GREEN ENERGY IN NAMIBIA

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1. Introduction[1]

Energy does not have a colour, yet we often hear the expression “green energy”. What is meant by it? Green energy refers to those energies that do not degrade the environment while generated and used. Renewable energy sources, including solar, wind and geothermal energy, biomass as well as wave and tidal energies, are examples of green energies [1].

Why would one be interested in green energy? Increasingly, scientific evidence points to the important impact that the generation of electricity and use of energy has on our global climate [2]. Worldwide, a significant proportion of the total current energy supply is covered by fossil fuels; these emit carbon dioxide when burned [3]. Carbon dioxide is one of several gases called greenhouse gases. Their increasing concentration in the Earth’s atmosphere contributes to rising atmospheric temperatures. This phenomenon is called the greenhouse effect, and is a cause of the changing global climate [4]. In the eyes of many eminent scientists and international institutions, climate change and the multitude of repercussions of a rapidly changing global climate will become the single most important issue of this and coming generations. Failure to address climate change may lead to irreversible and even catastrophic environmental changes, requiring evermore resources for mitigation and adaptation activities. The rapid deployment and use of carbon-neutral energies – to satisfy the ever-increasing global demand for energy – is a prime imperative if we are to stand a chance to effectively address global climate change, now and in future [5].

When discussing energy and energy generating systems, it is useful to understand the most important units in which these are measured [6]. One common unit to quantify energy produced or used is kilowatt-hours, abbreviated kWh. As an example, a medium-income Namibian household typically uses between 5 and 15 kWh of electrical energy per day [7]. Many thousands of kWh are easier to express with a different unit, namely megawatt-hours or MWh. One MWh is equal to one thousand kWh. The Rössing uranium mine used more than 425,000 MWh of energy in 2007 [8]. If millions of MWh are used or produced, one often uses yet another unit, namely terawatt-hours or TWh. One TWh is equal to one million MWh. Namibia consumed some 3.6 TWh of electrical energy in 2007 [9]. In the same year, our total national energy consumption exceeded 15 TWh, which includes the consumption of all liquid fuels, electricity, biomass and other renewable energies, and liquid petroleum gas [10]. Namibia imports many goods, which all require energy for manufacturing and transport. Our total national energy consumption figure excludes the embedded energy – i.e. the energy used to produce and transport goods up to their final destination – contained in all materials imported across our nation’s borders [11].

To be able to use electricity, one has to generate it. Namibia’s hydro-electric power station at Ruacana for example has three turbines with a combined capacity of 249 MW [12]. This means that – when in full production for one hour only – the plant generates a maximum electrical energy of 249 MWh, or enough to supply 16,600 households (each consuming 15

[1] This booklet presents an overview of the many green energy potentials in Namibia. To keep it relatively short and easy to read, most technicalities and detail considerations are deliberately left out, and many important issues are only covered superficially, or not at all.

kWh per day) for one full day. Namibia's current electrical generation capacity includes the Ruacana power station, the coal-fired van Eck power station just north of Windhoek, having a capacity of 120 MW, and the Paratus power station in Walvis Bay, which uses heavy fuel oil and has a capacity of 24 MW. Presently, the installed national electrical generation capacity, and therefore the maximum that all Namibian power stations could supply, is mostly insufficient to match Namibia's demand for electrical energy. In 2008, our maximum demand was 533 MW, which is substantially more than the maximum of 393 MW that we have at our national disposal. To make ends meet, Namibia imports electrical energy generated mainly in South Africa and Zimbabwe, using NamPower's transmission networks. Assuming that our neighbours have sufficient generation capacity, these interconnectors to across-border suppliers had a maximum capacity of 600 MW in 2008 [12].

What about energy that is not generated in power stations? Our transport and mobility needs require copious amounts of liquid petroleum-based fuels, such as petrol and diesel. Both are liquid energy carriers. The energy content of petrol is 9.6 kWh per litre, while that of diesel is 10.7 kWh per litre [13]. Presently, Namibia imports all liquid fuels. In 2007, we consumed the equivalent of almost 10 TWh of liquid fuels, which constituted some 63% of the country's total energy consumption in that year [10]. As such, transport fuels are the single largest component of Namibia's overall energy mix. To illustrate, our national liquid fuel consumption is equivalent to every Namibian man, woman and child using almost 500 litres of petrol in 2007, which is the equivalent to 4,800 kWh per person per year. In contrast, our total annual electricity consumption equates to some 1,800 kWh per person per year in 2007 [14].

Having established a common language, we can now discuss Namibia's green energy potentials and the many interesting aspects about the use of green energy. Energy consumption is often wasteful, or inefficient, which is why a section on energy efficiency and demand management in Namibia is included. Because the demand for specific forms of energy – for example liquid fuels or electricity – determines how the market makes them available, we discuss a few issues shaping the emergence of Namibia's green energy market. We touch on the question how the share of green energy in Namibia's energy mix can be increased. A brief introduction and discussion of carbon credits for green energy projects in Namibia is also presented. Lastly, conclusions summarise the main issues, and provide an outlook on the future of green energy in Namibia. Please enjoy, and share the fascination about Namibia's abundant green energy potentials!

