in tariff (REFiT) for projects >500kW and ≤ 5 MW including biomass, concentrating solar power, solar PV, and wind.
- A competitive auction approach for projects >5MW

This differentiation of regulations and procurement based on system size, helps to target different sectors and encourage wider adoption of renewable energy. However, Namibia is still facing some challenges with its approach to date including:

- Limited participation by some distribution utilities in net metering to date
- Challenge with accurately setting REFiT amounts that are competitive, bankable, reduce risk of exchange rate fluctuations, and account for technology advancements
- Lack of clear and efficient land procurement and access rules for projects
- The need to stick to best practices when competitively procuring capacity

Fortunately, these challenges provide lessons to learn from when improving on future renewable energy programs and harmonizing efforts by Government. The IPP Policy will also provide more detail on future rules and procurement guidelines for both renewable energy and other resource options.

Policy Statement
Government shall ensure periodic update license guidelines, exemptions, and potential regulatory registration requirements for the renewable energy sector as technology and market develop.

Government shall also seek to harmonize efforts and build on experience from previous efforts. Some near-term regulatory improvements to consider include:

- *Increasing the REFiT size limit of 5MW to 10MW account for high transaction costs*
- *Replacing future REFiT with competitive auctions for more competitive renewable energy technologies (e.g. solar PV and wind)*
- *Integrating donor support into these programs (e.g. GET FiT) without building a dependency on donor support for sector development*
- *Introducing penalties for developers that don't meet commitments made in the auction process*

Existing laws in Nambia require the regulator to obtain Ministry of Mines and Energy approval for its decisions on the energy sector. The 2006 World Bank's Handbook for Evaluating Infrastructure Regulatory Systems, provides best practices for effective regulation and recommends an independent regulator model based on organizational, financial, and management indepedence. This regulatory independence is critical in order to depolitisize regulatory decisions. The energy regulator in Namibia should be independent and make decisions objectively in line with government policy (The World Bank, 2006).

Moreover, a fully independent regulator would allow it to clarify rules on RE procurement including stakeholders roles in the bidding process, work through the details of the modified single-buyer model, and develop regulations for off-grid energy options.

The draft Namibia Energy Regulatory Authority Bill aims to expand ECB's authority beyond the electricity sector and establish a single energy regulator, the Namibian Energy Regulatory Authority, to cover:

- Electricity
- Downstream gas including gas pipelines and storage facilities
- Downstream petroleum pipelines and storage facilities
- Renewable energy
- Energy efficiency and conservation (Bill of Parliament, 2016)

Policy Statement
The RE Policy supports strengthening the role of the regulator by providing it with autonomy to make objective decisions, in consultation with government, and broaden its authority.

Market Structure

Clear policy guidance and an enabling environment for IPPs will encourage greater development of Namibia's renewable resources through an appropriate market structure that, for example, allows IPPs to sell power to off-takers other than NamPower. It is currently supported through the development of market rules in the draft Electricity Bill (Bill of Parliament, 2015). More guidance on the preferred market structure for Namibia will be provided in the IPP Framework and Energy Policy.

Policy Statement
The RE policy supports the adoption of a market structure in Namibia that enables IPPs to generate and sell electricity to off-takers other than the Single Buyer, and enables distributed generation from various technologies and resources.

Subsidy Framework

Subsidies play an important role in developing economies like Namibia and can be an effective tool to encourage growth when implemented in a transparent and targeted way.

With the move towards cost reflective tariffs and an increase in the number of IPPs and embedded generators in the market, there is a pressing need for transparent and manageable subsidies. For example, cross subsidies built-in to tariffs where one customer is charged more to recover the underpayment from another customer, distort the market and make it difficult to track the true cost of the subsidy. They can also discourage the efficient use of energy in some cases and undermine energy efficiency goals. A subsidy framework aims to address this by helping answer:

- Who needs subsidy and at what amount?
- What type of subsidy and who will pay?
- What is the best method for disbursement and when will it be phased out?[xi]

Policy Statement

The RE Policy encourages the development of a subsidy framework that supports the targeted and transparent use of levies, surcharges, and subsidies, which is based on the following principles:

- Targets specific objectives and customer groups
- Remains transparent on who benefits, allocation process, and the amount
- Considered to be fair for those that fund the subsidy and those that benefit
- Introduces minimal economic distortions and can be phased-out over time
- Administered and monitored easily

Power Sector Planning

Namibia developed a National Integrated Resource Plan (NIRP) to evaluate and prioritize power generation options for the country. The NIRP's aim is to assess the full range of power supply development options that could meet future customer needs including renewable energy, and objectively compare these.

When developing an NIRP, countries often define a least cost plan of electrification as a base case scenario and may make strategic or policy adjustments to account for other strategic planning objectives. These other strategic planning objectives may include the need to:

- Develop domestic projects and use local resources to reduce dependency on imports (security of supply)
- Keep commitments to climate change targets with clean energy options
- Diversify energy mix to improve resiliency and system reliability
- Increase efficiency of end-users and across the energy supply chain
- Optimize government investment
- Create jobs for the local economy
- Provide access to electricity quickly and efficiently to unelectrified communities

The NIRP planning process shall establish clear responsibilities and authority of ESI stakeholders, set the planning horizon (e.g. 10-20 years), and the review period before the next update of the NIRP (e.g. 2-3 years[xii]). The NIRP planning process needs to also account for efficiency initiatives, mini-grids, net metering, storage, embedded generation, as well as other evolving features of the Namibian ESI.

It is important to ensure that the NIRP planning remains the responsibility of the Namibian government (i.e. Minsitry of Mines and Energy) as the policy custodian of the energy sector, and encourage fair treatment of all resources and potential power projects.

Policy Statement
Government shall continue to use a long term national integrated resource plan (NIRP) approach, to serve as a guideline for power sector planners, IPPs and electricity customers. The NIRP shall be revised periodically to take account for market and technology changes.

In addition, the Namibian government shall also conduct renewable energy resource mapping to assess the availability and location of local resources, which will inform future revisions of the NIRP and other potential government programmes such as Renewable Energy Development Zones (REDZ). REDZ are used in other countries including South Africa, to identify geographical areas where grid expansion can be directed and regulatory processes streamlined (e.g. pre-approved environmental assessment of location) in order to incentivize the cost effective development of renewable energy projects.

Policy Statement
Government shall conduct renewable energy resource mapping and develop a publicly available information portal with renewable energy technical baseline data and other relevant industry documents for the country.

Government shall also consider establishing Renewable Energy Development Zones (REDZ) in regions with high resources to assist with efficient network planning and cost effective renewable energy integration.

Third Party Grid Access & Wheeling

Namibia developed a Grid Code and a Transmission Connection Agreement (ECB, 2005) to provide rules and guidelines for electricity market participants on network access. Likewise, Namibia has in place a National Connection Charge Policy and a recent Amendment from NamPower on Technical Guidelines for Transmission provides more specific guidance on the integration for renewable energy facilities and other embedded generation (NamPower, 2016).

Namibia's Electricity Act of 2007 establishes the rules for third party grid access to the transmission and distribution system. It requires a license for the following activities related to electricity:

- Generation & Supply
- Trading
- Transmission & Distribution
- Import & Export

The Electricity Act of 2007 also clarifies license exemptions if for example, the installed capacity is less than 500 kVA, electricity is for own use, or in areas without a supply network. The Electricity Act of 2007, however, may need to be updated to reflect proposed changes to the market structure and allow for more bilateral transactions such as wheeling.

Wheeling is currently used in other markets, such as South Africa, to allow for the sale of electricity across a public power network in a way that allows the system operator to also recover its costs for the use of the system through use of system charges. Effective wheeling rules encourage wider adoption of renewable energy projects by allowing for larger than own-use installations and potentially community solar initiatives. A community solar initiative, for example, refers to a solar power farm that provides power and/or financial benefit to multiple community members that choose to provide capital for the project and has been successful in a number of other markets.

Policy Statement
The ECB shall consider the development of wheeling regulations that enable renewable energy projects (e.g. community solar initiatives). These regulations shall be aligned with the electricity market structure and the National Connection Charge Policy to address practical issues such as fair cost recovery for the system provider (e.g. unbundled use-of-system charges, energy losses, levies, and eligibility)

Net Metering

As of early 2015, distribution utilities in Namibia were required to offer net metering services for customer generation such as rooftop solar PV installations (ECB, 2015). Objectives of the Net Metering Rules are summarized below:

- Generate additional power for the national grid and reduce investment requirements of utilities and conventional IPPs
- Allow customer-generators to off-set their grid electricity usage through generation for self-consumption
- Allow customer-generators to export energy to distribution networks up to a limit of the customer's imports from the distribution network
- Promote sustainable renewable energy sources, small scale investments, value addition and electricity market development
- Contribute towards reducing unemployment (ECB, 2015)

There has been mixed results in the success of the program to date as some distribution utilities view net metering as a threat to their revenue, despite the fact that existing regulatory rules help to reduce net metering risks for distribution utilities by:

i. Restricting max capacity per site (e.g. 500kVA)
ii. Limiting customer net-exports
iii. Capping the distribution utility's aggregate net metered capacity (e.g. % of peak capacity)

These limits should ultimately be set by the ECB who shall also be given more authority to ensure that distribution utilities comply with rules.

Policy Statement
The RE Policy supports the requirement for distribution utilities to offer net metering to customers. Restrictions on the site capacity (e.g. 500kVA) and caps on the distribution utility's aggregate net metered capacity shall be determined by the ECB based on technical and practical limits, and updated periodically as the industry and technology develop.

In order to protect the financial viability of distribution utilities over the longer-term, alternative tariff options to net metering should be considered once net metering caps are reached. A number of other markets are adopting tariffs which both compensate customers for energy fed into the grid and allow utilities to recover costs of servicing the customer.

In South Africa, for example, the national regulator is in the process of finalizing an embedded generation tariff for installations <1MW. These rules will take precedence over existing municipality tariffs for embedded generation and require municipalities to compensate customers at the avoided variable purchase cost of the distributor. In other words, municipalities will buy energy from customers at roughly the same rate they pay Eskom for its power (wholesale rate). It also allows for both fixed and variable charges to apply to small-scale embedded generator customers, so the municipalities can recover fixed costs of servicing the customer and other levies. (NERSA, 2015)

Policy Statement

The ECB shall develop an alternative tariff compensation approach for net metering to become embedded generation as and when net metering caps are reached. This tariff shall:

- *Fairly compensate customers for energy fed into the grid*
- *Allow the distribution utility to recover costs of servicing the customer*
- *Incentivize embedded generation when and where it will be most useful to the system operator through tariff signals*
- *Provide equal opportunity to renewable energy resources and storage technologies*

As proposed in the net metering rules, embedded generation customers shall also be exempt from generation licensing requirements.

Energy Storage

Energy storage technologies and solutions have the potential to provide a number of benefits in Namibia's ESI such as:

- integration of intermittent renewable resources
- increase in supply during peak periods with load following
- enhancements to electrical grid in both operations (e.g. ancillary support) and deferred infrastructure investment
- potential reduction in emissions from reduced use of fossil fuel alternatives
- end-user avoided costs[xiii]

Effective and safe integration of energy storage technologies to the existing public electric network requires Grid Code rules on the parameters and technical specifications the storage technology needs to meet. Namibia already has a Grid Code (ECB, 2005) providing rules and guidelines for electricity market participants on network access, however, an amendment is needed to provide more guidance on the integration of energy storage solutions and technologies.

Grid Code rules and targeted tariff signals for energy storage solutions can enable the wider adoption of energy storage and ensure it adds value for a number of stakeholders in Namibia's ESI including both the customer and system operator.

Policy Statement
The ECB shall provide equal opportunity for energy storage solutions, by amending or developing relevant codes to account for energy storage. The ECB shall also consider tariff signals that aim to fairly compensate the customer and incentivize storage solutions when and where it will be most useful on the existing electricity network.

Regional Integration

Namibia's domestic demand for electricity currently limits the size of new power projects it has the potential to develop. Enabling power exports through regional integration increases the country's renewable energy generation potential. For example, the ability to export and import electricity when needed offers one solution to potential intermittency issues associated with large amount of renewable energy capacity.

As a member of the Southern African Development Community (SADC), Namibia has already signed some international agreements that help create an enabling environment and initial framework for renewable energy generation and cross-border trade. (SADC, 2016) International agreements with organizations of particular importance for Namibia's renewable energy and efficiency sectors include:

- The Southern African Power Pool (SAPP)
- Regional Electricity Association of Southern Africa (RERA)
- Southern African Customs Union (SACU)

Policy Statement
The RE Policy and its implementation shall align with and support international agreements previously signed, and work with the Southern Africa Development Community (SADC) to further enable renewable energy exports and potentially imports for Namibia.

In addition, enabling exports from power projects requires supporting rules and regulations for large-scale projects to be built and transactions to take place. Guidelines on who may be eligible for an export license and potential royalties or export levies should be clarified by Government in the national Energy Policy and supportive legislation. RERA also provides guidelines on cross-border power trading in Southern Africa, which provide guidance for future projects (RERA, 2010).

Rural Energy and Mini Grids

Namibia's Vision 2030 (GRN, 2004) and the commitments in the UN Sustainable Energy for All (SE4ALL)[xiv] are aligned in their longer-term energy goals to provide access to modern energy services to almost all of the population by 2030. Likewise, the Harambee Prosperity Plan set near-term goals to:

- Increase in local electricity generating capacity from 400 MW to 600 MW;
- Provide electricity to all schools and health facilities by 2020; and
- Increase the rural electrification rate from 34 percent in 2015 to 50 percent by 2020 (GRN, 2016)

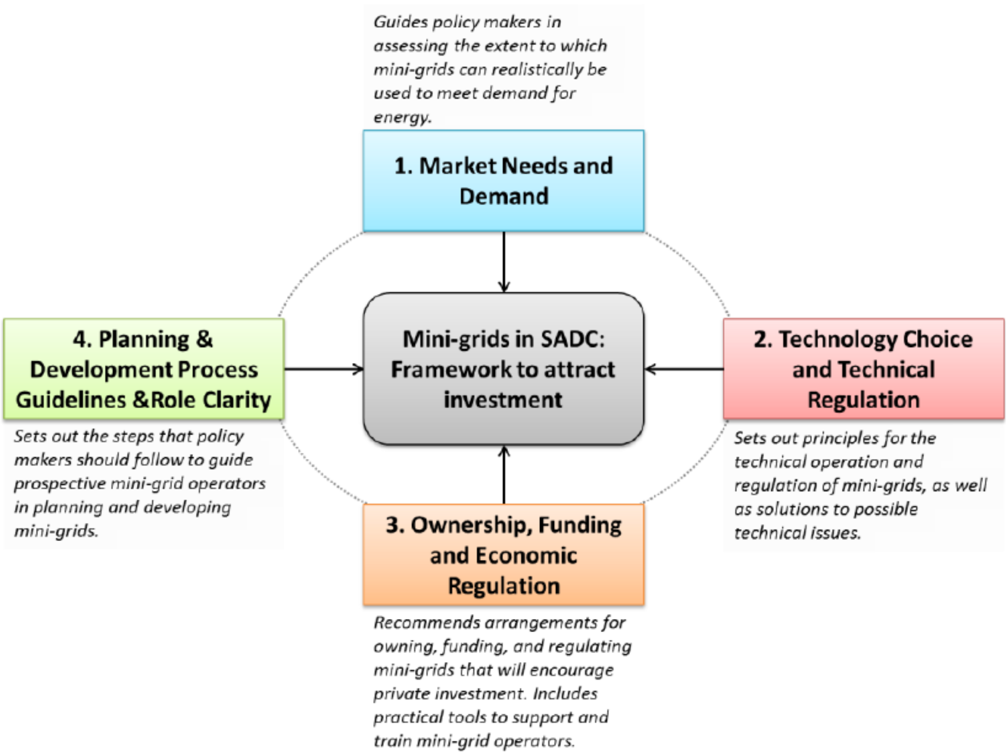
Achieving these goals requires effort on multiple fronts, including an expansion of grid infrastructure and centralized power generation as well as the development of off-grid energy and distributed energy solutions for communities. Off-grid energy solutions such as the development of mini-grids can provide a number of benefits including reduced investment required for grid expansion and use of local renewable energy resources which encourages local jobs. The potential economic benefits from providing off-grid energy services are significant for both the energy end-user and the local economies as new value chains develop to support this market.

Mini-grid potential in Namibia has been identified in both the 2005 Regional Electricity Distribution Master Plan (REDMP) and 2007 Off-grid Energisation Master Plan (OGEMP), which provide valuable context for the RE Policy. While the roll-out of mini-grids continues, a number of challenges have contributed to the slow speed of implementation including:

- Limited government funds and capacity to manage the program
- High up-front capital costs
- Challenge with balancing goals of cost reflectivity and affordability
- Insufficient financing and customized investment support
- Lack of effective institutional arrangements to ensure reliable O&M over time

The SADC has also established guidelines in 2013 for mini-grids in countries like Namibia. These guidelines are summarized in Figure 4.

