A Sustainable Energy Mix to Power Namibia Vision 2030

Monish Gunawardana

Abstract

Presently, 40% of Namibians and 84% of the rural inhabitants have no access to electricity. All economic sectors largely rely on fossil fuels, imported electricity and aging power plants. The production of additional 350 MW of electricity by 2016 and increase in the generation capacity to cater the emerging needs are vital. And Namibia's energy mix should reduce carbon emissions and up-scale renewable energy targets. In order to retain energy security, it is essential to construct the proposed of 300 MW coal plant, 400 MW solar systems, 450 MW of nuclear Small Modular Reactors and 150 MW from renewables energy systems. Aging Van Eck coal power station and Ruakana hydroelectricity plant need refurbishments. The implementation of 800 MW Kudu Gas project will ensure Namibia`s energy security.

Key Words

Clean Energy, Economic Growth, Energy Independency, Fossil-Fuels, Carbon Emission, Industrialization, Low - Carbon, Solar Energy, Nuclear Energy, Renewables

Introduction

The paper accesses the status quo in Namibia`s electricity sector focusing on its energy security. And it introduces an efficient affordable, sustainable and low-carbon power supply system to power a competitive industrialized economy as per the national socioeconomic development agenda: Namibia Vision 2030 (NPC, 2010). American Council for an Energy Efficient Economy (ACEE) reminded: "The national policies to improve energy efficiency can reduce oil imports, improve the reliability of the U.S. electric grid, save consumers money, reduce air pollution, create jobs, and reduce prices. (ACEE),

The United Nations` 'Energy for Sustainable Future'report (UN) has pinpointed that the decisions countries take today on how they produce, consume and distribute energy will greatly influence their ability to eradicate poverty and respond effectively to climate change. Therefore energy will be one of the defining issues of the globe. Namibia's power demand will be tripled by 2030. To establish a sustainable power generation system is essential to ensure sustainable economic growth. Hence future demand growth, status of the current power generation system and the dependence on imported power supply were studied. The importance of renewables as a key component of the power generation mix was also examined.

Methodology

To evaluate the Namibian electricity sector and offer sustainable solutions, social science research methodological tools were utilized. Primary and secondary sources were examined analytically to assess the techno-economic feasibility of proposed energy sources. The reports produced by the Namibia Electricity Control Board (ECB), World Banks` Documents and Government Policy Papers on Energy were considered. Views that emerged from workshops and seminars on Vision 2030 and Energy Issues were also accommodated.

The reports, annual publications and news pieces on sustainable energy which originated from the United Nations, multilateral agencies and researchers strengthened the contents of this paper. Furthermore, authentic publications on energy studies were thoroughly consulted. These sources of information helped to formulate and test the recommended solutions. The views and arguments of Namibia's parliamentarians, National Planning Commission researchers and government executives were also obtained through interviews.

Results

In 2014, the Gross Domestic Product of the country was U$ 13.4 billon and the National Budget was 10.7 billion. (CIA). According to Namibia Labour Force Survey 2014 (NSA,2015) , the unemployment rate was 28.1%. Namibia possesses vast land resource, abundant minerals, extraordinary tourist attractions, adaptable young workforce and socio-political stability. In spite of these, the country still could not marshal its resources adequately. Currently, Namibia exports what it does not consume and imports what it could not produce. But, one of the best solutions to bring the economic independence is expansion of the industrialization process.

As Prof. Robin Maris of the University of London wrote, " The economic growth in a developing country is a process of industrialization". (Maris,1999) . For instance, from 1992 to 2001, India`s GDP growth was 6%. But after establishing s heavy industrial companies like Tata, Mittal and Birla and Information Technological Companies like Office Tiger and Infosys, the country's GDP grew up to 8%. Today, India is a highly industrialized country that maintains their global competiveness through innovations and by producing high quality products and services employing advanced technology. Those economies are sustained and driven on a stable power supply system.