2. Namibia's Green Energy Potentials

2.1 Biomass

Extensive areas in Namibia – of the order of 26 million hectares – are covered by invader bush [15]. This phenomenon is called bush encroachment, and sees indigenous thorny bush and shrub species found in our natural rangelands grow in such abundance that the invader bush increasingly suppresses the growth of grasses, reduces biodiversity, and reduces the penetration of rainwater required to recharge our all-important underground water resources. Invader bush, while not the only source of Namibia's biomass, is a substantial and as yet underutilised source of energy [16]. Bush can add value to Namibia's economy, and is not merely the nuisance that some farmers feel it is. To illustrate, the energy content of Namibia's bush-infested areas amounts to about 1,100 TWh, assuming a mere 10 tons of bushy biomass per bush-infested hectare[2] [16]. This is more than 70 times the total amount of energy that Namibia consumed in 2007! Our bush resource is an essential source of food for browsers, and is used for fire wood and to produce charcoal. Almost 2 TWh, or 13% of Namibia's total energy consumption in 2007, was covered by biomass [10].

Namibia's invader bush is a potential fuel source for power plants [17]. Wood from invader bush can fuel the boilers of conventional power stations. Alternatively, the volatile parts of biomass can be liberated through a process called gasification, and be used to power conventional piston engine, which in turn can drive a generator. To optimise the logistics of transporting bush fuel to such power plants, these would ideally be small (only a few MW), and decentralised. Biomass-to-electricity power plants could contribute more than 100 MW to the national capacity, while providing some 0.5 TWh to the national energy mix. Presently however, only one 250 kW proof-of-concept plant is expected to become operational in 2010 [18]. The financial feasibility of small bush-to-electricity plants is marginal at most, but plants between 5 and 20 MW each may one day prove economically viable [17]. Utilising bush as an environmentally sustainable energy resource could create many new rural jobs and livelihood opportunities [16]. Such developments, however, will not happen on their own. To develop the potential of our national bush resource, policy support and incentives are needed, which are further discussed in section 6 below.

2.2 Biofuel

Biofuels are liquid fuels derived from plants and crops, and are a renewable resource [19]. Some, but certainly not all biofuels emit less greenhouse gases than are sucked out of the atmosphere while the biomass from which they are derived is growing [20]. The development of carbon-neutral biofuels is a key to the future of our transportation systems.

One type of biofuel, namely ethanol, is produced by the fermentation of maize, corn or sugar cane [21]. Ethanol can be blended into petrol, or be used in specially equipped ethanol-powered engines. Another type of biofuel, i.e. biodiesel, is derived from oil-bearing fruits and nuts, such as soybean, canola, castor, sunflower

[2] This number is the approximate calorific equivalent of the bush resource. It is only provided to illustrate the sheer size of the resource, and not intended to promote the idea of the indiscriminate or wholesale use of all bushy biomass in Namibia. One should also remember that many losses occur during the conversion of a primary energy source into a more useful energy form, which implies that only a fraction of it can ever be made available.

seeds, and the seeds from jatropha trees. Biodiesel can also be manufactured from organic and vegetable oils, recycled cooking oil and animal fat [22].

The complete biofuel manufacturing and distribution process, from planting and harvesting, to processing and distribution, until it is poured into an engine's fuel tank, plus the emissions when the fuel is burned, determines whether a biofuel can be considered energy positive and carbon neutral [23]. The use of fertilisers, pesticides and water requires energy. Additional energy is necessary for harvesting and transporting feedstock biomass material to the processing plant, and from there to fuel depots and filling stations. This production chain determines how much extra energy is to be invested, and carbon emitted, before the fuel is available for consumption. Not all biofuels are a true source of green energy, irrespective of what the producer's marketing materials may claim [24].

The cost and availability of home-grown food may be adversely affected if there is a large-scale switch from food to fuel crops [25]. Namibia's arable land in medium- to high-rainfall areas is very limited, and we remain a net importer of most cereal crops. Aspects of land ownership, the promise of many new rural jobs, and the invasiveness of certain plant species are important issues to consider before embarking on large-scale biofuel production. Namibia's expansive and seemingly unused tracts of land may give the impression that they are waiting to be used for the production of fuel crops. The availability of sufficient water, and optimal sustainable land use criteria are key issues to be kept in mind. Namibia's highly variable climate necessitates drought- and flood-resistant plant species, ruling out many conventional fuel crops currently planted in more moderate climate zones.

There is some promise that ethanol can be derived from cellulose, i.e. grass, woody biomass and biomass waste, thereby producing biofuels without affecting the production of cereal crops [26]. Cellulose-based biofuel production takes place in bioreactors in which cellulose is converted to ethanol in enzymatic reactions. Also, processes such as pyrolysis can produce biofuels. Both enzymatic conversions and pyrolysis remain technically challenging, and do not as yet produce biofuels on scales that significantly reduce the international demand for fossil fuels. Further development, the creation of conducive market mechanisms, and fuel standards are needed before – what may seem like "liquefied grass" – is poured into our fuel tanks. Namibia has the potential to benefit from the emerging biofuel developments, but we have to remain cognisant that not all that seems green remains so once properly examined.