Figure 4: SADC Support Framework for Mini-Grids



Source: (RERA, 2014)

Policy Statement
The RE Policy supports Namibia's modern energy access goals through the increased use of economically viable and locally available renewable energy resources along with the expansion of the mini-grid roll-out that aligns with the SADC's mini-grid framework and Action Plan (See Annex D).

The RE Policy also supports the near term goals of the Harambee Prosperity Plan as well as Namibia's Vision 2030 and *UN's SE4ALL goal of universal access to modern energy services by 2030*

Modern energy is defined as the level of energy and energy services required to meet people's needs. In some locations this means access energy from centralized sources, while in other locations it means access to off-grid or distributed energy solutions that don't compromise quality or reliability required to meet people's needs.

Feedback from stakeholders and recommendations from a gap analysis of Namibia's mini-grid program (RERA, 2014) further highlight the need to establish a government agency dedicated to managing the program (See Annex D for Mini-Grid Action Plan). This Rural Energy Agency will oversee the further expansion of the mini-grid roll-out in Namibia, coordinate existing efforts on all forms of rural energy (e.g. efficiency, thermal energy, electrification), and help address capacity shortfalls experienced to date. The Rural Energy Agency will likely need to work closely with existing organizations such as the Namibia Energy Institute (NEI) to build on existing efforts in this sector.

Funding for the Rural Energy Agency may need to come from a levy on electricity tariffs, but other funding options should also be explored.

Policy Statement
Government shall establish a Rural Energy Agency or add more capacity to an existing Agency to manage energy access programs in rural areas (both on and off-grid). Responsibilities of this agency include, but are not limited to:

- *Educate public and create awareness on energy options for rural communities*
- *Monitor and evaluate progress in meeting energy goals*
- *Work with stakeholders (e.g. REDs, municipalities, and private sector) to coordinate efforts to develop affordable mini-grid solutions and ensure reliable ongoing maintenance*
- *Develop updated mini-grid planning documents and technical guidelines*
- *Manage Government funds for rural energy services and mini-grid programs*

Some delays and challenges have been experienced to date with existing initiatives for off-grid and rural electrification, such as a lack of clarity on the responsibilities for mini-grid operations to date resulting in maintenance challenges at a number of sites. The regional council is often not well equipped to handle the maintenance requirements, so alternative solutions need to be explored to build and finance mini-grids such as potentially assigning more authority to REDs to install and maintain mini-grids. Another option is to structure scalable public-private partnerships (PPPs) to allow private sector companies to develop and maintain mini grids.

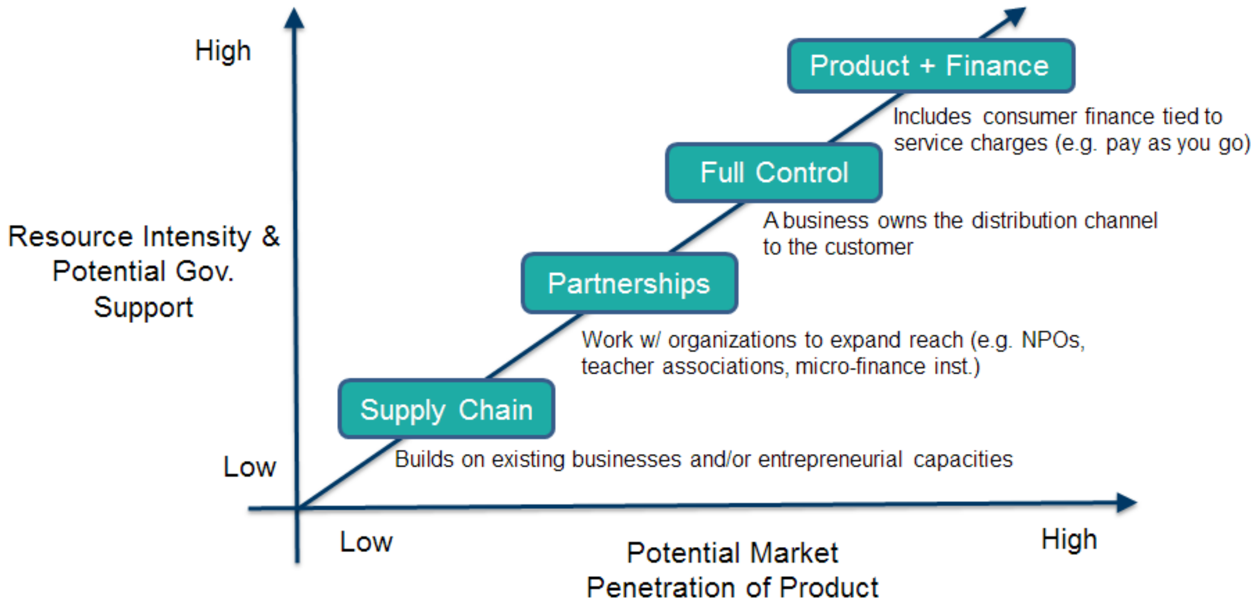
In addition, some positive achievements have also been made to date with the Solar Revolving Fund (SRF) and the number of systems financed to date (See Annex C). The SRF focuses on solar waters heaters, solar homes systems, and solar PV pumping, so an expansion of the program should be consider to also cover energy efficiency, mini-grids, and storage technologies.

Policy Statement
Government shall consider giving more authority to REDs, other distributors, NamPower, NPOs, and the private sector (e.g. through PPPs) for the design, installation, and maintenance of mini-grids. An appropriate tariff regime and streamlined licensing process shall be developed to support the financial viability of this concept.

Government shall consider further expansion of the financing solutions for renewable energy (e.g. Solar Revolving Fund) or creation of additional funds to include energy efficiency, mini-grid and storage technologies.

Lastly, Government shall also build on experience from previous projects and learn from other initiatives piloted in the region to address rural and off-grid energy challenges. For example, a recent study from 25 pilot projects in East Africa using various business models (e.g. pay as you go financing, packaging sale of biomass with cook stoves, and solar community centers), highlights that there is no one size fits all solution as different regions and markets each have unique characteristics and needs (SESA, 2016). Figure 5 depicts a few of the approaches for promoting sustainable products in off-grid communities and demonstrates that each requires a varying level of resources and has its own challenges.

Figure 5: Various Routes to Market for Sustainable Products



Source: (SESA, 2016)

Energy Efficiency and Demand Side Management

Energy efficiency and Demand-Side Management (DSM)[xv] measures are often some of the quickest and most cost effective ways to address national energy goals by helping reduce overall customer demand for energy and its associated emissions. Therefore, development of a renewable energy policy also requires consideration of energy efficiency options that help to achieve similar goals.

Energy efficiency is a cross-cutting topic and applies to a number of sectors in Namibia's economy as illustrated in Table 2.

Table 2 Priority Areas for Energy Efficiency Policy

Energy Efficiency Priority Areas	Examples of international policies and measures
Buildings and homes	Building codes and performance ratings for existing and new buildings
Appliances and equipment	Minimum energy performance standards (MEPS) and labelling
Lighting	Efficient lighting requirements for retail sales and street light installations
Transport	Vehicle fuel-efficiency standards, support for electric vehicles, and transport system efficiency
Industry & Mining	Energy management protocols such as ISO 50001 and MEPs for energy intensive equipment (e.g. motors)
Other sectors & cross-cutting areas	Utility efficiency requirements and targets, price signals, data collection, monitoring and verification, enforcement, public awareness and education

Source: (IEA, 2011)

Detailed policy recommendations for all of these priority areas, are beyond the scope of this RE Policy, however, it is recommended that a more detailed energy efficiency policy be developed for Namibia that covers all sectors of the economy.

Policy Statement
Government shall develop a detailed Energy Efficiency and DSM policy by 2020 for all sectors of the economy that continues to build on existing energy efficiency efforts including research on energy end-use data and public education campaigns promoting the efficient use of energy.

Government shall implement energy efficiency and renewable energy standards not only for its facilities but at all levels nationally.

A number of efficiency and DSM programs have already been implemented in Namibia such as:

- Raising public awareness
- Promoting efficient residential lighting
- DSM campaigns from NamPower (1 million LEDs, 20,000 SWHs, virtual power station)
- Incentives and financing for solar water heating
- Implementing time-of-use price signals for utility tariffs
- Direct load control
- Promotion of commercial and industrial efficiency

Despite these initiatives, more is needed to realize Namibia's full energy efficiency potential and harmonize efforts across all sectors. For example, a recent DSM study for Namibia (emcon, 2015) identified the need for a national DSM programme with the following objectives:

i. reduce the evening peak, as it causes considerable resource constraints and higher electricity costs;

ii. reduce the daytime load for at least as long as local and regional electricity supplies remain constrained; and

iii. increase the night-time load as long as sufficient capacity remains available, to further flatten the load profile and leverage lower cost electrical energy when it is available.

The DSM study also suggests a number of new DSM initiatives to consider (e.g. promotion of consumer storage, energy efficiency standards, increased customer generation), which should also be considered as part of a broader energy efficiency policy for the country and implemented with the assistance of a national energy efficiency and DSM committee.

Policy Statement
Government shall consider establishing a National Energy Efficiency and DSM Committee consisting of relevant stakeholders (e.g. ESI players, Government, NEI, Green Building Council, industry associations) to oversee the implementation of a national Energy Efficiency & DSM initiative. The committee shall enable:

- *Support for the development of a national Energy Efficiency and DSM policy*
- *Systematic implementation of national Energy Efficiency & DSM goals*
- *Relevant national standards to be developed and/or international standards adopted*
- *Baseline assessments and progress reports on impacts of Energy Efficiency & DSM initiatives*

R&D, Innovation Support, and Standards

A number of existing research efforts focused on energy including renewable energy, efficiency, and storage solutions through local Universities and institutions. For example, the Namibia Energy Institute (NEI), SOLTRAIN, and Namibia's University of Science and Technology have worked on a number of projects to in the renewable energy sector that address energy research, technology, policy, and education needs.

Likewise, NamPower and some REDS (e.g. Erongo RED's Battery Energy Storage System Feasibility) are also pursuing research efforts in this sector, which may benefit from government participation or support. Research and demonstrations of innovative solutions customized for the Namibia environment help create awareness and encourage wider adoption of these solutions.

Innovative business models addressing rural energy needs are also becoming more popular in the sub-Saharan Africa region including small-scale solar home energy solutions financed through affordable payment schemes. Given the significant rural electrification needs in Namibia, government funds for research and enabling these business models should prioritize efforts that address rural energy goals.

Policy Statement
Government shall consider expanding existing efforts in R&D, demonstrations, and potential RE technology test sites by working with local Universities and other stakeholders on projects that enable innovation in the renewable energy sector and encourage alternative business models to meet energy goals. In particular, solutions that address rural electrification goals should be prioritized.

In addition, there is a need to ensure that quality and reliability of renewable energy and efficiency technologies and equipment used in Namibia, especially for government led projects and rural energy projects. In some cases adopting international standards for these technologies may suffice and will help to avoid the use sub-standard equipment which damages public perception of the technology.

Policy Statement
The RE Policy supports the development of standards for the renewable energy and efficiency sector in government projects with respect to technical specifications for equipment, environment, health and safety.

Government shall continue to coordinate with Namibian Standards Institution (NSI) and the National Technical Committee on Renewable Energy (NTCRE) to update and enforce standards in the renewable energy and efficiency sectors.

Furthermore, the government should also prioritize essential technical research regarding integration of renewable energy into the existing grid, investigating the impact of intermittent power on grid stability and the capacity of sub-stations to absorb renewable energy. Ongoing studies should examine how the grid can be strengthened or modified to enable greater integration of renewables.

Policy Statement
The Government shall commission periodic grid integration and stability studies to assess grid capacity for renewable energy absorption, and to identify ways that the grid can be upgraded or modified to enable larger intake and distribution of renewable energy as well as storage capacity.

Thermal Energy Supply

Thermal energy generally refers to energy in the form of heat. A number of renewable energy sources can provide thermal energy such as solar radiation, geothermal energy, ocean thermal gradients, and the combustion of biomass or biofuels. Thermal energy can also be used in a wide variety of applications including but not limited to process heat for industry, water heating for domestic hot water, and cooling/heating supply for commercial buildings. As these resources and their applications are at various stages of research and commercialization, the RE Policy focuses primarily on those that are more commercialized and relevant for Namibia in its current context. Electricity sector applications for thermal energy are dealt with in more detail in the electricity sector section of this RE Policy.

Policy Statement
The RE Policy supports further R&D, demonstrations, and test centres on thermal energy and renewable energy supply options for Namibia.

Government shall also work with local institutions and stakeholders to encourage education on renewable energy and efficiency at Universities, vocational schools, and at the community level through awareness and training programs (e.g. Centres of Competence).

Geothermal

Namibia has a number of hot springs across the country indicating availability of geothermal resources, which could potentially be used for electricity generation, process heat, or other applications. There has been very little development of these resources to date and limited data is available on country's resource potential. While Namibia has a high abundance of other renewable alternatives that are currently more commercially viable such as solar and wind, the RE Policy still supports the inclusion of geothermal energy in resource mapping and related research to inform future potential for the country.

Bioenergy

Namibia currently uses a significant amount of bioenergy for domestic cooking and heating needs (e.g. wood and charcoal). The environmental impact and emission levels from burning of biomass varies depending on a number of factors including what type of biomass is used, how its processed (if at all), and how the equipment used to burn it. The RE Policy supports the use of efficient and clean household equipment (e.g. cook stoves) using biomass and biofuels, which should be enabled as an alternative to less efficient methods.

In addition, Namibia has a large amount of invasive plant species (aka encroacher bush) which covers ~30% of Namibia's land area (GIZ, 2016). The encroacher bush contributes to a number of negative environmental impacts including:

- Reduced biodiversity
- Limited land available for livestock
- Decreased groundwater available for other species

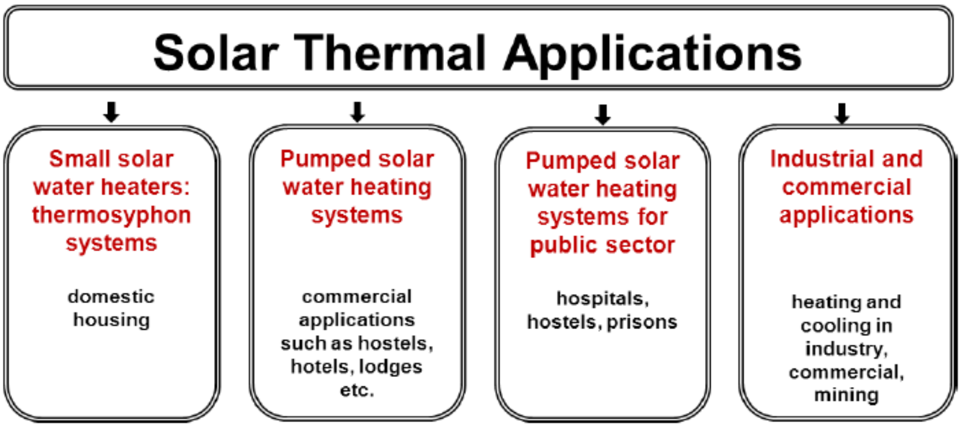
The large amount of encroacher bush creates an opportunity for thermal energy and power generation applications. The RE Policy supports the use of bioenergy for various applications that are economically viable relative to alternatives and help meet the goals Namibia's RE Policy.

[NOTE: please also refer to the larger discussion of Renewable Energy Fuels in a subsequent section of this Policy.]

Solar Thermal

Namibia's abundance of solar resource and the increasing affordability solar technologies make solar thermal technologies and applications a high priority the country. The Namibian Energy Institute in collaboration with NUST and SOLTRAIN developed a Solar Thermal Technology Roadmap for Namibia, which highlights the potential for solar thermal among various end-use segments as depicted in Figure 6. (Dr. Chiguvare & Ileka, 2015).

Figure 6: Summary of Solar Thermal Applications Relevant for Namibia



Source: (Dr. Chiguvare & Ileka, 2015)

In addition solar thermal desalination, solar cooking, solar dryers, and others were also identified as relevant for Namibia. The Solar Thermal Technology Roadmap provides suggested sector specific solar thermal targets until 2030 to meet a goal of 0.5 m² (approximately 0.35 kW thermal equivalent) of flat plate solar thermal collector installed capacity per inhabitant.