Installed Power Generation Capacity

In the 1990s, after gaining the political independence, African nations faced the challenge of developing their economies to reduce poverty and accelerate economic growth. As power is a key determent in economic growth, during the pre-independent era, the South West Africa Water and Electricity Corporation (Pty) Limited (SWAWEK) constructed the

Ruakana Hydro Power Station on the Kunene River in northern Namibia. (Nampower)

It was an interim measure. In 1974 SWAWEK constructed the Van Eck, coal-fired thermal power station in Windhoek to reduce the dependence on hydropower in an arid country. Walvis Bay`s diesel powered Paratus Power Station was commissioned in 1976. It bridged the generation capacity lost at Ruakana. Presently Paratus provides limited back-up service to the national grid during the peak-demand periods. In 1981, a small diesel generator (2.5 MW) was installed in Katima Mulilo. (Nampower)

Source & Type	**Installed Capacity**	**Established in**
VanEck : Coal	120 MW	1973
Paratus: Diesel	24 MW	1976
Ruakana: Hydro	240 MW	1978
Katima: Diesel	2.5 MW	1981
Anixas: Coal	22.5 MW	2011
Total	**409 MW**	

Table 1: Namibia`s installed power generation capacity in 2011

Van Eck Coal -fired Power Station

Van Eck`s capacity is 120MW. It supplies 23% of the peak-demand of Namibia. It is the second largest national power utility next to Ruakana, It is also a strategic base-load supplier for the administrative and commercial capital of Namibia. As of now, its actual power generation is below its installed capacity. Also as a coal-based power generation that burns 14,000 tons of coal monthly pollutes the serene environment of the capital city. Anyhow, that plays a critical role in the industrial sector. Now it is under refurbishment. But, even after the refurbishments, after ten years it will need another refurbishment to give a fresh technical life. And in the long run, that exercise economically and technically not viable.

Paratus Diesel Power Station

This emergency standby power utility powers Walvis Bay, the harbor town of Namibia. Paratus (24 MW) was commissioned in 1976 to address the generation capacity loss of Kunene hydro power station and supply electricity to the town during the peak demand seasons. Its present actual generation capacity is around 17MW. Moreover, similar to Van Eck, it emits greenhouse gases that pollute the clean environment of the port city.

Ruakana Hydro Power Station

This is a run-off hydropower station and does not have an upstream water storage facility (Reservoir) and its output depends on the viability of water in the Kunene River. The rainy season is from February to May and during that period, it operates at optimum level generating electricity for 8 hours a day. But from June to January, it serves as a peaking power station producing less than the rainy season.

Katima Diesel Power Station

This 2.5 MW diesel generator was installed in 1981 and serves Katima Mullio, the capital of the Caprivi region. The operation and maintenance cost of this ailing and aging power utility is very expensive.

Electricity Imports

As the electricity generated from the above-discussed local power plants could meet the national demand, Namibia imports around 60% of power from foreign sources. According to NamPower (Nampower, 2011), in 2010, Namibia has imported 2.480 GWh of electricity. Most of Namibia`s power import agreements are less reliable and challenge the energy security of the nation.

Imports from ESKOM

According to a bilateral power supply contract signed between NamPower and ESKOM, South Africa`s national power utility agreed to supply power. This special assistance-contract is formulated to supply up to 200 MW annually. The supply option is therefore limited and Namibia can only request power when all other options are exhausted. In addition, Namibia should follow the load shedding pattern of South Africa. In 2008, ESKOM`s decision to stop power exports to Namibia, Mozambique and Zimbabwe sent shock waves to the countries that had relied on power imports.