2.3 Biogas

Methane and carbon dioxide – the two main constituents of biogas – are produced when micro-organisms feed on organic matter [27]. Methane is a potent greenhouse gas, but can be used for heating or to power conventional internal combustion engines. Organic matter from which biogas can be produced is plentiful, and is found in manure and slurry from dairies, pig and poultry farms, municipal waste dumps, and wastewater treatment plants [28].

Heat and electricity generation are attractive decentralised options for biogas use, provided sufficient quantities of feedstock are available. Biogas can be used as engine fuel. Presently, there are only a few small-scale biogas reactors operational in Namibia, none of which generate electricity. A soon to-be-established dairy in Mariental may build a biogas plant to generate heat and electricity, and thereby also benefit from carbon credits [29]. This would be an important step to showcase the operations and viability of biogas plants under Namibian conditions.

2.4 Geothermal Energy

Geothermal power stations generate carbon-neutral electricity using hot water found close to the Earth's surface, or the heat trapped in geological formations deep underground [30]. They do not exhibit the daily or seasonal variations so characteristic of wind and solar energy, making geothermal power stations ideal for base-load power generation. Geothermal power plants produce low cost electricity, for example in the USA, Iceland, Indonesia and Kenya [31].

Namibia's geothermal resource potential remains largely unknown. High drilling and assessment costs render a detailed country-wide resource estimate unfeasible. The presence of hot springs, from Warmbad in the far south of Namibia, to Rehoboth, Windhoek and Gross Barmen, as well as those in the Kunene Region, are insufficient evidence to conclude that viable high-temperature geological formations useful for geothermal power generation exist in the country [32]. However, geothermal technology development is rapid, and enhanced geothermal systems, including those using low-temperature resources, could one day realistically contribute to Namibia's green energy mix. This is a resource waiting to be explored!

2.5 Hydro-electric Energy

NamPower's Ruacana hydro-electric power station covered more than 88%, or 1.3 TWh, of Namibia's locally-generated electricity consumption in 2008 [33]. Three turbines of 83 MW capacity each generate electricity when the Kunene River's water flow allows. A fourth turbine will be added in 2009, and will increase the station's capacity to some 320 MW. As a run-of-river station, Ruacana will remain dependent on the daily water flow from Angola. In the absence of sufficient flows it cannot feed electricity into the national grid on demand.

The proposed Baynes hydro-electricity scheme, also on the Kunene River and downstream of Ruacana, is to have a generating capacity of some 360 MW [34]. A storage dam is planned, which implies that Baynes could contribute some 1 TWh per annum to the national electricity mix. Such a development would provide much-needed base-load power and power on demand, provided the dam holds sufficient water.

The lower Orange River in Namibia's south, and the Okavango River in the country's north-east, have the potential for a number of smaller-scale hydro-electric power plants [35]. At least 120 MW could be realised if the existing potentials are developed, and could contribute some 0.3 TWh of green electricity per year.

2.6 Solar Energy

Namibia’s solar energy potential is amongst the world’s best [36]. At an annual solar radiation average exceeding 6 kWh per square meter per day, this resource is most significant, and it is and will remain free to use. Presently, solar energy for power generation remains mostly untapped – except for the photovoltaic electricity and water pumping installations throughout the country – but could provide significant quantities of green energy for the long-term sustainable development of the country [37].

For example, concentrated solar thermal plants of 50 MW each, yielding some 0.2 TWh per annum, could contribute to the decentralised provision of electricity. Our excellent solar resource, the many open and flat spaces in Namibia and good connection possibilities to the national electrical grid all contribute to make the application of concentrated solar power a realistic future generation option [37].

Conventional gas-fired combined-cycle power plants can be boosted by solar thermal energy. An integrated solar-gas combined-cycle power station’s main advantage is that the peak capacity can be increased by using solar boosters, thereby enhancing daytime generation [37]. One or several plants in the range of between 50 MW and 150 MW are possible, yielding a generation output of some 0.3 TWh per annum per 50 MW unit. Namibia’s Kudu gas field could provide the required gas resource [38]. Electricity generated in this way is not free of carbon dioxide emissions, but emissions from gas-fired power plants are significantly below what coal-fired power stations achieve. In addition, using our solar and gas resources in synergy allows for night-time and season-independent generation, which is essential for base-load power stations. For interest, a combined-cycle gas power plant of 400 MW capacity, fed from Namibia’s Kudu gas field, could be operated for some 40 years, availing some 3 TWh per annum. A solar-boosted plant could extend the lifetime of the gas resource by several years.

The generation potential of solar photovoltaic (PV) plants in Namibia is not limited by the availability of the resource, or space requirements [37]. Rather, matching the supply from such power plants to the current demand, and accommodating their supply peculiarities in the Namibian grid, are key issues. Under prevailing conditions, a generation output of some 0.08 TWh per annum per 50 MW of installed capacity is possible. Large-scale photovoltaic power generation remains expensive and requires storage capabilities if output power is to be available continuously.