Table 3 Solar Thermal Technology Roadmap 2030 Targets by Sector

Sector	Thermal Energy Measure (Units)	Collector Area (m2)
Mass Housing Project	SWHs for additional 185,000 domestic houses	400,000
Private one-family housing	SWHs to replace domestic electric water heaters	600,000
Private multi-family housing	~20,000 SWH units	100,000
Private commercial locations	~1,000 SWH units	20,000
Hotels, hospitals, student homes	180 hotels, 343 hospitals and clinics units	60,000
Solar airconditioning and cooling	Office Buildings units	20,000
Industry & mining applications	Low temperature applications, <200°C	200,000
Domestic and commercial	Solar Cooking, 1m²/family	100,000
	Total	**1,500,000**

Source: (Dr. Chiguvare & Ileka, 2015)

Policy Statement

The RE Policy supports the Solar Thermal Technology Roadmap for Namibia and its goal to achieve a fully functional 0.5 m² (approximately 0.35 kW thermal equivalent) of flat plate solar thermal collector installed capacity per inhabitant in Namibia by 2030.

The RE Policy also supports government efforts to continue to lead by example with solar thermal installations. For example, the 2007 Cabinet Directive requires government buildings to install solar water heaters in all new buildings and for future replacements provided a practical incentive for the local industry. (Epp, 2013)

Policy Statement
Government shall extend solar water heating requirements for government buildings and continue to work with various stakeholders (e.g. National Housing Enterprise, local industry) to implement solar thermal solutions for Government housing projects.

On a larger scale, Concentrating Solar Power (CSP) applications also have potential to address some of Namibia's energy sector needs such as providing process heat for industrial processes and power generation. Opportunity may exist to leverage international climate financing to help reduce the high upfront cost of capital for CSP projects. Since CSP is most commonly used for power generation with storage, the electricity sector section of this report provides more context for this technology. In addition, more research and potential demonstrations on other CSP applications for Namibia would be beneficial, such as desalination applications which could help address water challenges faced by the country.

Renewable Fuels

The availability of abundant feedstocks allows Namibia to investigate and grow the use of renewable liquid fuels such as ethanol and biodiesel. In terms of ligno-cellulosic biomass potential, Namibia may have as much as 25 terawatt / hectare, while the potential for cellulosic biomass is 1.5 terawatt / hectare. Produced correctly, advanced, second and third-generation biofuels result in net-zero carbon emissions.

Growing vehicle numbers in Namibia and growing passenger-miles (or kilometres) driven have led to Namibia importing ever greater quantities of liquid transportation fuels (petroleum and diesel). Domestic production of biodiesel for transportation would therefore provide the added benefit of reducing Namibia's imports and reducing foreign exchange outflows.

Amongst the various options Namibia has explored and could further develop are Jatropha biofuel (although Jatropha has failed to live up to expectations and oil yields have been underwhelming), castor and soy based biodiesel, algae-based biofuel (which is presently cost-prohibitive but could be researched for cost-reductions in the future), and dry biomass based biofuel. Given the prevalence of invader bush in Namibia, the last of these may be the most promising option (with one source estimating yields of 190 liters of yield from one ton of dry biomass).[xvi]

Blackthorn has also been shown to be a viable biofuel source in Namibia, providing thermal energy in the form of wood chips for cement manufacturers (such as Ohorongo Cement).

Biofuel production would bring co-benefits of job creation in rural areas, contributing to rural development, income diversification, and skills-building in rural settings. However, the production of biofuels often comes with challenges, ranging from impacts on soil and water, trade-offs with food security, impacts on biodiversity, management costs etc. Thus this type of renewable fuel development is often suited to experimental, pilot projects before scale-up and commercialization. As such, biofuel development would be a good candidate for R&D and field trials in the proposed Renewable Energy Development Zones (REDZ).

The development of the biofuel industry is often impossible without proactive government support in the form of subsidies, fixed tariffs, seed funding, financial incentives (like tax breaks or rebates) etc. Simultaneously, the government must create safeguards to ensure sustainable land use and to curb potential negative impacts from biofuel production. The complexity of managing and growing a renewable fuel industry calls, in fact, for a dedicated biofuels policy, based on an in-depth understanding of Namibia's own experience with biofuels.

Policy Statement

The Government should initiate biofuel R&D programs and invest in comprehensive studies of the costs and benefits of biofuels, as well as the needs of a growing biofuel industry. Based on insights gleaned from research and pilot projects, the government should formulate and adopt a National Biofuels Policy by 2025 with incentives and safeguards for renewable biofuels, and with special focus on job-creation through biofuels development.

Capacity Building and Skills Development

Growth of the renewable energy sector in Namibia is a valuable economic opportunity that should translate into skills-development and job creation for Namibians. In particular, off-grid technologies offer significant scope for training of personnel and capacity building. Significant new value-chains can be created in the RE sector, with training and job opportunities in each level of such value chains. Namibia already has provisions for the creation of renewable energy shops, which allow for certain small-scale energy equipment to be retailed in rural areas. However, these shops largely serve the function of storing inventory produced elsewhere and making occasional sales. There is potential to expand the role of renewable energy shops and to create renewable energy value chains in rural areas, based on renewable energy technologies.

One potential solution the government should consider involves training corps of young Namibians in the manufacturing, installation, operations and maintenance of renewable technologies, and deploying these networks in rural areas so that these technicians can participate in the entire life cycle of renewable energy. For instance, some can engage in small-scale manufacturing of components that can be locally produced (including at renewable energy parks); some can be involved in a transportation and distribution network from the manufacturing unit to renewable energy shops or farther from the shops to villages; some can be installation technicians; others can work on repairs, upgrades, and maintenance.

The government should provide the necessary training and certification, as well as continuing education and a chance up update skills periodically with improvements in technology. This can be done both through degree programs at universities, through vocational colleges, or other technical institutions across the country. In this manner, not only will the government create capacity and generate jobs, it will also increase the operational lifetimes of renewable energy applications, so that minor problems in the installation or the lack of a spare part for prolonged periods does not lead to breakdowns or a lack of confidence in renewable energy technologies.

Policy Statement
The RE Policy calls on the government to invest in a comprehensive renewable energy technology training programme focused on imparting technical vocational skills to Namibians, and also developing clean energy focused courses at universities. Such training and certification should be designed to also create post-completion job opportunities and to develop skilled personnel who can support off-grid renewable energy manufacture, sale, deployment, operation, and after-sale services both in Namibia and the region.

Land Procurement Best Practices

One of the major barriers faced by IPPs and renewable energy project developers is the challenge of acquiring or leasing land for new projects. Under Namibian law, land rights are vested in three distinct categories of owners: private land owners, the state (predominantly conservation areas), and communities. Within this land rights regime, those wishing to secure leases for renewable energy projects have to deal with a multiplicity of actors based on the location they prefer, and the process to obtain land can be laborious, unpredictable, and susceptible to change. There is no standardized approach for securing land for renewable energy projects. In particular, securing community-owned land is exceptionally onerous and lengthy, often taking years. Acquiring rights to develop renewable energy projects on agricultural land has also proven to be extremely cumbersome in many cases.

A useful approach to ameliorate such barriers exists in Namibia's tourism industry. In collaboration with non governmental organizations and industry associations, the Government of Namibia has begun exploring the creation of somewhat standardized models for land negotiations between tourism facility developers and traditional authorities that govern community lands. These models include negotiations based on adequate benefit-sharing between the private developer and the local community, job-creation for the local community, and a recognition that the establishment of the tourist facility typically adds value to the land.

The renewable energy sector would benefit from similar approaches that simplify, standardize, expedite, and clarify the process for acquiring leases on community lands. This should be treated as a high priority by the Government of Namibia.

Another challenge related to land is the existing land use regime. Land use plans and regulations prescribing land use provide very specific categories of land use in Namibia. When land is classified under or earmarked for one type of land use, conversion to another land use is extremely challenging and faces many regulatory hurdles. Given the sheer potential of renewable energy in Namibia and the role that land can plan in enabling Namibia to become a leader in renewable energy, it is advisable that Namibia revise its current land use regime to include clean energy as a specific type of land use, allowing easier conversion and reducing constraints on renewable energy activities. The Ministry of Land Reform should play a key role in modifying the existing land use regulations and policy frameworks.

Policy Statement

The RE policy supports the creation of standardized procedures for land acquisition on all categories of land, for RE activities, to facilitate the development of RE projects at appropriate sites by project developers. Standardized models with clear and predictable requirements should be developed by 2018 in consultation with different land owner categories and should ensure adequate benefit-sharing, but should also enable accelerated timelines for land access.

Financing Barriers and Solutions for Renewable Energy in Namibia

The most significant barrier standing in the way of robust development of the renewable energy sector in Namibia is inadequate finance, in terms of both limited availability and the high cost of credit. While the sector is replete with potential projects that are technically viable, the financial feasibility of many projects falters in the face of high due diligence and project preparation requirements demanded by the small number of commercial banking institutions that lend to renewable energy projects in Namibia. Because financial institutions adopt a project finance approach to renewable energy projects, it is the cost of such project development that often makes projects unviable for developers. Thus, new and innovative arrangements and support for project preparation are necessary, including the creation of new financial products and lending streams that can modify the due diligence requirements based on prior experience or a firm's credibility.

Another equally important barrier for financing in Namibia is exchange rate fluctuations. Because the Namibian Dollar is pegged to the South African Rand, the precipitous devaluation of the rand against the dollar, pound, and euro (due to a slowing South African economy) has also brought down the value of the Namibian Dollar in recent months. Since electricity tariffs are set in Namibian Dollars, while capital costs are often in foreign currency, the change in the value of the Namibian Dollar has led to several projects becoming significantly more costly simply due to exchange rate variation. The challenge is amplified when credit for the project is derived from foreign sources, making repayment rates even more expensive. It is imperative, therefore, for the Government of Namibia to investigate and implement ways to protect or insulate the renewable energy industry in some manner from currency devaluation. One method of doing this is to negotiate adjustable tariffs contingent on inflation (e.g. consumer price index).

The high cost of credit from domestic lenders is not a uniquely Namibian problem, but is nevertheless a challenge for IPPs. In renewable energy markets the world over several measures have been adopted to reduce the risk to financial institutions or lenders, such as risk guarantee funds, revolving funds and similar mechanisms. Namibia should make it a priority to develop mechanisms that allow lenders to reduce interest rates due to lower risk levels.

New and additional sources of finance should be actively sought by the Namibian Government. For instance, it should draw on international climate finance, including from the Climate Investment Funds (CIF), the Energy Facility, and Green Climate Fund (GCF), exploring ways to support the private sector in Namibia benefit from such climate finance. This would include assisting private developers with the legal and regulatory requirements of climate funding, reducing their transaction and administrative costs.

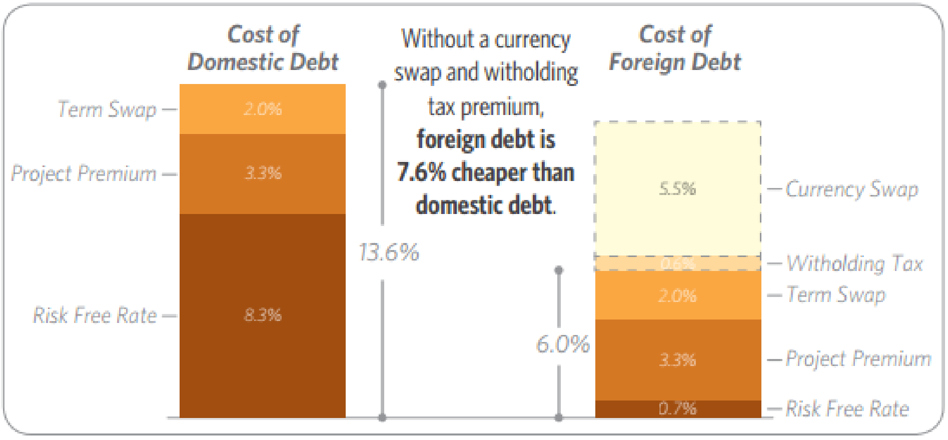
The Government should also redouble efforts to secure multilateral funding and development assistance for publicly funded renewable energy projects. New opportunities in Africa are likely to emerge through AfDB's Clean Energy Investment Framework for Africa, the African Renewable Energy Fund, the Sustainable Energy Fund for Africa, SACREE and similar regional collectives.

Across developing countries and emerging markets, new and innovative financial mechanisms are being used to support the growth of renewable energy. Many of these do require public finance, which Namibia should consider.

Options include the setting up of a dedicated renewable energy financing institution, focused on better attracting and structuring finance for clean energy (such as the Indian Renewable Energy Development Agency); crowd-sourced financing (such as the Solar Mosaic model in California); issuing Green Bonds (exemplified in Costa Rice, and championed in particular through World Bank programs); the setting of preferential interest rates for RE projects (as has been done by the Central Bank in Japan) or interest rates guided by Environmental and Social Governance (ESG) criteria; and one-stop-shop financing and facilitation through entities like the World Bank's "Scaling Solar" initiative.

There are also a range of options to reduce risks from currency fluctuation. Currency Exchange Funds (such as one pioneered by the Dutch Ministry of Foreign Affairs, along with the African Development Bank and the European Bank for Reconstruction and Development) allow investors putting money into developing markets to hedge local currency risk with the help of swap products. PPAs themselves could be structured with built in currency exchange protection on tariff payments (as is happening in Ghana). Yet another option is a government-sponsored foreign exchange hedging facility. India is exploring this model, where a 10-year currency hedge, provided by the Government through the facility, would cost 16% of the current capital cost of a solar plant. Under its model such a hedge would reduce the developer's debt costs by 7%, the cost of renewable energy by 19%, and the cost of government support by 54%.[xvii]

Figure 7: Impact of a Currency Hedge on the Cost of Foreign Debt



Source: (Climate Policy Initiative, 2015)

The role of public finance in the renewables sector is key for several reasons. It allows for the minimization of risks, and to maximize the leveraging of private finance (through vehicles such as Public Private Partnerships). Public finance can also help create a level playing field for renewables, to make them competitive against fossil fuels – which have received various forms of government subsidies and support for multiple decades. If the perception of risk in renewables can be lowered to some degree by public finance, it also helps to accelerate private lending and equity, including lower credit rates. Lower finance costs have been show to lead to more affordable energy.

In addition, the Namibian Government should explore methods to generate funding for renewable energy projects through new revenue streams. Some options to be explored include a financial transactions tax to be channelled into clean energy, or a carbon tax to be channelled into clean energy.

Financing needs are different for grid-connected and off-grid technologies. In recognition of this, the Namibian Government should adopt a differentiated approach to improving finance for each of these sectors. It is likely that grid-connected technologies can be scaled up through private investment and finance, therefore making off-grid applications – particularly in rural areas -- a priority for public support and finance through dedicated credit lines (including, potentially, collectively owned community RE assets). Thus, targeted public funding should be used to fill such finance gaps, especially for small-scale, rural renewable energy projects.

Namibia is already taking steps towards affordable financing for renewables. The Environmental Investment Fund of Namibia has been set up to provide grants, green soft loans, green concessional loans and bursaries. It recently received accreditation from the Green Climate Fund (GCF).[xviii] Other entities such as the Namibia Investment Centre and the SME Bank can also support the growth of RE in Namibia.

Policy Statement

The Government should identify and capacitate a dedicated department within the Ministry of Finance or the Ministry of Industrialization, Trade, and SME Development, whose mandate would exclusively be to increase the diversity and scale of financing options for public and private renewable energy projects in Namibia.

This entity would, on an ongoing basis, evaluate financing options, models, and structures that would meet Namibia's specific needs, and – as a project preparation facility -- would provide guidance and advisory support to developers and financial institutions to enable lower cost financing, reduce risk from currency fluctuations, help streamline project preparation obligations for project finance lenders, and address other financial barriers to renewable energy in Namibia as they may emerge.

This entity should also help coordinate existing efforts by Government and local stakeholders to leverage international climate financing for renewable energy and efficiency projects, without building a dependency on such funding. The entity should be fully set up and capacitated by the end of 2017.

Potential Financial Incentives and Tax Breaks

In the electricity sector, translating renewable energy targets into specific policy instruments can include a wide range of different policy mechanisms. The selection of particular policies and measures can help focus regulatory and monitoring resources more efficiently.
To promote renewable energies, countries have over the years developed a range of different policies. The most common implemented policies include:

- Rebates: to promote the installation of renewable energy systems and energy efficiency measures.
- Grants: to decrease the cost of eligible systems or equipment, research and development, and project commercialization.
- Production incentives: to reward performance. Cash payments are given based on the number of kilowatt-hours (kWh) generated by a renewable energy system.
- Industry support: Financial incentives to recruit or cultivate the manufacturing and development of renewable energy systems and equipment.
- Corporate tax credit: credit for the purchase and installation of green energy technology.
- Personal tax credit: tax credits on multiple years for the purchase of renewable energy systems for personal use.
- Sales tax: exemption from the state sales tax for the purchase of a renewable energy system.
- Property tax: exemptions, exclusions and abatements for renewable energy equipment on property.