Imports from Zambia

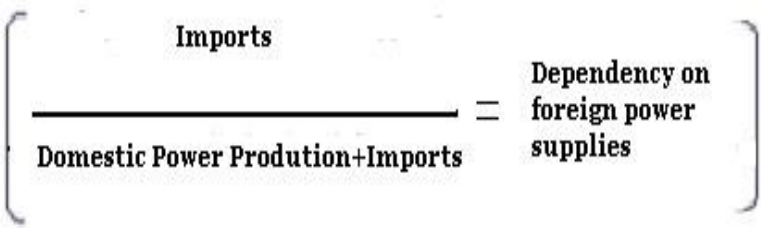
In order to import 50 MW of electricity, NamPower signed a 10 year agreement with the Zambia Electricity Supply Corporation Limited (ZESCO). There was another non-firm agreement to supply 50 MW, but after experiencing transmission technical problems, it did not materialize. In addition, the growing industrial base, the copper industry and households' demands, in the future Zambia will not be able to pool adequate electricity to the Namibian grid.

Imports from Zimbabwe

In 2009, NamPower signed a 5-year agreement with the Electricity Supply Authority (ZESA) to obtain 150MW. Namibia agreed to invest U$ 40 million towards the refurbishment of Hwange coal-fired power station. But Zimbabwe had to extend the agreement for another one year because ZESA failed to supply the agreed 150MW per day for the past three years.

Counting on national power utilities

Due to unpredictable climatic, technical and transmission problems, the effective generating capacity of the Kunene Hydropower Plant and fossil oil-driven power stations was lower than the installed capacity. Therefore the country was forced to rely on power imports. But to defend its energy independence, Namibia should establish its own power utilities.



Dependency on Foreign Power Imports
(Kwasaki, 2010)

Since 1997, the country relied on electricity imported from South Africa and its main supply source was nuclear reactors at Koeberg. In 2008 that reactor complex was closed for corrective maintenance and the 200MW supply to Namibia was terminated. The ESKOM-NamPower power purchasing agreement was unfavorable, unpredictable and costly. As the country rely more on electricity imports from an unpredictable and costly sources, the national energy security and economy are facing an eminent risk.

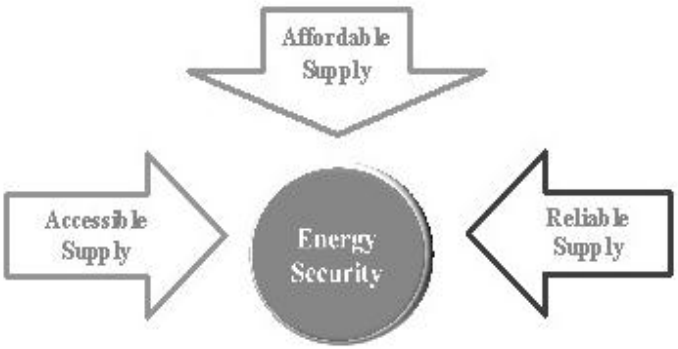
Power Transmission

An increasing number of industries, mines and households are constantly being linked to the national electrify transmission network. It comprises of different transmission capacities such as 66kV, 132kV, 220, kV, 330kV, 400kV and 350kV High Voltage Direct Current (HVDC). The transmission lines of 66kV and below cater for the bulk of the extensions. National transmission line starts from Ruakana near the Angolan border in the northern part of the country. The length of NamPower`s high voltage transmission line

with 330kV that starts from Ruakana is almost 1,518 km. And it extends to the ESKOM`s grid at the South African border in southern Namibia.
In order to reduce the transmission lost (around 15-20%) and accommodate more electricity supply from the proposed renewable and non-renewable sauces country should upgrade the existing transmission network as a smart grid.

Current Energy Security Level

According to the definition of the International Energy Agency (IEA) "energy security is the uninterrupted access and availability of energy sources at an affordable price ." (IEA). Lack of energy security is linked to the negative economic and social impacts of either physical unavailability of energy, or prices that are not competitive or are overly volatile.



Key elements that ensure energy security

As per the facts revealed in the beginning of this paper, the growing demand of power overshadowed Namibia's installed generation capacity. Due to climatic and technological factors, Ruakana`s actual generation capacity is normally very low during the dry seasons and that challenges its reliability as a base-load utility.