2.7 Wave and Tidal Energy

Namibia boasts a coastline of more than 1,600 km, offering unexplored wave and tidal energy potentials [39]. Similar to our geothermal resource base, the size and potential yield of our wave and tidal energy resources has not been assessed yet.

Internationally, research and development initiatives in this underdeveloped energy field have been assisted by increasing concerns about global warming and energy security, and rapidly rising fossil fuel prices [40].

The wave and tidal energy sector remains dependent on development support to overcome technical hurdles. In contrast to many other green technologies, wave and tidal energy generation capabilities are immature. Presently, various ocean energy technologies are developed, and it is predicted that the European Union could have an installed capacity of some 3,000 MW by 2020 [41]. In Namibia, we will remain ignorant of the treasures that our near limitless ocean resources hold unless we quantify their suitability and potential yield, and determine their viability for development.

2.8 Waste-to-energy

Household and industrial waste is deposited in landfill sites throughout Namibia. Except for the collection of materials for recycling, little other value is derived from these continuous waste streams. Waste dumps however offer opportunities for energy generation, either through incineration to generate heat and electricity, or by capturing methane gas, which in turn can power conventional piston engines and drive electric generators [42].

Considering that our larger municipalities have to dispose of tens of thousands of tons of bio-degradable waste every year, there are a variety of opportunities for energy generation from such waste disposal sites [43]. Again, only a detailed assessment can reveal the costs and benefits of using waste for power generation under Namibian conditions.

2.9 Wind Energy

Wind resources along the Namibian coast are considerable, and it is no secret that the wind energy potential in the area south of Lüderitz is outstanding [36]. Several on-shore wind farms with an installed capacity of between 20 and 50 MW each could be built along our coast, taking the constraints of the Namibian transmission system into account [44]. A typical 50 MW wind farm positioned on our southern coast would yield some 0.12 TWh every year [37]. Off-shore sites may one day add to such capacity, but would also substantially increase the cost of supply, as the installation and connection to the national grid is demanding [45]. Presently, very limited site specific wind resource measurements are available [46]. Such wind resource data is required to optimally size, position and design a wind farm, and their absence prevents potential investors and future wind farm operators from understanding how viable such investments could be.

2.10 Clean Coal

Coal-fired power stations are well-known in design and operation, and NamPower is currently investigating the context of establishing a plant of between 200 and 800 MW capacity at or near Walvis Bay [47]. While coal-fired power plants cannot be considered “green”, there are a variety of methods to reduce the emissions of particulates and greenhouse gases from their smokestacks [48]. The clean coal option in modern coal-fired plants adds significantly to the cost of a conventional coal-fired power plant, as does the use of sea water for cooling purposes [49].

Namibia does not have domestic coal resources with proven mine-ability. Remaining dependent – throughout the useful life of such a power plant – on international commodity prices, and therefore exposed to foreign exchange fluctuations, is an important draw-back for a new coal-fired power station in Namibia [50].

2.11 Reflections

A distinguishing feature of many renewable energy power plants is – in contrast to those using fossil fuels – that fuel resources for most green energy plants are indigenous and often free of charge, that they create local benefits including local jobs, and that they do not pollute the environment [51]. Very importantly too, their operating costs are known before they are commissioned. Conventional fossil-fuel power stations rely on continuous fuel purchases: these are coupled to international commodity price developments and remain subject to foreign currency exchange fluctuations. This renders realistic lifecycle and output costing subject to many intangible assumptions, and means that we will never know for sure how much the electricity generated by fossil-fuelled power plants may cost in five years time, or for that matter, next year [50].

The modularity of renewable energy power plants and most green energy ventures is another key advantage [51]. The ability to rapidly scale up such operations as local demand grows, and local lessons have been made, is most valuable. Renewable energies' suitability for smaller-scale decentralised implementation makes them well-suited for sparsely populated countries such as Namibia.

It is sobering to remember, however, that our national electric system requires base-load power that remains relatively independent of the season and time of day. Energy storage systems can be used to smooth out the supply of those green energy technologies that have a daily or season-dependent variable output. Such storage systems are currently developed, but substantially increase the cost of many green energy systems [52]. We conclude that we have to remain cautious about the real benefits and costs of both conventional and green technologies before we have not comprehensively determined their true lifecycle costs.

3. Energy Efficiency and Demand Management

Energy efficient practices and technologies aim to reduce the amount of energy required for a given task [53]. Take the example of domestic water heating: a household may decide to switch from using an electric water heater to a solar water heater. In this way, energy is saved by using a green technology without a loss in reliability, while also saving money [54].

Most Namibian households can save between 5% and 20% of their normal electric energy consumption without a real loss in service levels or comfort [55]. This can be achieved by merely applying a combination of different consumption behaviours, and using energy efficient appliances. For example, increasing the set point of an air conditioner unit to only start cooling at a higher temperature, or washing clothes with cold water detergents instead of a hot water variety, using a washing line instead of a tumble dryer, and enabling the power saving options on electric and electronic devices all result in lower electricity bills. Our very personal consumption habits and decisions matter a lot, and energy conscious behaviours are a key to save energy the smart way, and help the environment [56].