Tariff-based support schemes such as Feed-in tariffs (FiT) and Feed-in premiums (FiP) have been widely used in the past, and have proven to be effective in promoting and stimulating growth in renewable energies. Tariff-based support mechanisms are price-driven policy instruments, where the price is set (or partially set) by the responsible regulatory body, and the quantity of renewable energy electricity is determined by the market actors. The price is usually guaranteed over a certain time period. The tariff rates are usually determined for each renewable technology, enabling account to be taken of the technology-specific generation costs, and to ensure profitability. FiT have the advantage to guarantee access to the grid, favorable rates per unit and guarantee the tariff term.

Over the recent years, however, auction/public tendering schemes (also tariff-based) have become increasingly popular as a policy tool to promote renewables, given their potential to achieve deployment of renewable energies in a cost-efficient and regulated manner. The regulatory body usually sets the quantities (and often other selection criteria), and the tariff is defined by competitive bidding from the project developers. When well-designed, the price competition inherent to the auction scheme increases cost efficiency and allows price discovery of renewable energy-based electricity, avoiding potential windfall profits and underpayments that can occur in FiT or FiP schemes.

The process of renewable energy auctions (also known as “demand auctions” or “procurement auctions”) is usually as follows: the government issues a call for tenders to install a certain capacity of renewable energy-based electricity, with defined requirements imposed for project developers to participate in the bid (e.g. proof of financial capability, secured land, licenses, etc.). Project developers who participate in the auction submit a bid with a price per unit of electricity at which they are able to realise the project. The government then evaluates the offers on the basis of the price and other criteria and signs a power purchasing agreement with the successful bidder. The contract provides the renewable generators with a fixed price for a certain number of years and a guaranteed purchase for all generation, which can be used as a basis for financing the project.

Different types of auctions exist: the sealed-bid auction, where project developers submit their bids with an undisclosed offer of the price at which the electricity would be sold under a power purchase agreement; the multi-round descending-clock auction, where the auctioneer offers a price, and the developer bids with an offer of the quantity it would be willing to provide at that price; and hybrid auction, where a combination of the two above is used in the different phases. Important for all of these is to limit the award decision in time to be operational.
Auctions have the following non-negligible advantage:

- Limited risks for investors: project developers are assured a market for the electricity they produce over a defined period of time
- Cost efficiency: the competitive bidding situation puts downwards pressure on prices. With the FIT or FIP, overpayment is a concern.
- Volume and budget control: capacity is capped, and with the use of ceiling prices, budget is controlled.
- RE-electricity supply more predictable: deployment volumes are controlled and policy makers can predict future supply trends.

While auctions have become very attractive, they only benefit successful bidders and tend to favour large –scale established developers that are able to afford the associated administrative and transaction costs. There is a risk of underbidding since bidders are incentivized to bid as low as possible to increase their chances of securing a contract, but might not be able to honor their contract afterwards. Moreover, the risk of a "stop-and-go pattern" of deployment is real if auctions schemes are not linked to a fixed schedule.

Auctions to be successful should be designed with stringent bidding requirements (financial, environmental, grid connection, etc.) and strong compliance rules (penalties, bid bonds, project completion guarantees, etc.) that reduce the risk of underbidding, project delays and project failure.
Namibia currently differentiates renewable energy regulations based on system size as follows:

- Net metering rules for installations ≤500 kW for all renewable energy technologies (not to exceed the main electricity supply circuit breaker current rating)
- A renewable energy feed-in tariff (REFiT) for projects >500kW and ≤ 5 MW including biomass, concentrating solar power, solar PV, and wind.
- A competitive auction approach for projects >5MW

This differentiation of regulations and procurement based on system size, helps to target different sectors and encourage wider adoption of renewable energy. However, Namibia is still facing some challenges with its approach to date including:

- Limited participation by some distribution utilities in net metering to date
- Challenge with accurately setting REFiT amounts that are competitive, bankable, reduce risk of exchange rate fluctuations, and account for technology advancements
- Lack of clear and efficient land procurement and access rules for projects

- The need to stick to best practices when competitively procuring capacity

Fortunately, these challenges provide lessons to learn from when improving on future renewable energy programs and harmonizing efforts by Government. The IPP Policy will also provide more detail on future rules and procurement guidelines for both renewable energy and other resource options.

It is recommended that Namibia follows South Africa and other countries' shift towards an auction-based system for renewable projects > 10 MW to support the development of renewable energy in the country. To begin with, it is advised to implement a sealed-bid type of auction, which is easy to implement, simple, and fosters competition, avoiding collusion. As advised by the IRENA study (2013)[1] and experienced in South Africa, **ceiling prices** should not be disclosed to the bidders in order to ensure greater competition. The undisclosed ceiling price can be determined based on previous policies of the country (e.g. FiT levels). **Auction volumes** should be limited, and determined in relation to the capacity of the market to deliver. They can be technology-specific or technology-neutral. Technology-specific auctions enable the diversification of the energy mix and reduce technology risks. Site-specific auctions moreover reduce the risk of non-compliance by freeing the investors from the liability of securing land, obtaining environmental permits, etc. but it requires additional government resources. Determining the optimal **number of rounds** and volumes is a challenge that requires learning by doing, but should be based on the country's energy plan and the size and maturity of its actual RE market. Streamlined **administrative procedures**, with **communication** and **transparency** are essential and should be provided to all bidders. Similarly, strong **guarantees** and **penalties** are essential to the success of auction schemes to prevent potential underbidding and minimizing the risk of project delays and completion failure.

For RE projects < 5MW, it is recommended to use the Renewable Energy feed-in tariff (REFiT) already in place. The viability of the projects depends on enforceable off-taker agreements with NamPower who controls the distribution channels.

All RE systems less than 500 kW, will be regulated by the net metering rules.

[1] IRENA, 2013, "Renewable Energy Auctions in Developing Countries"

Quantifying Renewable Energy Targets and Emissions Benefits

Note to the reader: The outcome of energy modelling that informs the quantitative target for this policy is that a **70% renewable energy target for Namibia's power generation in 2030 is indeed technologically feasible**. The specific mix of RE sources and technologies in the 70% may change over time based on changing economics in the power sector, but a 70% target is nevertheless well within Namibia's reach in the 2030 timeframe. The remainder of this section provides a detailed discussion on how the target was quantified, by way of background. It is expected that in the final draft of this policy, the analysis that follows in the next several pages will be placed in an Annex to the policy, rather than in the main body.

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For the purpose of this study, 3E has developed an accounting model of the Namibian electricity sector (presented in this Chapter) coupled with an investment analysis model (presented in the next Chapter). The combination of the accounting model for the electricity sector and the investment analysis model enables absolute estimates for the total energy consumption, the related costs, the required investments and subsidies, etc. In addition, this leads to important insights from the relative comparison of the scenarios, showing the impact of possible policy choices in terms of costs and benefits, RE targets, etc. For details on the methodology used and the functioning of the model, please refer to Annexure A. A user guide is also provided together with the accounting model to enable the client to update/modify the scenarios.

The accounting model presented in this Chapter includes some important checks to make sure that the outcomes make sense. The two most obvious examples are in what extent the energy system is able to meet the peak demand and the annual energy demand (also taking into account the comparison between the required electricity imports and the available interconnection capacity at transmission level).

The analysis is not meant to be prescriptive on what technology path Namibia should ultimately take, but rather informs the viability of a 70% renewable energy target by 2030 for the country from an economic and technology perspective. Based on the analysis conducted, a 70% renewable energy target for Namibia is a viable option for Namibia.

Scenarios for Renewable Energy Development in Namibia

i. Scenarios

Four main scenarios have been developed: the **Reference scenario**, a **Pro-Wind/Solar Scenario with Kudu**, a **Pro-Hydro Scenario without Kudu** and a **70%RE in 2030 Scenario**.

1. The Reference scenario

The Reference scenario takes into consideration the actual installed capacities and the several known committed capacities. This scenario is not intended to predict the most probable or best evolution of the energy system, but serves as a reference to evaluate different options for the future.
The installed capacities assumed in this scenario are shown in Table 4. The full load hour assumptions used for this study have been based on the capacity factors used in the NIRP.

Table 4: Installed capacities in the Reference scenario

	Reference Scenario		
Electricity Demand scenario	**2015**	**2020**	**2030**
Gross Final Consumption (GWh)	4,829	5,557	7,361
Peak demand (MW)	597	659	803
Capacity scenario	**2015**	**2020**	**2030**
Nuclear (MW)	0	0	0
Coal CFB (MW)	120	120	168
Peak Units (MW)	0	0	0
Natural Gas - CCGT (MW)	0	0	452
LNG - CCGT (MW)	0	0	0
LNG - GT (MW)	0	0	0
LFO - CCGT (MW)	46	22	22
LFO - GT (MW)	0	0	0
HFO - MSD (MW)	0	0	0
Biomass (MW)	0	0	40
Wind - onshore (MW)	0	49	49
Solar PV (MW)	0	137	137
CSP - 12h storage (MW)	0	54	54
Hydro (MW)	332	347	653
Geothermal (MW)	0	0	0
Import (MW)	740	730	600
Demand Flexibility (MW)	0	26	32

The following details are worth mentioning about the Reference scenario:

- It is assumed that the gross final consumption increases yearly by 2.85%. Similarly, the peak demand is assumed to increase yearly by 2%.
- The van Eck coal plant (120MW) is expected to be retired in 2025. However, and additional 168MW will be added in 2021 (**Erongo**).
- Peak plants are assumed to be inexistent
- The **Kudu** natural gas CCGT plant (452 MW) is expected to be operational in 2021. No other gas plant will be added in this scenario.
- As far as diesel power plants are concerned, the Paratus LFO CCGT plant is expected to phase-out by 2018, and **no other diesel** power plant is added in this scenario.
- 40MW of additional biomass will be integrated in the system in 2020.
- A 44MW onshore wind plant is planned to be operational in 2020, and 5MW are to be installed as part of the REFIT programme by 2020.

- 9.5MW of solar capacity was installed in 2016. To this, an additional 20MW should be operational in 2018 (GreeNam solar), 37MW in 2020 (NP Solar Tender), and 70MW by 2020 through the REFIT programme
- A CSP plant with 12 hours storage capacity of 54MW is planned to be operational 2020.
- As far as hydro power is concerned, Namibia benefits from the 347MW installed since 2016 (Ruacana). An additional 300MW will be added in 2025 (Baynes) in this scenario. Please note that additional hydro power does not come without climate change risks, which have to be taken into account.
- With very high imports, the installed import capacity in 2015 was of 740MW (ESKOM supplemental, ESKOM off Peak Bilateral, ZESCO Zambia, ZPC Zimbabwe, Aggreko Mozambique). In 2016, and additional 50MW have been installed from ZPC Zambia. Other committed imports lines are: Lunsemfwa Zambia 50MW in 2017, Mozambique 100MW in 2017, and Botswana 200MW in 2017.
- It is to be noted finally that demand flexibility has been considered to. The flexibility available in the Belgian power system today has been estimated to be roughly 4% of peak power in Belgium, based on a survey by Febeliec, Elia and Energyville[2]. It has therefore been assumed for the Reference scenario and the following ones that demand flexibility will increase gradually from 0% to reach and stabilise at 4% of the peak demand in 2020. This percentage could however be modified in order to take into account additional improvements in demand side management, energy efficiency, etc.

2. The Pro-Wind/Solar Scenario – With Kudu

In the Pro-Wind/Solar Scenario – With Kudu, the installed capacities assumed are shown in Table 5. The gross final consumption scenario, peak demand scenario, full load hours scenarios and price scenarios are kept exactly the same as in the reference scenario.

[2] Febeliec, Elia & EnergyVille, Summary Results Demand Response Survey, 2013, Available online http://www.febeliec.be/data/1385111565Elia%20Febeliex%20EnergyVille%20Demand%20Response%20Survey%20results%20-%20public%20version.pdf

Table 5: Installed capacities in the Pro-Wind/Solar Scenario – With Kudu

Pro-Wind/Solar Scenario - With Kudu			
Electricity Demand scenario	**2015**	**2020**	**2030**
Gross Final Consumption (GWh)	4,829	5,557	7,361
Peak demand (MW)	597	659	803
Capacity scenario	**2015**	**2020**	**2030**
Nuclear (MW)	0	0	0
Coal CFB (MW)	120	120	0
Peak Units (MW)	0	0	0
Natural Gas - CCGT (MW)	0	0	452
LNG - CCGT (MW)	0	0	0
LNG - GT (MW)	0	0	0
LFO - CCGT (MW)	46	22	22
LFO - GT (MW)	0	0	0
HFO - MSD (MW)	0	0	0
Biomass (MW)	0	0	0
Wind - onshore (MW)	0	114	400
Solar PV (MW)	0	178	600
CSP - 12h storage (MW)	0	54	54
Hydro (MW)	332	347	347
Geothermal (MW)	0	0	0
Import (MW)	740	730	600
Demand Flexibility (MW)	0	26	32

Compared to the Reference Scenario, this scenario has the following specificities:

- No additional coal is expected after the Van Eck plant phases-out in 2025.
- Apart from the Kudu natural gas plant, no other gas plant will be installed.
- The Paratus diesel plant will be phasing-out in 2021.
- As far as biomass is concerned, no additional biomass will be installed.
- Wind will increase linearly to reach 400MW by 2030.
- Solar PV will increase linearly to reach a 600MW by 2030. A 54MW CSP plant with a 12 hours storage possibility will be included in this scenario.
- No additional hydro will be added to the installed capacity of 2016.

Please note that the solar PV and wind combination is a positive and efficient one, since their load profiles compensate each other and enable a certain base load. The wind load profile is particularly interesting since wind tends to blow on the Namibian coast especially during the morning and evening peaks.

3. The Pro-Hydro Scenario – No Kudu

The Pro-Hydro Scenario – No Kudu is similar to the Reference, but without investing in the 442MW Kudu natural gas plant, replacing it by an additional 300MW Hydro in 2025 (Baynes), an additional 100MW Hydro in 2025 (Orange river), and an additional 20MW Hydro in 2026 (Okavango river). Furthermore, a CCGT plants using liquefied natural gas of 156MW will be operational in 2021, and two GT plants using liquefied natural gas are expected to be operational in 2019 (51MW) and in 2020 (102MW).

The installed capacities assumed in this scenario are shown in Table 6. The gross final consumption scenario, peak demand, full load hour scenarios and price scenarios are kept exactly the same as in the reference scenario.

Table 6: Installed capacities in the Pro-Hydro Scenario -No Kudu

	Pro-Hydro Scenario - No Kudu		
Electricity Demand scenario	**2015**	**2020**	**2030**
Gross Final Consumption (GWh)	4,829	5,557	7,361
Peak demand (MW)	597	659	803
Capacity scenario	**2015**	**2020**	**2030**
Nuclear (MW)	0	0	0
Coal CFB (MW)	120	120	168
Peak Units (MW)	0	0	0
Natural Gas - CCGT (MW)	0	0	0
LNG - CCGT (MW)	0	0	156
LNG - GT (MW)	0	153	153
LFO - CCGT (MW)	46	22	22
LFO - GT (MW)	0	0	0
HFO - MSD (MW)	0	0	0
Biomass (MW)	0	0	40
Wind - onshore (MW)	0	49	49
Solar PV (MW)	0	137	137
CSP - 12h storage (MW)	0	54	54
Hydro (MW)	332	347	775
Geothermal (MW)	0	0	0
Import (MW)	740	730	600
Demand Flexibility (MW)	0	26	32

4. 70% RE in 2030 Scenario

In the 70% RE in 2030 Scenario, investments in conventional power plants are minimised, whereas wind and solar power is maximised. The installed capacities assumed in this scenario are shown in Table 3.

The installed capacities assumed in this scenario are shown in Table 7. The gross final consumption scenario, peak demand, full load hours scenarios and price scenarios are kept exactly the same as in the reference scenario.

Table 7: Installed capacities in the 70% RE in 2030 Scenario

	70% RE in 2030 Scenario		
Electricity Demand scenario	**2015**	**2020**	**2030**
Gross Final Consumption (GWh)	4,829	5,557	7,361
Peak demand (MW)	597	659	803
Capacity scenario	**2015**	**2020**	**2030**
Nuclear (MW)	0	0	0
Coal CFB (MW)	120	120	0
Peak Units (MW)	0	0	0
Natural Gas - CCGT (MW)	0	0	0
LNG - CCGT (MW)	0	0	156
LNG - GT (MW)	0	0	0
LFO - CCGT (MW)	46	22	22
LFO - GT (MW)	0	0	0
HFO - MSD (MW)	0	0	0
Biomass (MW)	0	0	40
Wind - onshore (MW)	0	114	400
Solar PV (MW)	0	178	600
CSP - 12h storage (MW)	0	54	54
Hydro (MW)	332	347	653
Geothermal (MW)	0	0	0
Import (MW)	740	730	600
Demand Flexibility (MW)	0	26	32

Main results of the modelling

The main task of this project was to look at scenarios for Namibia's energy future towards 2030 to set renewable energy targets. As mentioned above, there is enough time between now and 2030 to set targets, reach them and transform the Namibian electricity system. However, in order for this to happen, it is crucial that several important steps and decisions are taken today.