Secondly, thermal power stations are responsible for 41 % of power generation in Namibia; the carbon emissions created by them stand as a serious environmental challenge.

Thirdly, the renewable component (i.e. Solar, Wind) of the present power generation mix is extremely low.

Fourthly, nearly 86 % of the rural population has no access to electricity due to the long distance from the national grid and massive investment that needs to extend the grid.

Finally, in relation to the vastness of the country, growing industries and mines, linking them to the existing transmission network of the national grid needs capital injection to extend, upgrade with high load capacity and reduce transmission losses.
By 2030 the national power sector should generate three times more than the present power generation (around 1500 MW) to operate the industrialized economy with world-class competiveness. And that needs an efficient and reliable transmission and distribution network, which will be the lifeline of the national economy.

Namibia`s Energy Future

Guaranteeing the access to power for all, aggressively increasing the share of renewables in the energy mix, reversing the CO2 emissions and utilizing advanced technology should the key elements of Namibia`s future power sector. Climate changes and sustainable economic growth as well as the survival of human race depend on only low-carbon economic development. Namibia`s reasonable monetary and fiscal policies, sound infrastructure, efficient ICT foundation, and sociopolitical stability as well the national development agendas are considered. And those factors were used to develop the assumptions on economic growth and power demand. The following table projects the electricity requirements National Deployment Plans.

NDP	Period	Demand Growth	Demand for Each NDP	Why More Megawatts?
4	2012-16	6%	543-686 MW	To start new industries
5	2017-21	7%	734-961 MW	Power industrialization
6	2022-26	6%	1019-1287MW	High-tech products/ services
7	2027-31	5%	1351-1642 MW	To retain competitiveness

Table 2: Namibia`s power demand growth: 2012-2030
543 MW (2012) is used as the base to forecast the national demand.

During the NDP4 period, the emerging industries, expanding businesses, mining sector and households will demand at least 686 MW in order to lay a solid foundation for industrialization. Therefore the country should generate around 300MW additionally. This can only be achieved by installing the proposed 300MW coal–fired power station at Walvis

Bay. That base-load project should be a national priority. The employment of clean-coal technology can reduce the carbon emissions of that power plant.

Reversing the Import Dependence

As the White Paper of Energy Policy of 1998 noted, the unpredictability of the electricity sources (national and regional) has weakened Namibia`s energy security. Besides that, the carbon footprint of aging fossil-oil-driven three power stations is posing a major concern. And to power the economic sectors and households, the country is forced to rely on power imports. But to defend its energy independence, Namibia should reverse dependence on imports and plan to establish its own power utilities.

Proposed Power Utilities

The below-mentioned Table 2 and Table 3 note the proposed power utilities` output during each NDP period. And they will ensure the required electricity to establish and sustain an industrial economy envisaged by the vision 2030 planners.

Wallis Bay 300 MW coal-fired power station, utility level solar concentrating and photovoltaic projects, Wind Plants, two Small Modular Rectors and Kudu Natural Gas Plants are to be implemented. The refurbishment and rehabilitation of Van Eck Paratus power plants are to be completed during the NDP4 period to ensure required base load. By 2021, the technical and economic life span of Van Eck and Paratus power stations will be ended. Hence by that time, the renewable projects and establishment of nuclear plants will provide adequate power supply for the economic sectors. The recent shale gas boom in the USA and other parts of the world and the international gas market are undergoing uncertainties.Due to above-highlighted factors, foreign investors do not show much interest in the Namibian gas industry. Namibia can therefore delay the implementation of the Kudu Gas project. But during the 6th NDP period, the project can be resumed. The gas project can then generate 800 MW and around 300 MW of this can be exported. This means, by 2030 Namibia will stand as an industrial country with energy security.