Most Namibian businesses and industries offer significant energy saving potentials [55]. Awareness and training programs can enable consumers to make smart energy choices and decisions. Using heat-reflective paint on roofs and insulating materials, closing windows when using air conditioners, and investing in more energy efficient technologies, all make an impact on a business's bottom line by saving energy. In many cases, an experienced energy auditor will be able to shave off between 10% and 25% of a business's electricity bill, even before money is spent on additional energy efficient technologies. Choosing the right-sized pump, or replacing old heating or cooling devices with more energy efficient ones, or making power factor corrections make a considerable difference to the amount of energy used in standard processes [55].

Demand management activities reduce a consumer's demand for and therefore consumption of electrical energy. For example, many consumers change their demand for electricity in response to time-of-use electricity tariffs, simply by switching devices off or reducing their on-time when electricity is expensive, or postponing the use of high-wattage appliances to when electricity tariffs are lower [54]. Regional electricity distributors and municipalities will introduce these differentiated electricity tariff scales for large power users from July 2009 [57].

Some municipalities can remotely switch on or off certain household or industrial devices, using so-called ripple control systems. For example, the City of Windhoek can remotely control the operations of some domestic electric water heaters [58]. In this way, the demand for electricity is remotely managed, and often leads to more productive uses of energy during a particular period of the day, or during the month. Demand can also be temporarily lowered by load shedding, which is the selective or wholesale disconnection of consumers from the electricity grid. In this way, the demand for electricity is suspended until the local authority or electric utility can again match demand and supply. Most demand management practices do not actually reduce the total energy used by a consumer in a given year [54]. However, incentivising or disallowing the use of electricity at certain times fosters the productive use of electricity, which can have monetary benefits for all.

The energy-conscious design of buildings is an often overlooked yet critical aspect to reduce the ongoing energy required by domestic or industrial consumers. Here, the orientation of a building relative to the path of the sun across the sky, the use of suitable building, cladding and insulating materials, taking natural air flows into account, using double glazed windows, and optimising the natural and artificial shading of a building can all reduce the energy requirements, while making a building more hospitable and reducing its carbon footprint [59].

4. Potential Markets for Green Energy in Namibia

4.1 Demand for green energy

Little is known about the actual demand for green energy in Namibia. It is quite likely that there are consumers interested in purchasing green electricity if it were offered [60]. However, we should not forget that a very sizeable group of Namibian consumers exist who are either not connected to the national grid, or do not have the means to pay for electricity, let alone if offered at a premium price [61].

First discussions with select manufacturers as well as operators in the tourism industry indicate that products and services exist that could benefit if they were produced or offered using green energy [62]. Examples include the speciality export industry, where green energy could effectively lower the carbon emissions of the production chain. Think about eating Namibian carbon-free salami in Oslo! The tourism industry could offer carbon-reduced tours and green-powered lodgings in Namibia. Offerings that add to Namibia's reputation as a clean and environmentally appealing travel destination would generally benefit if green energy was used more widely.

The Namibian demand for low-carbon fuels, i.e. biofuels, is similarly unknown [63]. It is assumed that such a demand will develop once such fuels enter the market. Initially, niche markets similar to the ones for green electricity are the most likely, and certainly the most promising initial demand drivers for such fuels.

4.2 Supply of green energy

In May 2009, no officially branded green electricity or fuel is available in the Namibian market – this is despite the fact that in 2008, 88% of the total electricity generated in Namibia was hydro-electricity, which could offer such branding opportunities[3]. In the absence of a clear regulatory framework guiding the feed-in of green electricity into the Namibian grid, and without appropriate feed-in incentives, the playing field between conventional grid supplies and new green electricity remains skewed [64].

In the fuel sector, some entrepreneurs have started to invest in the production of biodiesel from the cultivation of castor and jatropha [65]. A small-scale producer of biodiesel from cooking oil has established itself [63]. However, the wider

[3] Maybe this is the reason why NamPower's logo is mostly green?

market has not yet benefitted from such offerings, and it will be some time until any significant supplies of green liquid fuels will reach the established distribution points.

4.3 Markets for Green Energy in Namibia

Where could tomorrow's markets for green electricity and fuels be? In the last few years, the demand for energy efficient products, such as compact fluorescent lights and solar water heaters arose almost singularly because of a rapid increase in electricity tariffs and enhanced consumer awareness and understanding. Consumers realise that some products are simply more environmentally benign than others, and are also keen to benefit from cost-savings.

Future markets for green energy should not merely have to rely on consumer sentiments. In an effort to promote the establishment of green and sustainable industry sectors, tax breaks and incentive programs specifically promoting the creation and consumption of locally generated products and services are needed. Sectors that would specifically benefit from a greening of their value chains include the tourism sector, the exporting meat and fresh-produce sectors, and the beer brewing fraternity.