This section explains the main results of modelling for the period up to 2030. It deals with the contribution of renewable energy, gives an indication of the type of installations that will deliver the peak power and energy demand and lists which new installations would be required to make this happen.

i. Renewable Contribution

Figure 8 shows the contribution of renewable energy in the electricity sector for the 4 scenarios.
While the first 3 scenarios see renewable energy targets in the future reaching between 43% and 57% in 2030, the last Scenario outstands in terms of shares of renewable energy in the capacity mix, with nearly 70%.

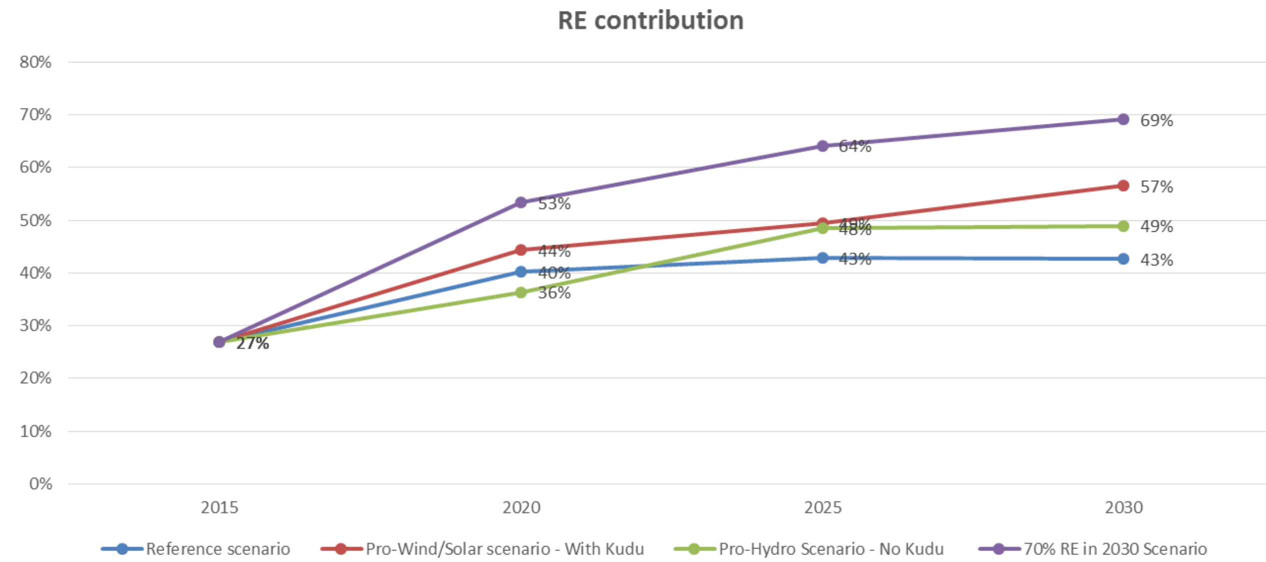

Figure 8: Contribution of renewable energy in the electricity sector for the different scenarios

ii. The electricity system – peak contribution and energy provision

This section looks at how the Namibian electricity system can deliver peak power and fulfil energy demand. An overview of the 70% RE in 2030 scenario is provided in Figure 9 and Figure 10. Since these figures may appear complex, the following paragraphs provide some explanation:

- Figure 9 gives an overview of the installed capacity per technology and compares this to peak demand and the required dispatchable capacity. The objective of this graph is to quickly show whether there is enough capacity to meet peak demand in Namibia.
- The installed capacities of all different technologies have been listed starting with the 'dispatchable capacities': Conventional technologies (i.e. nuclear, coal, diesel CCGT, diesel GT, gas CCGT, gas GT and peak units), biomass and electricity import capacity.
- The variable renewable energy technologies come on top of these.
- The yellow line represents the peak demand (when there would be no additional capacity). It rises steadily and is based on assumptions made in the NIRP study.
- The dark blue line represents the 'residual peak demand' that needs to be met by dispatchable capacity, i.e. the peak demand that is left after:
  - All available flexibility is used
  - The capacity credit[3] of variable renewable energy sources has been subtracted
  - 15% reserve margin has been added
- As long as the dark blue line does not go above the grey area for Imports, the system is assumed to be able to cope with peak demand.

[3] The capacity credit is the amount of firm capacity that can be replaced by variable renewable energy sources. The idea is that no backup capacity is needed for this percentage of the renewable energy capacity when integrated in the grid. The capacity credit decreases with the overall penetration of renewables in the grid. In this project, a low and conservative capacity credit of 5% is taken into account.

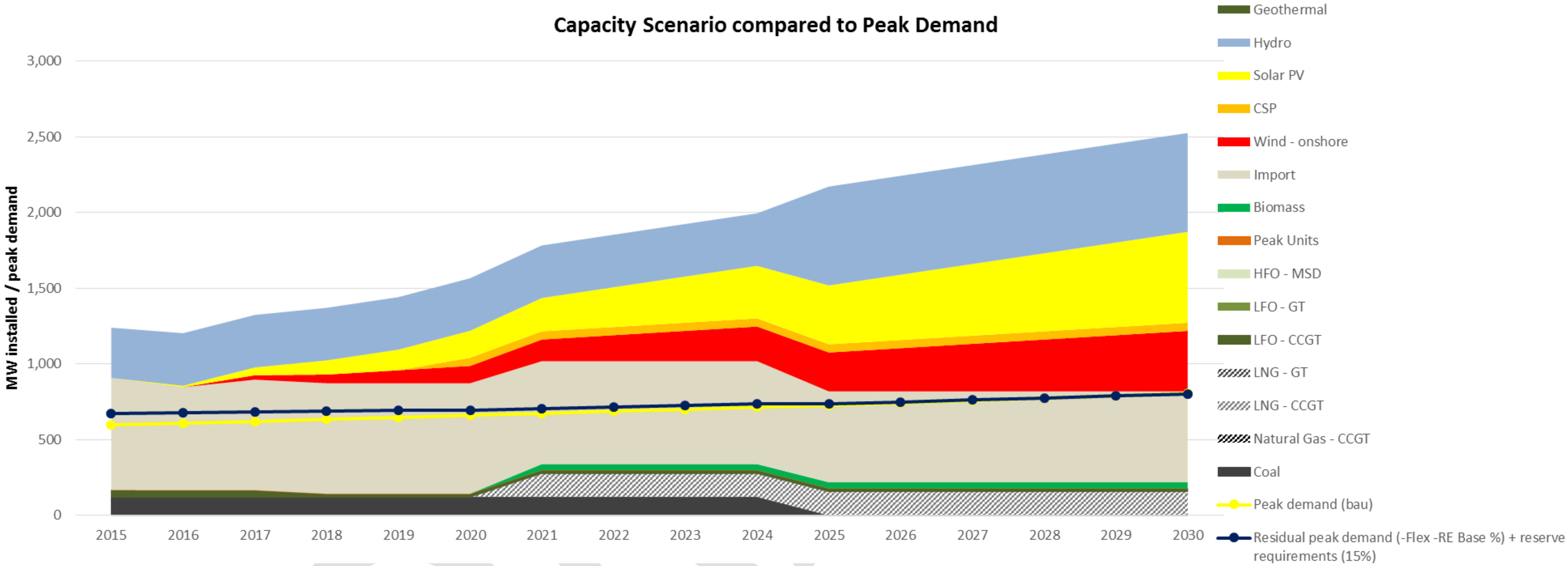

Figure 9: Capacity scenario for the Namibian energy system, compared to peak demand (without flexibility) (yellow line) and required dispatchable capacity (dark blue line). The areas above the grey area for import show the renewable capacity from variable sources. The dark blue line (residual peak demand) should stay below the top of the grey area (import capacity) to avoid issues in the provision of peak demand.

Figure 10 gives an overview of the energy production by each technology, along with a comparison to the annual energy demand. The objective of this graph is to quickly show whether there is enough energy production in order to meet the annual total electricity demand in Namibia.

- The yellow line represents the annual electricity demand.
- The contribution in electricity production of each technology is shown with the coloured areas for the different years up to 2030.
- The difference between the sum of electricity production of all technologies and annual demand is assumed to be covered by electricity import/export. A control formula in the model ensures that the amount of import/export stays within the boundaries of available interconnection capacity.

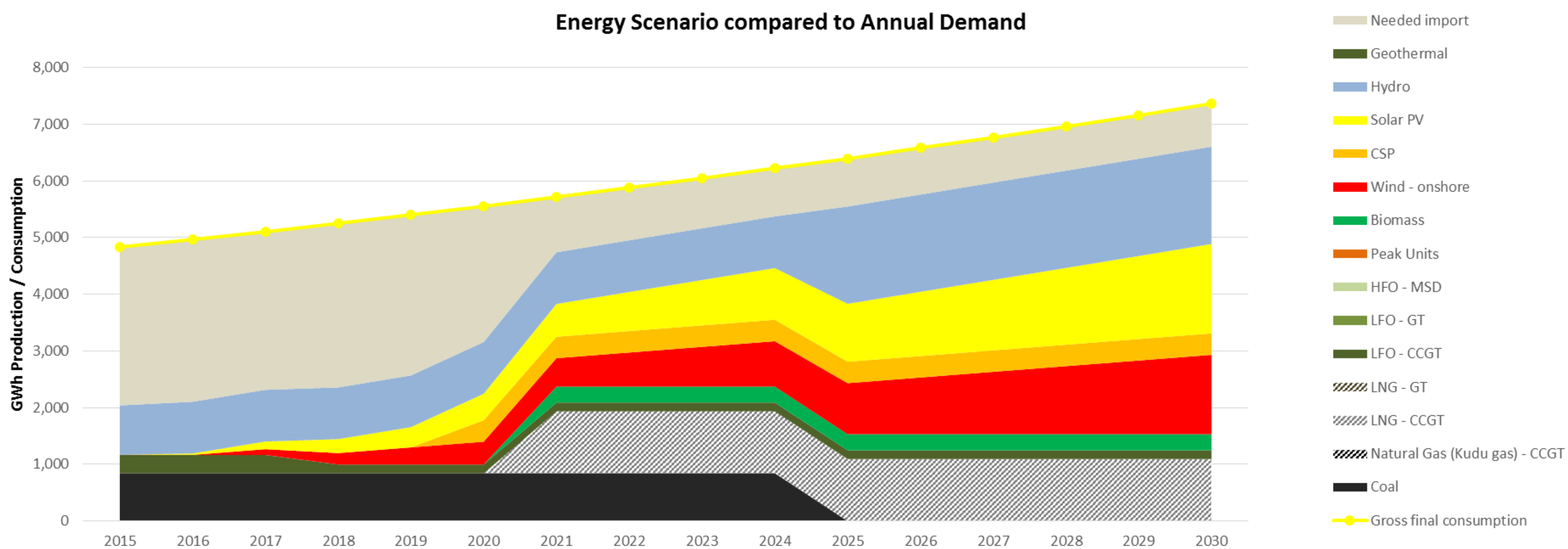

Figure 10: Energy scenario for the Namibian electricity system, compared to total annual demand (yellow line). The grey area just above or below the yellow line is the required import/export of electricity to meet the annual demand.

Both Figure 9 and Figure 10 show that the 70% RE in 2030 scenario meets the criteria of reaching peak demand and delivering annual electricity demand provision. There is enough firm capacity (and flexibility) to meet peak demand even when wind and solar energy production are minimal, and there is enough energy production (and possibility to import if needed) to meet the total electricity demand.

As explained above, peak demand without flexibility continues to rise. Increasing flexibility in demand and increasing interconnection would result in a significant reduction of the required backup capacity.

The figures also show that it is perfectly possible in the 70% RE in 2030 scenario to replace coal and partially diesel energy in Namibia during the period up to 2030. Renewable energy sources are able to add significantly to energy supply, and additional CCGT plants can help when there is too little wind and sun.

The evolution of the capacity mix is shown in Figure 11.

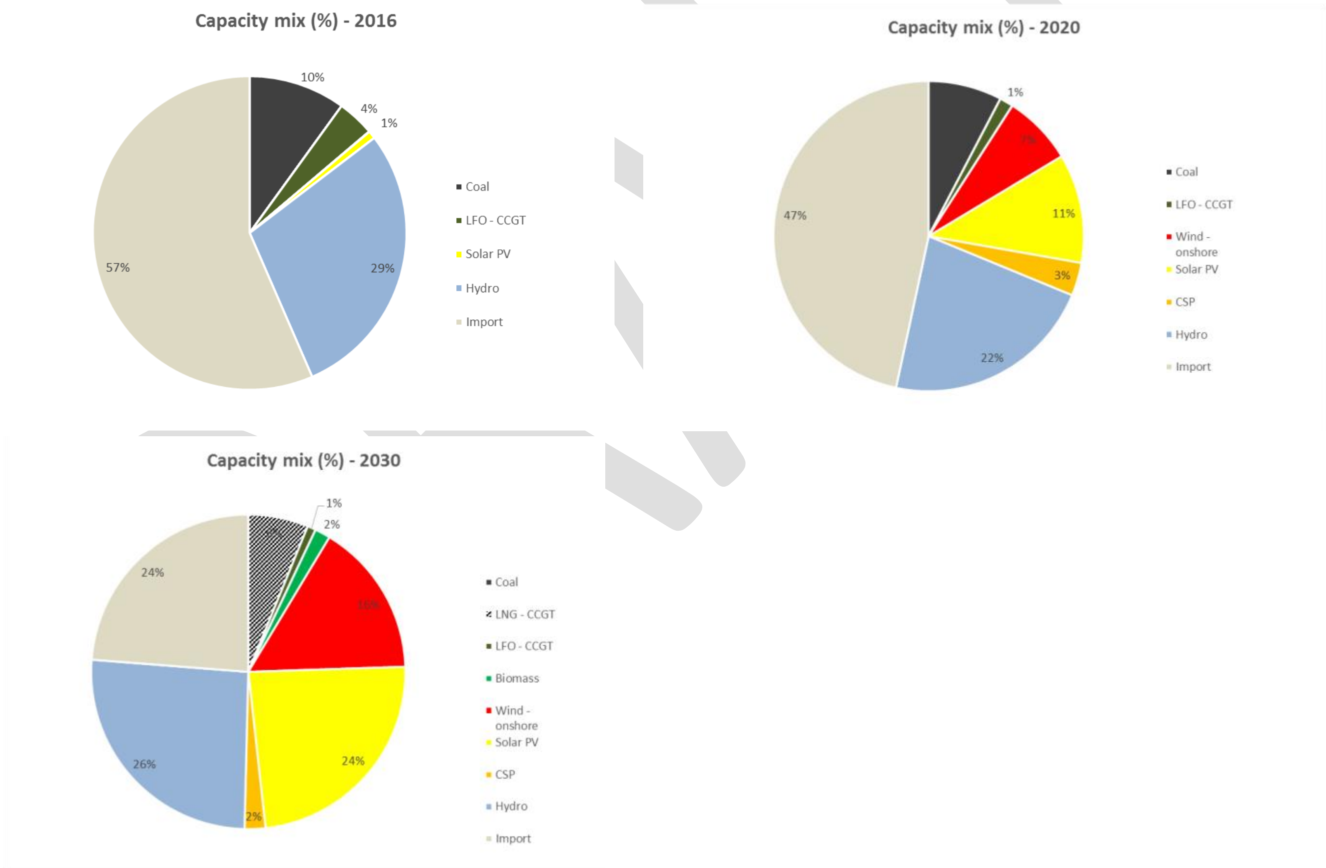

Figure 11: Installed capacity mix in 70% RE in 2030 scenario (% of installed capacity) in 2016, 2020 and 2030

The Energy Scenario compared to the annual demand for the other scenarios is shown in the following figures.