NDP	Status	Type	M.Watt	Site
NDP4 2012-2016	New	Fossil Fuel	23	Anaxis
	New	Solar CSP	100	Osakati
	New	Wind Turbines	50	West Coast
	New	Coal	300	Walvis Bay
	Refurbished after 2012	Coal	90	Van Eck
	Refurbished after 2012	Fossil Fuel	17	Paratus
	Refurbished after 2012	Hydro	200	Ruakana
	Imports	Nuclear/Hydro	150	ESKOM/SAPP
			930	
NDP5 2017 2021	New	Solar CSP	100	Katima Mulilo
	New	Wind Turbines	25	Windhoek
	Previously Constructed	Fossil Fuel	23	Anixas
	Previously Constructed	Solar CSP	100	Oshakati
	Previously Constructed	WInd	50	West Coast
	Previously Constructed	Coal	300	Walvis Bay
	Previously Constructed	Coal	90	Van Eck
	Previously Constructed	Fossil Fuel	17	Paratus
	Previously Constructed	Hydro	200	Ruakana
	Imports	Nuclear/Hydro	100	EXCOM/SAP
			1005	

Table 3: The proposed power plants are market as "NEW". Under the title of "PREVIOUSLY CONSTRUCTED" means the power Plants that prosed to construct during the given NDP period. Projected power supply through the proposed energy generation systems for NDP4 :930 MW and NDP5 :1005 MW.

NDP	Status	Type	M.Watt	Site
NDP6 2022-2026	New	Solar PV	100	Okahanja
	New	Solar PV	100	Rundu
	New	SMR/Nuclear	225	Walvis Bay
	New	Thermal	100	Windhoek
	Previously Constructed	Solar CSP	100	Katima Mulilo
	Previously Constructed	Wind Turbines	25	Windhoek
	Previously Constructed	Fossil Fuel	23	Anixas
	Previously Constructed	Solar CSP	100	Oshakati
	Previously Constructed	Wind	50	West Coast
	Previously Constructed	Coal	300	Walvis Bay
	Decommissioned	Coal	0	Van Eck
	Decommissioned	Fossil Fuel	0	Paratus
	Previously Refurbished	Hydro	200	Ruakana
	Imports	No	0	No
			1323	
NDP7 2027-2031	New	SMR/Nuclear	225	Walvis Bay
	New	Gas	800	Oranjemund
	Previously Constructed	Solar PV	100	Okahanja
	Previously Constructed	Solar PV	100	Rundu
	Previously Constructed	SMR/Nuclear	225	Walvis Bay
	Previously Constructed	Thermal	100	Windhoek
	Previously Constructed	Solar CSP	100	Katima Mulilo
	Previously Constructed	Wind Turbines	25	Windhoek
	Previously Constructed	Fossil Fuels	23	Anidxas
	Previously Constructed	Solar CSP	100	Oshakati
	Previously Constructed	Wind	50	West Coast
	Previously Constructed	Coal	300	West Coast
	Previously Refurbished	Hydro	200	Ruakana
			2348	

Table 4: The proposed power plants are market as "NEW". Under the title of "PREVIOUSLY CONSTRUCTED" means the power Plants that prosed to construct during the given NDP period. Projected power supply through the proposed energy generation systems for NDP6 :1323 MW and NDP7 :2348 MW.

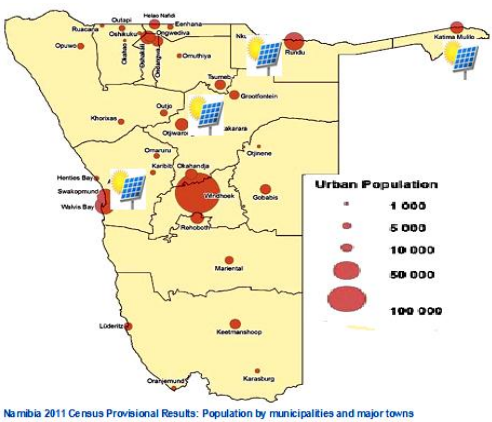
The rationale behind the Proposals

To ensure energy security with the increasing amount of clean energy and guarantee reliable electricity supply is essential for the industrialization process. And the proposals are guided by those needs. Moreover, after commissioning the Kudu Gas Project, by 2030, Namibia will become an energy exporting industrialized country with commendable energy independence.