An as yet untapped market opportunity exists in the carbon offset industry: already we welcome tourists who have offset the carbon produced while travelling to and from Namibia using international carbon offset providers who invest in projects throughout the world [66]. As yet, Namibia does not offer carbon offset opportunities, while there are many potential avenues to do so: why not offer carbon-neutral holidays? For example, "*Experience carbon-free Namibia*", or maybe "*The carbon-neutral airline*". Export products could be turned carbon-neutral: how about "*zero-carbon Aussenkehr grapes*"? Why not invite your guests to down a "*sparkly no-carbon Camelthorner*"? Or attract funds from institutions and individuals eager to reduce their carbon footprint by creating carbon-free services and development initiatives. We have to realise though that it is one thing to come up with a snappy marketing idea. Sadly, it is often more demanding to create a real and sustainable carbon-sequestering project. Section 5 below discusses the carbon market opportunities in further detail.

4.4 Rural Electrification

Since Independence in 1990, Namibia has made substantial progress in bringing electricity to the furthest corner of the land [67]. In 2009, most of the lower hanging fruit in rural electrification have been picked, yet more than 200,000 households remain without access to modern energy services [68]. Economic considerations prohibit the country's complete electrification using conventional grid electricity. Would green energy technologies be suitable to provide decentralised energy services to people in areas far away from the existing national grid?

Investments in off-grid energisation[4] in Namibia have been small, and few real and sustainable successes can be shown. The playing field between grid and off-grid technologies remains far from level. Rural customer demand for off-grid technologies remains underdeveloped, despite a number of attempts to introduce novel financing vehicles to bring such technologies closer to consumers [69]. Reliable service, the long-term provision of maintenance, and the ongoing collection of fees remain a challenge in rural Namibia. Realism in terms of what rural electrification targets are achievable, and how rural energisation can be incentivised, is needed. A continued commitment Government to systematically bring affordable energy services to rural Namibia is necessary, thereby also introducing new and decentralised livelihood, learning and business opportunities [70].

4.5 Issues, Barriers and Options

Namibia's fledgling green energy sector is far from being well-established, and remains vulnerable. Low electricity tariffs render most non-mainstream energy investments unattractive. We do not have national green energy or energy efficiency targets which would drive new investments and innovation. Opportunities in the green energy market are limited even though we have amongst the best solar resource in the world, have an excellent wind regime along our coast, and are endowed with considerable biomass resources.

Our tax and investment incentives do not specifically promote green energy ventures. The market size and demand for green energy products and services is small, especially when compared to our southern and northern neighbours. Institutional support, compared to what investors find in other parts of the world, for example for resource assessments, feasibility and impact studies, and to avail reliable data, remains minimal. Green energy investments still rely mostly on the entrepreneurial vision of a few individuals.

In an energy hungry world, potential energy sector investors have a wide choice of locations to go to, some offering excellent incentives in addition to a resource base as good as Namibia's. So what could be done? Our feed-in tariffs for green energy technologies have to at least match those offered in the region. Indigenous energy resource development requires active incubation and establishment support. National green energy and energy efficiency targets need to be established. Investment framework and business conditions need to be made more investor friendly, and attractive. Consumers need to be aware of what is available, and information needs to be provided on the costs and benefits of using of green energy technologies, and the productive use of energy. The green energy sector would expand if access to development funds to trial and introduce green energy technologies were available, and energy-conscious consumer decisions promoted. Section 6 discusses the most important facets to promote green energy in Namibia.

[4] Energisation refers to the provision of a range of suitable energy sources to meet a consumer's electrical and thermal energy needs, and those for liquid fuels.

5. Carbon Credits in Namibia's Energy Sector

The Clean Development Mechanism (CDM) was established under the Kyoto Protocol of 1997 to promote environmentally friendly investments in developing countries [71]. The principle is simple: because it does not matter where emissions of greenhouse gases occur, investments in emission-reductions are most sensible where they are most cost-effective. As emission reductions are often cheaper in the developing world, CDM-accredited projects that lead to emission reductions in these parts of the world may issue so-called "certified emission reductions", or CERs [72]. These certificates can be bought and sold – often facilitated by international carbon brokerage firms – by governments, investment and insurance companies and banks, and companies in industrialised countries to help them reach their country-specific emission targets. Such trade is meant to assist developing nations in furthering their own development objectives, while creating opportunities for industrialised countries to reach national emission targets without having to make costly carbon-reducing investments in their industrial processes. In May 2009, one CER for a ton of carbon dioxide saved cost approximately N$ 120 [72].

In 2007, the World Bank estimated that the carbon market was worth about US$64 billion [73], which is more than 20 times Namibia's national budget spending figure for 2009/10. In 2008, the market for carbon was worth more than US$ 126 billion [74]. However, out of more than 4,000 CDM projects worldwide, only a little more than 50 CDM projects are currently taking place in Africa [75]. Presently, Namibia does not have any CDM projects, yet the potential for tapping into such development funds exists. Generally, green energy projects, energy intensive industries, and those in the electricity sector offer good opportunities for CERs [29], as do those in the country's forestry sector [76].