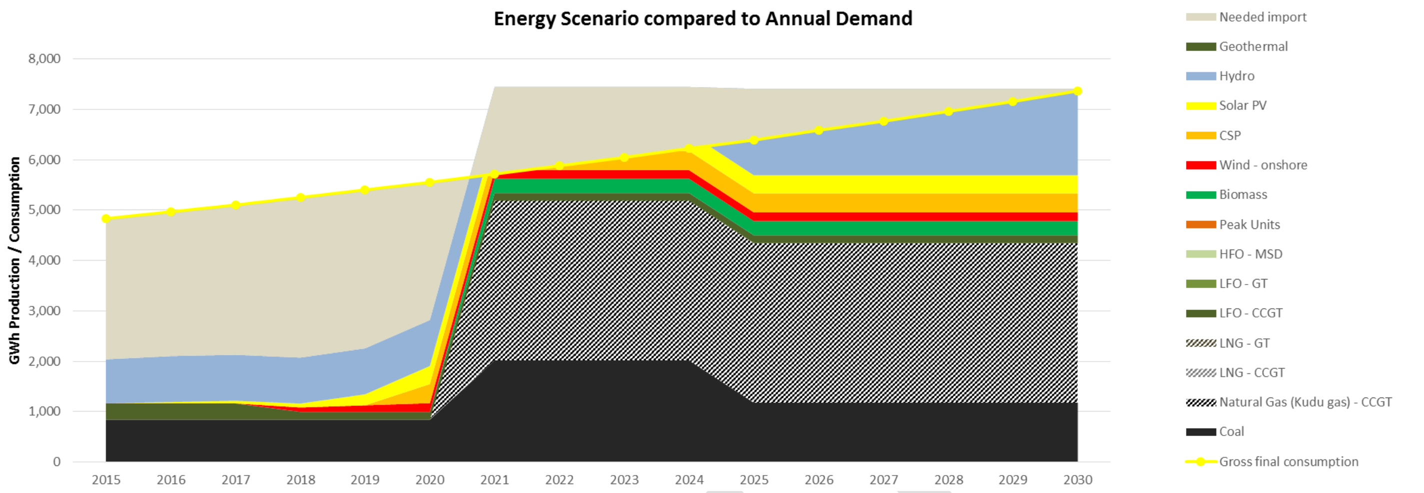

Figure 12: Energy scenario compared to the annual demand in the reference scenario

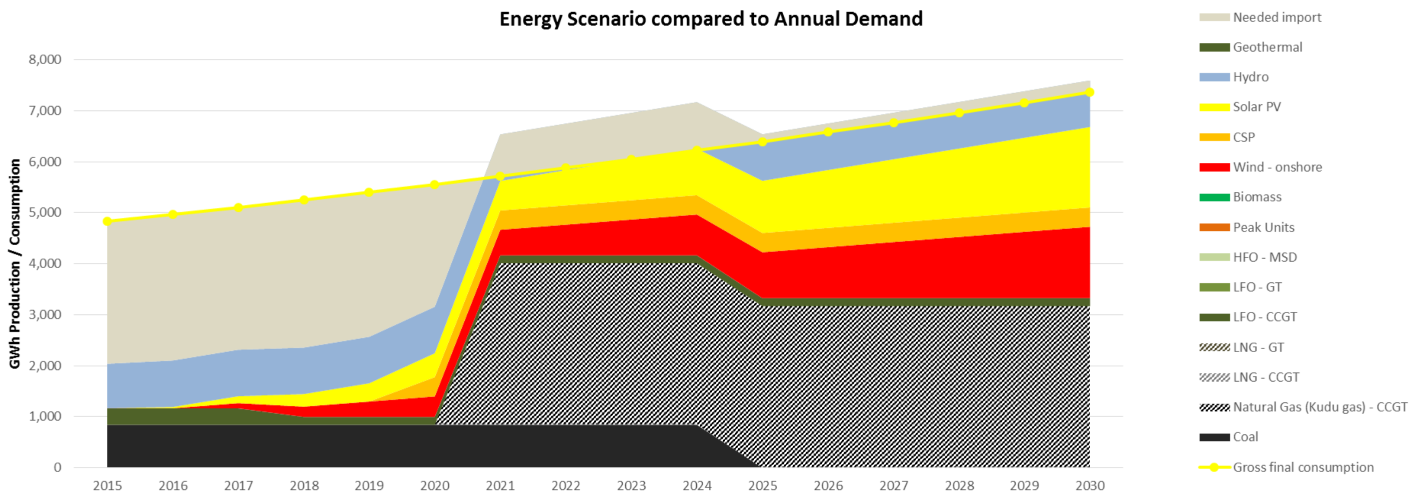

Figure 13: Energy scenario compared to the annual demand in the Pro-Wind/Solar Scenario – with Kudu

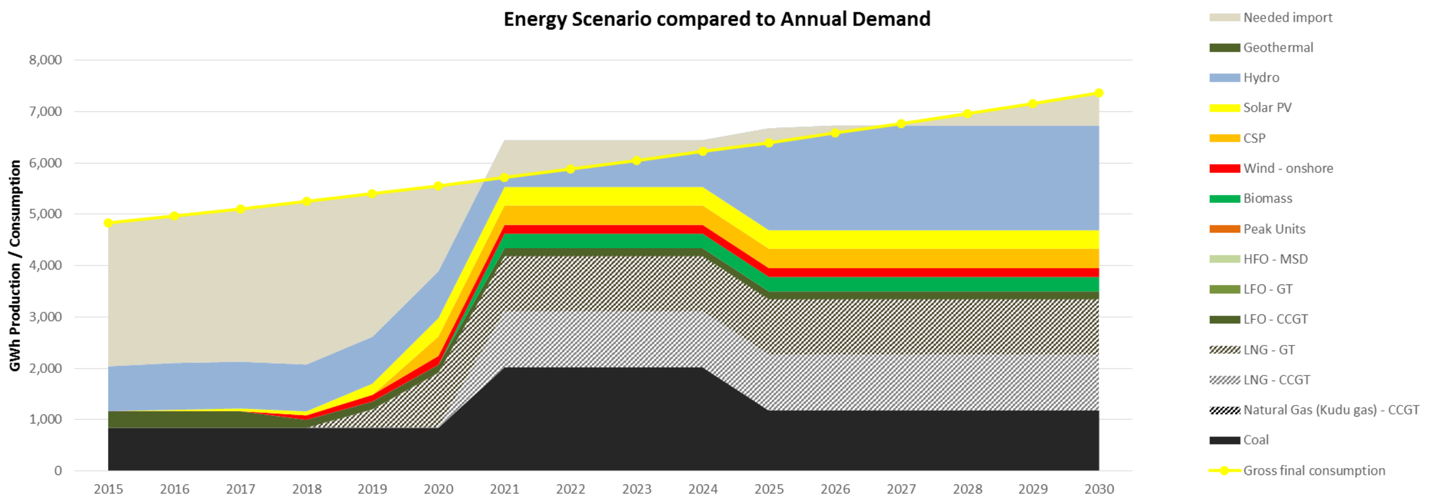

Figure 14: Energy scenario compared to the annual demand in the Pro-Hydro Scenario – No Kudu

Estimates of the Cost of Delivering the Policy

The starting point of 3E's model is the investor's point of view. For each technology - renewable as well as conventional technologies - a business model has been worked out that incorporates a broad spectrum of technical, financial and economic parameters. This enables the model to be flexible in terms of impact assessment and sensitivity analysis of one or more parameters. The investment model has been linked to the electricity accounting model.

One of the important outputs of the 3E model is an estimation of the Levelised Cost of Electricity (LCOE) for the different generating technologies. Combining all these elements together enables policy makers in Namibia to provide estimations of the total investment costs and required operational costs and to assess the impact of different parameters on the required subsidy levels

Important assumptions

iii. Energy price scenarios

The electricity price is a crucial factor for a technology to be profitable or not. In order to be coherent, electricity price scenarios need to be linked in some way to fuel price scenarios since these fuels serve as the input for electricity production.

The fuel price forecasts used in this study have been based on the data provided in the NIRP. For each vector, several price can be analysed in the model in sensitivity analysis if the client wishes to do so.

To make the comparison relevant, the same energy prices have been used for the three scenarios. They are summarized in Table 8. Sensitivity analyses on the prices can be performed to analyse the impact of variations.

Table 8: Summary of energy prices used for the different scenarios

Electricity Price Scenarios	**2015**	**2020**	**2030**	
Electricity (Average)	97.00	133.71	217.79	N$/MWh
Electricity (Av. Fluctuating sources)	97.00	133.71	217.79	N$/MWh
Electricity (Av. Non-fluctuating sources)	97.00	133.71	217.79	N$/MWh

Fuel Price Scenarios	**2015**	**2020**	**2030**	
Natural Gas Price (Kudu gas)	160.00	194.48	316.79	N$/GJ
LNG Price	216.00	350.07	570.22	N$/GJ
LFO Oil Price	288.00	233.38	380.15	N$/GJ
HFO Oil Price	192.00	262.55	427.67	N$/GJ
Biomass Price	53.13	64.58	105.19	N$/GJ
Nuclear disposal	57.62	70.03	114.08	N$/GJ
Coal Price	57.28	69.62	113.41	N$/GJ

Since biomass is a quite diverse term with a broad scale of fuels, only the invader bush price was investigated in this study. The other forms of biomass have not been considered.

Please note that a 5% inflation was used in the modelling.

iv. Investment parameters

In order to compare the scenarios on an equal basis, the investment parameters that have been used are the same for the four different scenarios analysed in this study. They have been defined based on the NIRP data and research done by 3E in previous studies.

The assumptions made in the framework of this study are shown in Table 9 for every technology considered.

Table 9: Assumptions per technology

Gaz:

Generation Technology	CCGT	CCGT	GT	GT
Fuel	Kudu Gas	LNG		
Plant Gross Capacity (MW)	452	156	51	102
Plant Net Capacity (MW)	442	150	50	100
Economic Life (Year)	25	25	20	20
Lead Time (Year)	4	5	3	4
Earliest On-Line Year	2020	2021	2019	2020
Net Heat Rate (KJ/kWh, HHV)	6,968	7,488	9,690	9,384
Primary Fuel Cost (N$/GJ) - 2015	160	216	216	216
Capex Cost (N$M)	24,021	24,106	20,137	19,125
O&M Costs - Fixed (N$/kW -year)	384	408	336	312
O&M Costs - Variable (N$/MWh)	240	240	240	240
WACC (%)	10%	10%	10%	10%

Coal:

Generation Technology	CFB	PC
Fuel	Coal	
Plant Gross Capacity (MW)	168	162
Plant Net Capacity (MW)	150	150
Economic Life (Year)	30	30
Lead Time (Year)	6	6
Earliest On-Line Year	2022	2022
Net Heat Rate (KJ/kWh, HHV)	11,600	11,000
Primary Fuel Cost (N$/GJ) - 2015	216	216
Capex Cost (N$M)	42,018	37,803
O&M Costs - Fixed (N$/kW -year)	816	720
O&M Costs - Variable (N$/MWh)	320	320
WACC (%)	10%	10.0%

Diesel:

Generation Technology	MSD	CCGT	GT	GT
Fuel	HFO	LFO		
Plant Gross Capacity (MW)	20.8	156	51	102
Plant Net Capacity (MW)	20	150	50	100
Economic Life (Year)	25	25	20	20
Lead Time (Year)	4	5	4	4
Earliest On-Line Year	2020	2021	2020	2020
Net Heat Rate (KJ/kWh, HHV)	8,860	7,216	9,338	9,043
Primary Fuel Cost (N$/GJ) - 2015	192	288	288	288
Capex Cost (N$M)	30,010	24,106	20,137	19,125
O&M Costs - Fixed (N$/kW -year)	528	408	336	312
O&M Costs - Variable (N$/MWh)	240	240	240	240
WACC (%)	10%	10%	10%	10%

Hydro:

Generation Technology	Baynes [1]	Okavango	Orange
Fuel	Water		
Plant Gross Capacity (MW)	306	20.4	102
Plant Net Capacity (MW)	300	20	100
Economic Life (Year)	50	50	50
Lead Time (Year)	10	6	6
Earliest On-Line Year	2026	2022	2022
Net Heat Rate (KJ/kWh, HHV)	/	/	/
Electrical efficiency	90%	90%	90%
Primary Fuel Cost (N$/GJ) - 2015	/	/	/
Capex Cost (N$M)	83,214	53,663	56,249
O&M Costs - Fixed (N$/kW -year)	559.2	600	600
O&M Costs - Variable (N$/MWh)	80	80	80
WACC (%)	10%	10%	10%

Note [1] : Namibia's 50% share only

Biomass:

Generation Technology	Biomass BFB	
Fuel	Invader bush	
Plant Gross Capacity (MW)	5.6	11.2
Plant Net Capacity (MW)	5	10
Economic Life (Year)	25	25
Lead Time (Year)	5	5
Earliest On-Line Year	2021	2021
Net Heat Rate (KJ/kWh, HHV)	15,000	14,500
Primary Fuel Cost (N$/GJ) - 2015	53.13	53.13
Capex Cost (N$M)	62,863	58,899
O&M Costs - Fixed (N$/kW -year)	1000	920
O&M Costs - Variable (N$/MWh)	320	240
WACC (%)	10%	10%

Solar:

Generation Technology	PV small	PV large	CSP - 12h storage
Fuel	Solar		
Plant Gross Capacity (MW)	0.01	0.25	54
Plant Net Capacity (MW)	0.01	0.25	50
Economic Life (Year)	20	20	25
Lead Time (Year)	1	1	5
Earliest On-Line Year	2017	2017	2021
Net Heat Rate (KJ/kWh, HHV)	/	/	/
Availability	98%	98%	98%
Primary Fuel Cost (N$/GJ) - 2015	/	/	/
Capex Cost (N$M)	27,076	21,463	116,721
O&M Costs - Fixed (N$/kW -year)	1%	1%	2,400
O&M Costs - Variable (N$/MWh)	138.84	110.08	160
WACC (%)	10%	10%	10%

Wind

Generation Technology	Wind
Fuel	Wind
Plant Gross Capacity (MW)	50
Plant Net Capacity (MW)	50
Economic Life (Year)	25
Lead Time (Year)	3
Earliest On-Line Year	2019
Net Heat Rate (KJ/kWh, HHV)	/
Primary Fuel Cost (N$/GJ) - 2015	/
Capex Cost (N$/kW)	40,919
O&M Costs - Fixed (N$/kW -year)	600
O&M Costs - Variable (N$/MWh)	80
WACC (%)	10%

Geothermal:

Generation Technology	Geothermal
Fuel	Earth heat
Plant Gross Capacity (MW)	5.6
Plant Net Capacity (MW)	5
Economic Life (Year)	25
Lead Time (Year)	8
Earliest On-Line Year	2024
Net Heat Rate (KJ/kWh, HHV)	/
Primary Fuel Cost (N$/GJ) - 2015	/
Capex Cost (N$/kW)	92,324
O&M Costs - Fixed (N$/kW -year)	2160
O&M Costs - Variable (N$/MWh)	240
WACC (%)	10%

The full load hour assumptions used in the different scenarios are summarised in Table 10.

Table 10: Full load hour assumptions per technology

	Full load hours
Coal	7,008
Natural Gas - CCGT	7,008
LNG - CCGT	7,008
LNG - GT	7,008
LFO - CCGT	7,008
LFO - GT	7,008
HFO - MSD	7,008
Biomass	7,008
Wind - onshore	3,504
Solar PV	2,628
CSP	7,008
Hydro	2,628
Geothermal	6,000

New installations and related costs

This section looks at the additional capacity per technology that needs to be installed in the 70% RE in 2030 Scenario for the period up to 2030. An overview is given in Table 11.

Table 11: Installed capacity per technology for 2030 in the Alternative scenario

	Installed capacity in 2030 (MW)	To be built (MW)
Nuclear	0	0
Coal	0	0
Peak Units	0	0
Natural Gas - CCGT	0	0
LNG - CCGT	156	156
LNG - GT	0	0
LFO - CCGT	22	0
LFO - GT	0	0
HFO - MSD	0	0
Biomass	40	40
Wind - onshore	400	400
Solar PV	600	600
CSP	54	54
Hydro	653	321
Geothermal	0	0

A total of 152.7 bn N$ would be needed to develop this scenario (Figure 15). The bulk of the investment costs (CAPEX) totalling 94.1 bn N$ is for the additional Hydro plant and for the additional wind farms 400MW. In terms of operational costs, about 58.6 bn N$ would be needed to make the scenario happen. The largest portion of this goes to the CCGT power plants. Note that the operating costs for PV and CSP are very low, not appearing on the graph due to the scale used.