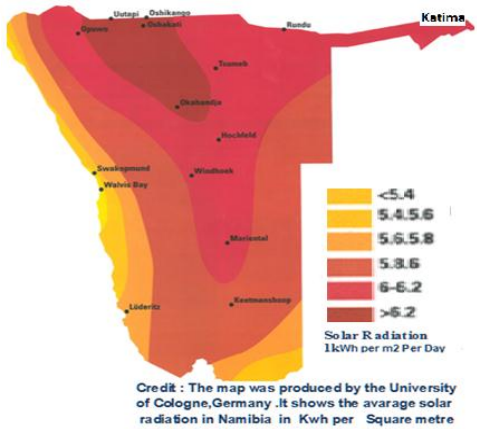
The proposed 300MW coal-fired power plants, Windhoek 100MW combined cycle thermal plant and 450MW small nuclear reactors will guarantee reliable base-load for the country. Moreover, they support the renewable power generation of 400MW solar power plants and 125 wind farms. But to retain an efficient renewable energy sector cannot be realized without supporting base-load utilities.

New Utility Scale Solar Systems

Namibia is one of the sunniest countries in the world (5 to 6 kilowatt hours per square meter) and solar power generation potentials should be explored. So, the proposed 4 solar power plants can generate 400 MW of low-carbon electricity. They can be constructed by utilizing he latest solar energy technology: Concentration Solar Power (CSP) and Photovoltaic (PV).



Namibia 2011 Census Provisional Results: Population by municipalities and major towns



Credit : The map was produced by the University of Cologne,Germany .It shows the avarage solar radiation in Namibia in Kwh per Square metre

Utility scale solar power plants generate megawatt level electricity. For example, in South Africa, our neighboring country, a leading solar energy group Abengoa of Spain has started construction on two concentrating solar projects (CSPs) in the Northern Cape Province: 100MW Parabolic Through plant in Pofadder and 50MW CSP Solar Tower in Upington. These two power projects will be operational in 2016 and their total cost is ZAR 11.4

billion. One of the largest CSP plants in the world, Solana Parabolic through CSP Plant in Gila Bend, Arizona, is designed to generate 280MW of electricity.

Wind Turbines

Wind is the second-hand solar energy. Its driving force is the unequal heating of the earth and atmosphere. The availability of wind resources depends on the geography. They are more productive and practical in mountainous areas and along the coastal areas. The success of a wind energy project is decided by the average wind speed and the availability of more windy hours. In Namibia we have abundance of solar radiation throughout the day and across the country but wind energy is limited to some locations. Wind power is another renewable energy agent that can generate clean energy. This paper proposes two wind projects in the west coast and Windhoek where adequate wind resources are available. They will generate 150 MW.

New Combined Thermal Power Plant

Windhoek is the capital city as well as the commercial administrative center of Namibia. Hence it deserves reliable base-load electricity supply. By 2022, the refurbished Van Eck coal plant`s technical and economical lifespan will be ended. After the decommissioning it, to ensure the strategic power supply to the capital, the paper proposes a 100 MW combined cycle thermal plant. This plant will remain as an emergency or backup power utility.

Nuclear Energy

The proposal underlines the economic and technical viability of another safe and cost effective nuclear technology: Small Module Reactor (SMR). The paper proposes two SMRs (225MWx2) for Walvis Bay Harbor Town. This harbor has the potential to develop as an international transshipment hub. A SMR can generate around 200 MW of electricity which is sufficient to power small cities, mines and factories. For instance, a Westinghouse SMR (225MW) can supply electricity to 45,000 homes in the Windhoek Municipality or to Scorpion Uranium Mine in Namibia.