Namibia, as a non-Annex I party to the United Nations Framework Convention on Climate Change, is eligible to host greenhouse gas mitigation projects to earn CERs. In August 2007, Cabinet approved the establishment of an office for the Designated National Authority (DNA) at the Ministry of Environment and Tourism, and the country's CDM office at the Ministry of Trade and Industry [77]. In May 2009, the DNA is established and operational, and is supported by the Namibia Climate Change Committee. A position of deputy director to coordinate Namibia's DNA activities is about to be advertised. The establishment of the CDM office, however, experiences delays. Project proponents wishing to benefit from CERs are required to work through the CDM and DNA offices to identify, prepare and ultimately launch and undertake their projects. A number of project identification notes, which constitute the very first step in developing a project that is to benefit from CERs, have been assessed to date. These include a proposal for the development of geothermal sources, and using invader bush in cement production. While Namibia has made some progress to participate in CDM-related activities, further institutional and project development support is required to ensure that Namibia can fully benefit from the many opportunities presenting themselves through the CDM [78].

CDM projects need to conform to a set of stringent selection criteria; these have to be demonstrated by the project developer, and verified by an independent verification agent, before carbon credit revenues accrue [79]. It is essential that a potential project uses a project methodology approved by the CDM Executive Board [80]. These methodologies specify in detail how emission reductions are calculated. For example, it is necessary to show that project activities and associated carbon reductions would not have been achieved without benefitting from CER revenues. Also, emission reductions achieved in projects benefitting from carbon revenues have to be real, be measurable against a historical emissions baseline, and remain sustainable. Furthermore, emission reductions made in one area should not lead to an increase of emissions elsewhere. Benefitting from carbon credits therefore requires rigorous preparation, registration, verification and validation processes, all of which come at a cost. Projects that save only a few tons, or tens of tons of carbon per year, are therefore not suitable under the CDM, and for these, the voluntary carbon market is more applicable [81].

An example of a CDM project in Namibia could involve an Independent Power Producer (IPP) wishing to add renewable energies to its generation portfolio [29]. The IPP may be interested to benefit from Namibia's excellent wind regime, and establish a wind farm that would feed electricity into the national grid. In this way, the wind generators would supply carbon-free electricity to the grid, and thereby displace some of the electricity generated by a fossil fuel-powered generator. The displacement of electricity from carbon-emitting power stations with carbon-neutral electricity from the wind farm qualifies as a CDM project, and can earn carbon revenues in addition to the income derived through the sale of electricity. In Namibia, taking our national grid emissions factor and the proportion of clean and carbon-polluting electricity in our national electricity mix into account, a wind farm of 30 MW capacity would reduce carbon dioxide emissions to the atmosphere by more than 40,000 tons every year, which is equivalent to the number of CERs that the IPP could sell per year [29].

The voluntary carbon market, or VCM, exists in parallel with the CDM [81]. Unlike the regulated CDM, VCM has no regulatory body and relies on various voluntary standards. These standards specify how projects can benefit from greenhouse gas emission reductions without having to fulfil the CDM's many bureaucratic and administrative requirements. The VCM therefore provides greater flexibility to those offering carbon credits, and to those wishing to purchase carbon certificates. A host of special-purpose carbon credit vehicles exist. Some VCM schemes are set up to specifically benefit projects offering more than just carbon reductions [82]. For example, projects promoting development initiatives while at the same time reducing the carbon signature of such activities are popular. The VCM also caters for individuals who wish to reduce their carbon footprint, such as airline passengers. Companies and institutions, to further their corporate social responsibility objectives while greening their image, can tap into the VCM to offset their emissions while at the same time rendering development and community support [83].

An example of a VCM project in Namibia could involve a community project that uses the manure produced by their cattle to generate biogas. The biogas could – and this is only an example to illustrate the possibilities – be used to generate electricity for the community. In this way, the project would displace electric energy from the national electricity grid, and qualify for carbon emission reductions, while simultaneously promoting a more environmentally benign biomass resource management approach throughout the community. Satisfying the requirements of a VCM standard, the community would sell their carbon reductions and add a development premium, which may appeal to certificate buyers seeking to support a community development project that achieves both development and carbon reduction goals [84].

While the opportunities to benefit from carbon trade certainly exist in Namibia, one should not expect that carbon revenues will simply make any non-starting project viable. Many interesting projects, after having been investigated, turn out to be too small to benefit from the trade in CERs, and the aspiration of many a project to benefit from VCMs is higher than is realistically achievable [29]. Only a careful analysis of a project and its context will reveal whether carbon revenues can be realised. Carbon credits are not a get-rich-quick scheme, and realism is required when conceptualising carbon projects. An emphasis on project fundamentals can unlock the considerable value of many environmental services that we so readily take for granted, while also creating benefits from carbon revenues.