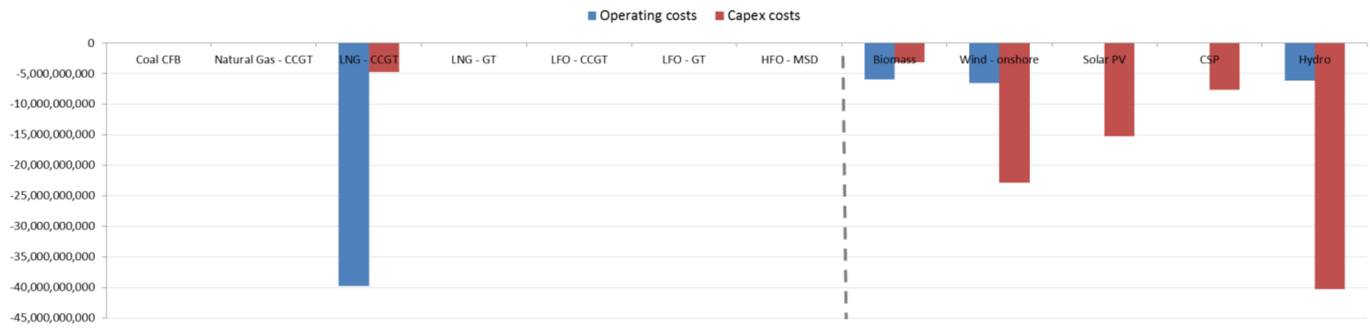

Figure 15: Overview of total costs needed (in N$)

While the investment costs have to be paid upfront, the operating costs are spread over the life time of the technology and don't need to be provided all at once.

v. Comparison of the 70% RE in 2030 Scenario with the other Scenarios

The results of the 70% RE in 2030 Scenario have been compared to the results of the Reference scenario, the Pro-Wind/Solar Scenario – With Kudu, and the Pro – Hydro Scenario -No Kudu.

As can be seen in Table 12, the 70% RE in 2030 Scenario needs more initial investments than in the three other scenarios. However, and more importantly, the operating costs during from 2016 to 2030 are lower than in the three other scenarios, totalling around 59 bn N$. It is important to note that the investment in renewables also reduces the risks of fuel price spikes and increases.

Table 12: Overview of investment and operating costs for the four different scenarios

	Investment Costs (bn N$)	Operating Costs (bn N$)	**Total Costs (bn N$)**
Reference Scenario	79.5	121.1	**200.6**
Pro-Wind/Solar Scenario - With Kudu	60.4	91.4	**151.8**
Pro- Hydro Scenario - No Kudu	70.3	117.7	**188.0**
70% RE in 2030 Scenario	94.1	58.6	**152.7**

vi. LCOE values for the different technologies

This section looks at the cost of different energy technologies and aims to provide insights into the best technologies for Namibia. As this section will show, renewable energy technologies are becoming cost-competitive and required subsidies are rapidly declining.

The calculations are made using the aforementioned investment model.

One of the first things that can be noticed when looking at the calculated LCOE values for 2016 in Figure 16 is that only solar PV has a LCOE value lower than 1208 N$/MWh. With today's wholesale market electricity prices (around 110 N$/MWh), this means that only solar PV is cost-beneficial if electricity prices don't rise significantly.

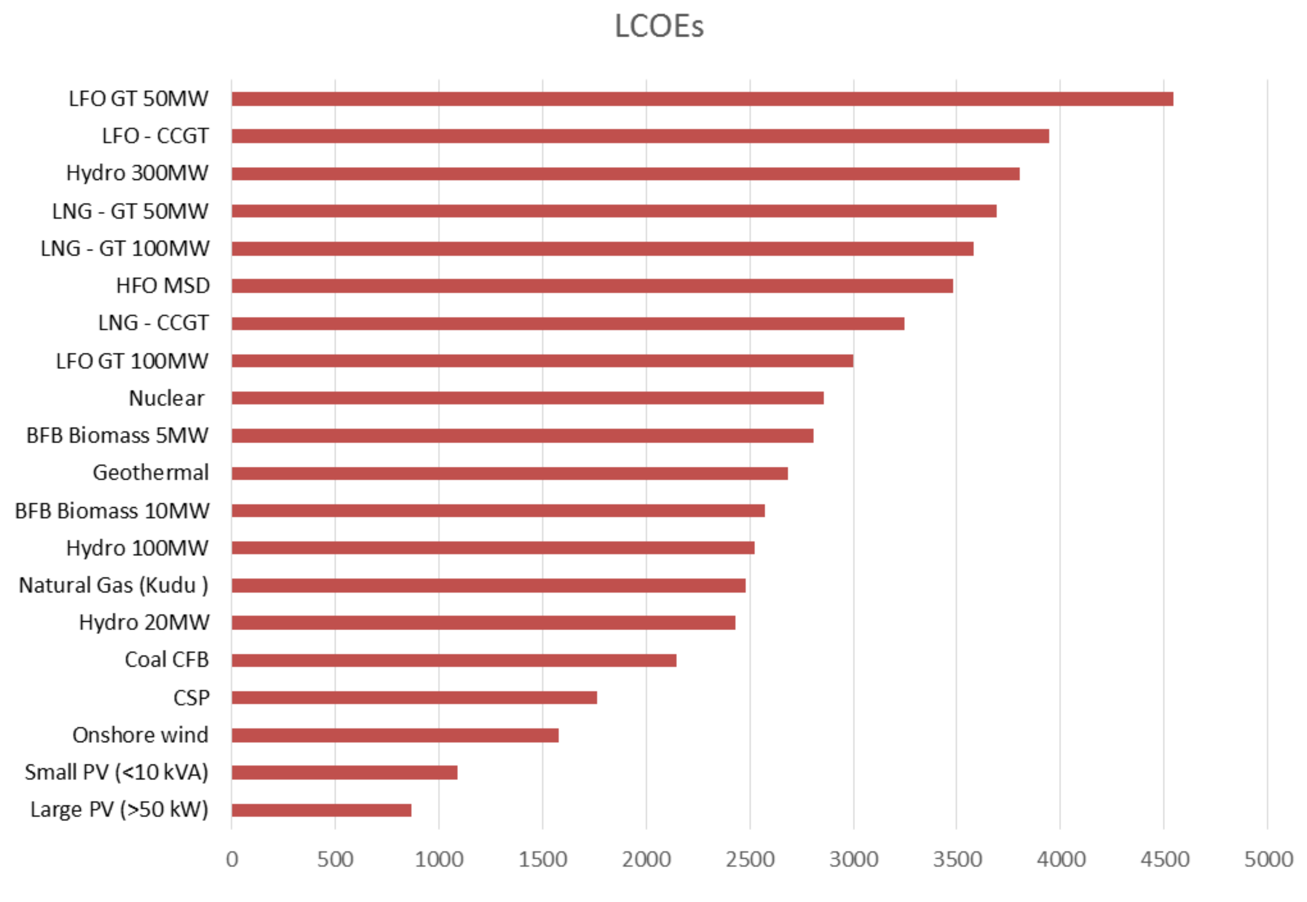

Figure 16: Calculated LCOE values for 2016 in N$/MWh

When looking at the relative comparisons between the technologies, some interesting points can be noted:

- According to the calculations, large PV is the cheapest technology today, followed by wind energy, CSP with storage and coal.
- The diesel gas turbines have a high LCOE value due to high LFO prices and low full load hours. These technologies should be used as peak units, if necessary at all to invest in them.
- CCGT and GT remain expensive technologies.

vii. A stable framework can significantly further reduce required subsidies

With a stable framework and low development risks, those investing in the development of new electricity production units demand less interest for their financing. The Weighted Average Cost of Capital (WACC) can then drop. In the long-term, this increases the value of the electricity produced for the project.
Since most renewable energy technologies are mainly CAPEX technologies, the WACC is even more important for them than for conventional technologies. A high WACC essentially reduces the value of profits at a later stage, and CAPEX costs at the beginning of the project thus become relatively more important.

Conclusions

Developing an ambitious sustainable electricity sector with large amounts of renewables and lower imports requirements is possible by 2030. In the 70% RE in 2030 scenario, an investment of about 94 bn N$ would be needed with operating costs of around 59 bn N$ to reach the target of 70% of renewables in the electricity sector by 2030.

The transition towards more renewables means a transition from a merely OPEX-based to a CAPEX-based electricity sector. Once the investments are done the operational costs are limited. This means it reduces risks for the future, and can be regarded as a sort of insurance against future fuel price evolutions. Investments in CAPEX-technologies like wind and solar energy mitigate the risks of such events.

To make the transition work, decisions have to be taken now and a stable investment framework needs to be created with the right incentives. Policy makers should choose to support innovative technologies that have the potential to create economical added-value in Namibia, while keeping a good mix of technologies. Demand flexibility can be part of the energy transition, reducing quickly the peak power demand. Measures need to be created to incentivise this further.

In order to set realistic targets for the future, two essential elements are missing:

- **Grid study**: necessary to ensure the grid stability and to foresee the upgrades required to be able to bear with the additional installed capacities.
- **Resources assessments and mappings**: essential to grasp the right renewable energy potential of the country. The World Bank provides funding for such projects in Africa. Namibia could

Finally, smart policies should be developed:

- **Increase investor confidence**: One of the most important things when designing a support framework is to make sure that it is stable and reliable. Sudden changes are detrimental to investor confidence. This makes money more expensive and in turn significantly increases the required subsidies.
- **Incentives for flexibility & peak reduction:** measures to incentivise demand flexibility and peak reduction include for e.g. increasing the costs for larger grid connections (thereby giving an incentive to reduce the peak demand) or installing smart meters to value electricity consumption according to the hourly wholesale market prices.
- **Maintain a mix of technologies:** for risk management purposes, it is important to keep an overall mix of sources of energy, without excluding the development of a potentially highly successful technology.

Implementation Framework and Action Plan

[To be drafted after RE Policy Draft is revised and updated, incorporating a round of detailed comments, and all core policy statements are finalized.]

Conclusion

[To be drafted after RE Policy Draft is revised and updated, incorporating a round of detailed comments, and all core policy statements are finalized.]

APPENDICES

A. Methodology for Renewable Energy Target Analysis and Evaluation of its Costs

Methodology and assumptions

For the purpose of setting renewable energy targets in Namibia, 3E developed an accounting model of the Namibian electricity sector coupled with an investment analysis model, as illustrated in Figure 17.

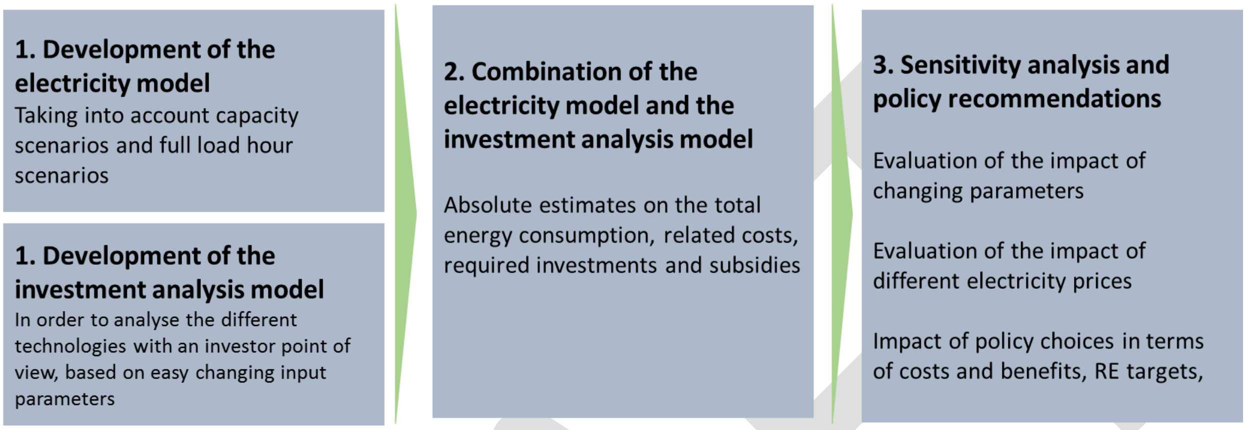

Figure 17: Modelling Methodology

The combination of the accounting model for the electricity sector and the investment analysis model enables absolute estimates for the total energy consumption, the related costs, the required investments and subsidies, etc. In addition, this leads to important insights from the relative comparison of the scenarios, showing the impact of possible policy choices in terms of costs and benefits, RE targets, etc.

The accounting model for the electricity sector

The accounting model for the electricity sector simulates the evolution of the Namibian electricity system. The model uses assumptions for installed capacity, full load hour and electricity and fuel prices. Based on the installed capacity and the annual full load hour assumptions, an electricity production scenario is calculated. By allowing the selection of different source scenarios, analysis of the future electricity system can be performed.

The benefit of the accounting model is that it allows checking the internal coherence of the energy system, comparing the energy demand with the required import, and the installed dispatchable capacity with the residual peak demand (after flexibility is used but with reserve margin). Since it is meant primarily to investigate options for the future (period up to 2030), it works with an annual resolution.

All parameters, assumptions and scenarios in the accounting model can be changed and tested easily, allowing for flexible and quick analysis possibilities.

The investment analysis model

The investment model that is used in combination with the accounting model is building on several previous studies 3E performed for the Flemish Energy Agency, the Walloon Government and for Greenpeace[4]. Most of the parameters were adapted to take into account the NIRP study[5] and the ECB and NamPower data.
For all electricity production technologies analysed in this study, a business model has been developed taking into account all relevant financial parameters (CAPEX, OPEX, WACC, tax regime, construction length, etc.). These parameters can be adapted easily in the model to allow for quick and detailed sensitivity analysis. The exercise is done for both renewable and conventional technologies. Learning curves for CAPEX are implemented for the wind and solar technologies, as are efficiency improvements over the years. The model enables to determine for example how much subsidies are required in order to allow developers to get an adequate return on investment.

Parameters taken into account

For each technology, the following elements have been taken into account in the profitability analyses:

- **Investment costs** (CAPEX), in nominal terms
- **Operating revenues** composed of:
  - the grey electricity revenues coming from the auto-consumption of electric
  - ity generated on site if applied
  - the revenues coming from the injection of residual electricity produced on the grid
  - the revenues from heat sold for the technology if applied (e.g. CHP)
- **Operating costs**:
  - O&M (operational and maintenance) costs, in nominal terms
  - Fuel costs, in nominal terms
- **EBITDA** (Earnings before Interest, Taxes, Depreciation, and Depreciation): computed as the operating revenues minus the operating costs.
- **Depreciation**: based on the linear depreciation principle, with a depreciation period equal to the operation length of the technology.
- **EBIT** (earnings before interest): calculated as the EBITDA minus the depreciation.
- **Profit before tax**: corresponds to the EBIT minus the financial expenses / revenues ratio.
- **Tax**: a tax rate of 33 % has been considered.
- **Profit before tax:** corresponds to the EBIT minus the financial expenses / revenues.
- **The deferred tax liabilities**: if for a given year the tax base does not cover the depreciation of the investment, the tax benefit is deferred to the following year.
- **Profit after tax**: calculated as earnings before taxes minus the taxes.
- **Operational cash flows**: computed as profit before tax plus the total depreciation (which are not cash).
- **Free cash flows**: computed as the cash flows minus the CAPEX (investment costs). The CAPEX is not spread over the construction length of the technology, but is due in year 1, and the operational cash flows over the years 1 to n, n being the economic life of the technology considered.

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[4] Steunmechanismen voor de productie van groene stroom en WKK, analyse, aanpassingsvoorstellen en beleidsaanbevelingen, 3E for VEA, July 2011, http://www.energiesparen.be/evaluatie_steunmechanismen
Report for the Walloon Government (SPW DG04), 2013, not published yet.
Crucial energy choices in Belgium – an investigation of the options, our energy future, 3E for Greenpeace, BBL and WWF, June 2014, http://www.greenpeace.org/belgium/global/belgium/report/2014/our_energy_future.pdf
[5] NIRP Review and Update Project, Preliminary Draft of Partial Final Report, HATCH for the Electricity Control Board, February 19, 2016

- **Discount rate:** equals to the WACC (in nominal terms) of each technology. A generic 10% WACC was taken.
- **Discounted cash flows:** equal to the free cash flows corrected by the discount rate.

Measuring costs and required subsidies: LCOE and NPV

The profitability of each technology is measured with the following two main indicators:

- **NPV** (Net Present Value): sum of the cash flows of the technology discounted on an annual basis. The net present value is the value of an investment, given the cash flows of the project:

  NPV = Σ CFt / (1 + WACC)^t

  Where NPV is the net present value, CFt the annual cash flows, WACC the weighted average cost of capital suggested, t (from 0 to n), where n is the last year of operation of the installation.

  A positive NPV indicates that the technology generates added value, above the required return to compensate for the financing costs. **A negative NPV means that the project requires subsidies in order to get the required return on investment.**

- **LCOE** (Levelized Costs of Electricity): is a metrics calculating the cost of electricity produced by a generator, or said differently, the price at which electricity should be sold to break even over the lifetime of the technology. The following expression for the computation of the LCOE is used, given by [IEA/NEA 2010] (p.34)[6]:

  $$\sum_t (Electricity_t{}^* P_{Electricity}{}^* (1+r)^{-t}) = \sum_t ((Investment_t + O\&M_t + Fuel_t + Carbon_t + Decommissioning_t)^*(1+r)^{-t}) \qquad (1).$$

  From (1) follows that

  $$P_{Electricity} = \sum_t((Investment_t + O\&M_t + Fuel_t + Carbon_t + Decommissioning_t)^*(1+r)^{-t}) \,/\, (\sum_t(Electricity_t{}^*(1+r)^{-t})) \qquad (2),$$

  which is, of course, equivalent to

  $$LCOE = P_{Electricity} = \sum_t((Investment_t + O\&M_t + Fuel_t + Carbon_t + Decommissioning_t)^*(1+r)^{-t}) \,/\, (\sum_t(Electricity_t{}^*(1+r)^{-t})) \qquad (2)'.$$

  The factors influencing the LCOE apart from the different costs are the discount rate and the load factor (which determines the amount of electricity produced per year).