The construction timeline for a Westinghouse's AP 1000 reactor is usually around seven years. As the SMRs are built in factories and transported to the intended location by ship, rail or land vehicles, they can be installed in less than 24 months. Also it is not necessary to open them for re-fuelling but if need be, they can be sent back to the factory for that task. Besides that, at the end of their lifespan, SMRs are returned to the factory for dismantling.

Kudu Gas Project

The Kudu Gas reserve is situated in Orenjemund area which is near South Africa`s border. This gas reservoir has the capacity of 800 MW. In addition to the renewable energies, Namibia needs strong base-load generation utilities. Gas can be combined with renewable energy sources like solar thermal. This hybridization leads to combine -cycle gas turbine

(CCGT) plants with concentrating solar power systems. Currently, a number of Integrated Solar-Combined Cycle (ISCS) power plants are in operation across the globe and the largest plant is 75MW Martin Next Generation Plant in Florida.

A report by the finance ministry (The Namibia, 21 Sept.2015) estimated that government would have to invest more than N$ 10 billion in cash and provide further N$ 32 billion in guarantee for the Kudu Gas plant. That investment is 15% of the GDP of Namibia and it is not viable for the country. Hence the planners of Kudu can explore possibilities to generate that capital from a joint venture comprising local and foreign investors.

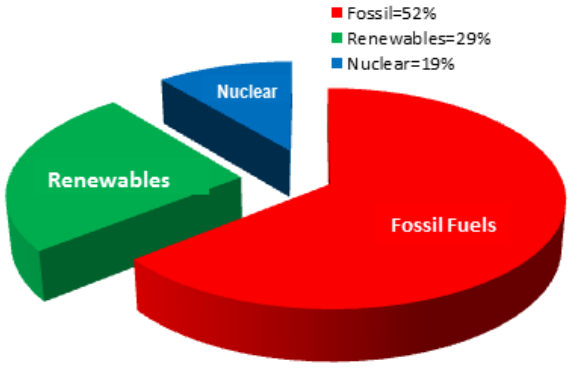
The United States of America has found massive shale gas reservoirs which will ensure the country`s energy security, create more employment and lower greenhouse gas emissions. But due to the prevailing unpredictable developments in the global gas industry investors are not prepared to invest in Kudu Gas. Hence, the Kudu Gas should attract international and local investors during the 7th NDP period and until that it is wise to delay the project. Nevertheless, the momentum of the present shale gas boom will wither gradually. And the global demand for clean energy resources like natural gas will increase. Definitely, it is necessary to capitalize this natural asset to ensure Namibia`s energy security.

Saving and Managing Electricity Efficiently

Electricity is a limited resource with a high-cost of production. Using energy wisely should be developed as a culture. Strong public awareness through the civil society organizations, religious institutions, schools and industries is vital. Also industries and households can save energy by using energy efficient technologies and promoting Light Emitting Diode (LED) that consume less electricity than and florescent bulbs. Architects should design energy efficient building and use more sunlight.

Clean Energy Generation Mix in NDP 7

Accommodating more renewables is becoming a global necessity. Germany, a leading solar energy generator in the world, currently use 50% of renewables for the national energy mix and other developed countries are also planning to raise their renewable energy targets to greater heights.



Proposed Energy to Power 2030

During the NDP7 period (2027-31), the restructured energy mix will comprise nearly 50% of clean energy regimes: renewables like solar and wind along with nuclear - this is an expansion of renewable energy targets to the global level. It will help to reverse the greenhouse gas emissions and push forward low-carbon economic growth. And gas is regarded as a low-carbon emitting clean energy source. Therefor the NDP7 Energy Mix is a low-carbon emitting energy blend.

Conclusion

The proposed renewable energy generation plants, including the rural and urban household solar panel installations, will create new employment opportunities, support small businesses and reduce carbon emissions. The reliable based-load generated by coal and nuclear plants will support the efficiency and the reliability of the renewable power supply. By implementing the Kudu Gas Project during the 7th NDP period, Namibia can rise as a competitive industrial nation with a marked higher renewable energy target. This nation could also win and retain its national energy independence and export energy to other countries.

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