Limits of the work

The present study uses an accounting model for the electricity sector. It is not an optimisation model that arranges the available installations in the merit-order curve and calculates for each hour which installations need to deliver how much energy. This is on the one hand good because it is clearer what the impact of each parameter is and it is not a black box model where the results are hard to analyse and understand. Yet on the other hand, it means that the input data is more rough (yearly resolution) and assumptions need to be made about e.g. full load hours and

[6] IEA and OECD/NEA, Projected Costs of Generating Electricity: 2010 Edition, 2010, Paris

electricity prices. These assumptions are not directly linked to the inputs of fuel prices, as they would be in an optimization model.

In general, this is a good method for the period up to 2030 since the important things are the trends and evolutions, and the internal sanity checks of the model are adequate for analysing this time period. Moreover, the impact of the assumptions is assessed with sensitivity analysis in order to make more robust conclusions.
When checking possible issues in the electricity system for the next five years, this method is however not sufficient.

B. Case Studies on Socio-Economic Impact from Recent Solar PV Installations in Namibia

Tsumkwe Energy Project

The Tsumkwe Energy Project is a 200 KW solar hybrid system developed and installed by Juwi (a German firm), in partnership with the Desert Research Foundation of Namibia and in close collaboration with NamPower and the Otjozondjupa Regional Council. The off-grid project is located in the Otjozondjupa region of Namibia, a remote area. The project consists of 918 polycrystalline panels and battery storage of one MW. For backup, the system has three diesel generators integrated into it.[xix]

Additional components of the project resulted in the installation of street lights, and the distribution of over 50 rechargeable electrical lanterns to select Tsumkwe residents who are not connected to the central mini-grid. A solar kiosk has been installed to charge the electric lanterns and mobile phones of residents. Outdated electric meters have been replaced with modern meters, which has allowed revenue collection by the Otjozondjupa Regional Council to increase markedly. Pre-paid meters have also been installed in government buildings.[xx]

The project's objective was to contribute to a reduction in poverty, through access to modern electricity services and infrastructure and by creating opportunities for social and economic development.

Socio-economic impact

The project, completed in 2012, supplies 100% clean electricity to the local hospital, police station, radio station, water supply, mobile network, and over 100 households in the town of Tsumkwe. Access to power has gone up from 12-14 hours a day (and many a time just three hours a day) to 24 hours a day, due to the project.[xxi]

Electricity costs from the PV system are lower than costs from the pre-existing diesel generators, given rising fuel costs of diesel in recent years.

Several impacts of the project have been assessed and recorded. These include an improvement in public service delivery, reduced plant operating costs for the local government, and a reduction of energy costs for some local businesses. Notably, the project appears to have sparked an interest in business development; business opportunities have been created through access to energy, and local officials have noted that there has been an increase in the number of applications in the local town hall for registration of new businesses including shops (or shebeens). One of the other impacts has been minor savings from energy efficiency, which have been diverted into other activities by households.[xxii]

Omburu Solar Power Plant

The Omburu solar power plant is a grid-connected solar PV park with a generation capacity of 4.5 MW, generating 13,500,000 Kwh a year. Developed by Innosun (a Franco-Namibian company), the solar park covers 16 acres, contains more than 33,000 panels, 100 inverters, and 67 tracking mirrors.[xxiii]

The PV panels are installed on a single axis horizontal tracking system, which allows the panels to follow the sun from East to West. The panels produce direct current, converted into 400 volt alternating current, which is more compatible with the national grid. This is then boosted up to 22,000 volts by four transformers within the solar park. The power is transported on a power line (1.2 km long) set up and paid for by the developer, and then injected into Omburu transmission substation – also constructed, operated, and maintained by the developer – and then sold to NamPower.

Socio-economic impact

The electricity generated from this facility is the equivalent of one percent of all of Namibia's power generation, enough to meet the power consumption needs of 20,000 Namibians.

During the construction phase of the project, which lasted four months, 60 Namibians had construction jobs on the site. Post-completion, 10 Namibians have full-time, long-term jobs operating and maintaining the power plant over an anticipated 25 year lifetime.

One of the noteworthy features of the plant is that (chiefly due to its tracking design) it is currently operating much like a baseload plant. It's production peaks shortly after sunrise, and continues at a relatively constant rate – at peak levels – until shortly before sunset, without much variance or intermittency during the daytime. The implications of this are that this significantly increases NamPower's ability to draw on electricity generation from Omburu to provide power to grid-connected households, with more assured and reliable supply – which brings with it a host of socio-economic opportunities.

C. Existing Off-grid and Rural Electrification Initiatives from the Ministry of Mines and Energy

The Ministry of Mines and Energy has a few existing initiatives supporting renewable energy solutions for off-grid and rural communities as listed in Table 13 with expected budget for each fiscal year. Currently just a small portion of the budget is used for off-grid electrification, so more budget would likely need to be sourced for an effective mini-grid program.

Table 13 Current Off-grid and Rural Electrification Estimated Expenditure by Ministry of Mines and Energy

Initiative	Estimated Expenditure (N$)		
	2016/2017	2017/2018	2018/2019
Off-Grid Electrification and Solar Revolving Fund	6,000,000	10,000,000	8,000,000
Rural Electrification	67,000,000	70,000,000	70,000,000

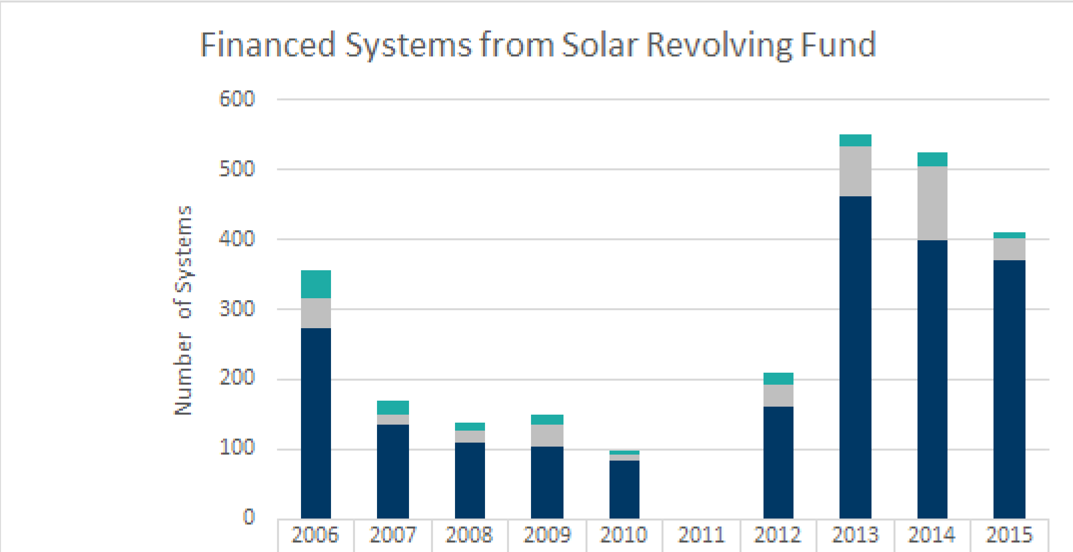
Note: Data provided by MME assuming business as usual

Solar Revolving Fund

Currently, the Ministry of Mines and Energy overseas the administration and allocation of the Solar Revolving Fund (SRF). The SRF is a credit facility established to stimulate demand for the utilization of renewable energy technologies in both rural and urban areas, with a focus on off-grid areas. Loan amounts range from N$6,000-50,000 varying by technology. Qualifying technologies and historical installations are included in Figure 18. Solar

Homes Systems includes solar PV equipment and solar cookers/stoves, which can be financed as part of a lump sum. Currently, there is not much funding available from MME for mini-grids.

Figure 18: Financed Systems from Solar Revolving Fund



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Solar Water Heaters	38	20	10	13	5	0	19	17	19	9
Solar PV Pumping	45	15	19	31	7	0	32	74	106	32
Solar Home Systems	272	134	109	105	85	0	160	461	400	369

Source: (MME, 2016)

D. Summary of the SADC Mini-Grid Gap Analysis and National Plan of Action for Namibia

Type	Identified Gap	Stakeholder Responsible for addressing gap
Market Needs & Demand	1. The selection criteria for off grid locations do not include current and potential social and economic impacts including productive use.	MME
	2. The Regional Electricity and Off- Grid Energisation Master Plans are not aligned with the SE4ALL objectives.	MME
Technology choice and Technical Regulation	3. There is no portal for accurate and updated renewable energy resource data and competitiveness for Namibia	REEEI with support from NamPower & Soitec
	4. Inadequate technical capacity for operation and maintenance of off-grid systems in the country.	REEEI/SEIAN
	5. Norms, standards and codes of practice for performance, manufacturing, installation and maintenance of mini grids need more regular reviewing.	NTCRE
Ownership, Funding and Economic Regulation	6. The regional electricity distributors are unwilling to take ownership of mini grids citing lack of viability and regulatory uncertainty	MME/REDs
	7. The off grid systems on public institutions and remote villages are not financially sustainable	ECB
	8. Solar Revolving Fund is unsustainable and has a backlog of customers.	MME
Planning & Development Process and Role Clarity	9. Namibia does not have a Rural and Renewable Energy (RRE) Policy, Act and Agency	MME
	10. There is ineffective coordination among players and the implementation of projects	MME
	11. The off grid electrification projects and programmes are not being systematically monitored and evaluated.	MME/REEEI

Source: (RERA, 2014)

E. Regional Trends in Renewable Energy Policy

A number of renewable energy supporting policies and incentives are being used in the SADC region. Regulatory incentives are more common than financial incentives, as these typically require less funding support from government.

Table 14 Renewable Energy Incentives in the SADC

	Regulatory Incentives						Financial	
Type/ Country	Feed-in-tariff/ Payment	Net metering	Biofuel obligation	Grid code revisions	Tradeable Credits	Auctions	Subsidy, Grant, Rebate	Tax Breaks
Botswana	✓					✓		
Mozambique			✓	✓				
Namibia	✓	✓				✓		
South Africa		✓	✓	✓	✓	✓	✓	✓
Tanzania	✓						✓	
Zambia	✓		✓	✓			✓	✓
Zimbabwe	✓	✓	✓	✓		✓	✓	

Source: (REN 21, 2015)

Auctions and feed-in-tariffs are two of most common regulatory incentives for procurement of utility-scale renewable energy. Feed-in-tariffs are more commonly used for small to medium scale projects (e.g. <10MW), while auctions are more appropriate for larger projects or for more competitive technologies such as solar PV.

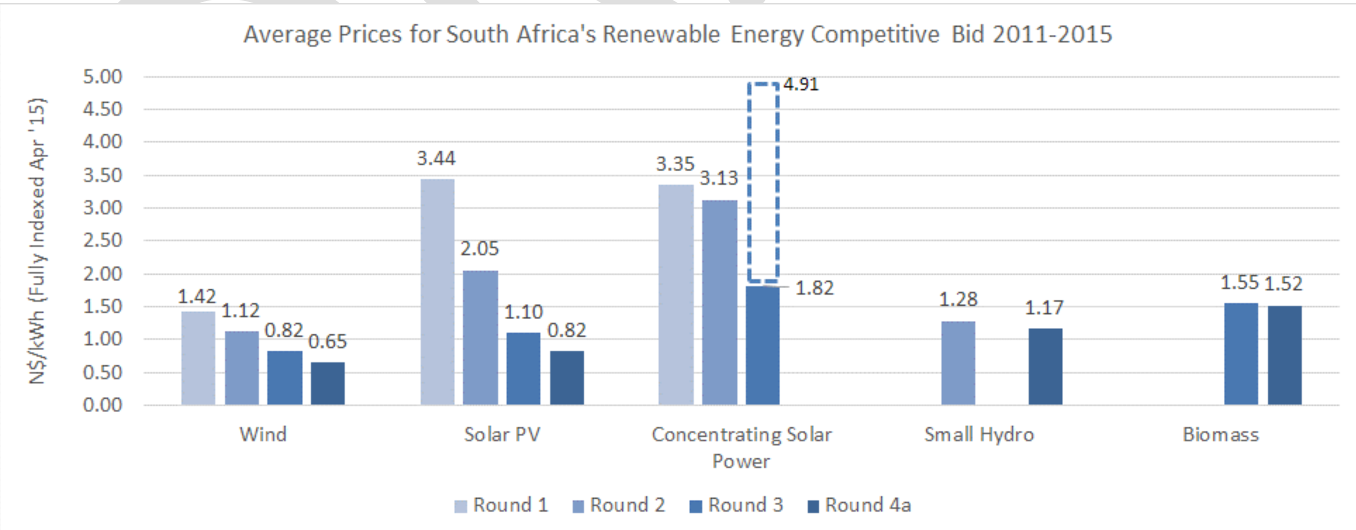
Table 15 Regional Feed-in-Tariff and Auction Programs for Renewable Energy

Country	Wind	Solar-PV	Concentrating Solar Power	Small Hydro	Biomass	Geothermal
Kenya	✓	✓	✓	✓	✓	✓
Uganda	✓	Auction		✓	✓	✓
Namibia	✓	✓	✓		✓	
Zambia (Draft rules 2015)	✓	✓	✓	✓	✓	✓
Tanzania	Technology Neutral Feed-in-Tariff: Tanzania's Small Power Purchase Tariff and mini-grid FiT are technology neutral and based on based on avoided cost of electricity					
South Africa	Auction: Competitive auction for utility-scale projects, and has embedded generation tariffs for projects <1MW					

Source: (Blue Horizon ECS, 2016)

South Africa switched from a REFiT to competitive auction in 2011 to enable more competition in its procurement of utility scale renewable energy. Through consistent commitment from government the auction successfully helped reduce costs for new projects especially solar PV and wind.

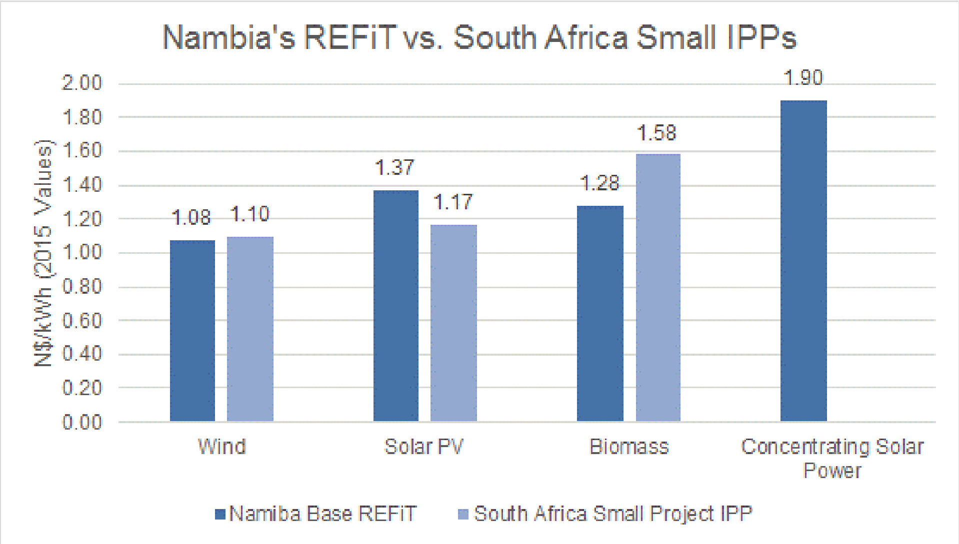
Figure 19: Average Prices for South Africa's Renewable Energy Independent Power Producer Programme



Note: CSP Round 3 adjusted for revised time-of-use contracting profile for 5 hours of peak/day at 270% of base rate

South Africa also held an auction for small-scale renewable energy projects (~5MW) of a comparable size to Namibia's REFiT. This auction lead to the procurement of 2 wind, 2 biomass, and 6 solar PV projects out of 102 applicants. The prices for solar PV were 17% less expensive on average than Namibia's REFiT, highlighting the benefits of an auction in helping to ensure competitive pricing.

Figure 20: Comparison of Namibia's REFiT with South Africa's Small-Scale IPP Auction



F. Sample Power Purchase Agreement for IPPs (Template)

(To be included)

G. Sample Wheeling Agreement (Template)

(To be included)

H. Sample Electricity Export License (Template)

(To be included)

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