6. 1P4T – or – Promoting Green Energies in Namibia

6.1 Policies

Presently, Namibia is developing a climate change policy [78]. Whether this policy will enhance the development and promotion of the many exciting opportunities offered in Namibia’s green energy sector remains to be seen. Namibia’s White Paper on Energy Policy of 1998, recognises the importance of renewable energies, and their potential role in realising the country’s energy policy goals [85]. Sadly, the opportunity to integrate energy as a key economic driver of cross-sectoral importance was missed in Namibia’s Vision 2030 [86].

The recent Cabinet directive making solar water heaters mandatory in Government buildings is an example of how targeted policies can lead to tangible change [87]. Many more such bold steps are needed before green energy can begin to make its rightful entry into Namibia’s energy landscape. In order to infuse new momentum into the country’s energy sector, an assessment of the outcomes of Namibia’s energy policy goals will be important, followed by a review and update of the White Paper. An energy sector Act is long overdue, and should explicitly address the critical and cross-cutting role that access to affordable energy and energy services plays in Namibia’s development.

6.2 Targets

It is said that if you do not know where you are going, you will never get there. The energy sector is an example where ambitious national targets and associated budgets can substantially change the way we do business [88]. Targets can foster smart investments, and drive future-oriented energy sector developments. Examples of such national targets could be: *"by 2030, 15% of Namibia's electricity supply will be generated from renewable energies other than hydro"*, or, *"by 2015, 10% of the national fuel consumption will be covered by locally manufactured biofuels"*, or *"by 2010, the average per kilometre emission of carbon dioxide of four-door passenger cars in the Government fleet will be less than 140 grams of carbon dioxide per kilometre"*.

For Namibia to embark on a systematic policy-led greening of its key economic sectors, and especially its energy sector, binding national targets are essential. Generally, targets are best embedded in the national development planning document of the day, for example the National Development Plans [89], taking an integrated development view that spells out the social, economic and environmental imperatives and trade-offs. Vision 2030 does not have a chapter on energy, and we do not have an energy Act. So, do we actually know where we will be going?

6.3 Taxes

Tax breaks and tax incentives specifically promoting green energy investments could result in a higher uptake and greater penetration of such technologies in Namibia. For example, exempting imports of green energy technologies from value added tax, introducing tax breaks for green energy enterprises, creating tax incentives such as tax-free establishment periods for green energy entrepreneurs, and creating special-purpose green incentives similar to those in free-trade zones could all be considered [90].

Unless fledgling markets and industries are protected they remain vulnerable and prone to failure. Green energy markets are a case in point. Although Namibia's tax regime is not biased against green energy technologies, there are also no special tax breaks to specifically promote them. In the absence of tax incentives, and in view of the other barriers stacked against green technologies, few local investors will manage to establish themselves successfully.

6.4 Tariffs

Energy investment decisions hinge on attractive tariffs [91]. Tariffs are one of the central pivots determining the viability of an energy business, and the value generated in the productive use of energy. Presently, in comparison with many other developing nations, Namibia's electricity tariffs are low and therefore fail to discourage the non-productive use of energy. Our tariffs do not differentiate whether energy is green or from fossil fuels. Feed-in tariffs that incentivise the generation and feed-in of electricity from green technologies are non-existent. Now that South Africa has such tariffs [64], few investors will be tempted to pour their monies into the Namibian electricity sector that does not offer similar advantages.

A transition to green energies will not just happen automatically in Namibia. The non-level playing field between fossil fuel-based liquid fuels and biofuels, and conventional versus green electricity, has deep historic roots and a shadow of legacies. Markets however can be rebalanced: creating targeted tax breaks, exempting innovative technologies during their incubation period, and creating tariff structures that promote green technology investments will foster the much-needed development of Namibia's rich diversity of indigenous renewable energy endowments.

6.5 Tears

Tears can be a sign that we are experiencing pain, or have been touched. Increasing petrol or diesel prices at the pump frustrate most of us, and we are delighted if we hear that their prices have been lowered again. However, few Namibian energy consumers will have had a reason to shed real tears about our energy prices. Historically, we have been spoilt by very low electricity prices, and have had few incentives to use energy in an environmentally responsible and sustainable manner.

The realisation that our natural environment cannot absorb increased carbon dioxide emissions without suffering long-term damage has arrived in Namibia. When the effects of human-induced climate change can no longer be ignored we will hopefully have made mitigation and adaptation decisions [92]. Not doing anything is just not an option. The question remains: have we taken the right decisions to green our lifestyles, value chains and energy sector? Or will our tears eventually make us realise that change has become inevitable?

7. Conclusions

Namibia's continued development relies on an energy sector that provides affordable, reliable and accessible energy. Our economic development depends on the cost-effective and reliable supply of energy. Much of our current energy supply comes from fossil fuels, despite us having to import all of them. Not only are fossil fuels finite and will eventually become too expensive to be considered the backbone of a developing nation, but we are also seeing increasing evidence of environmental changes and damage that is done by the unchecked use of fossil fuels. One important step to limit the economic implications of climate change, and at the same time become more energy autonomous, is to use non-polluting sustainable energy sources. That is, use green energy.

Namibia is blessed with abundant solar and wind energy resources, and has a considerable stock of biomass. Seemingly plentiful clean energy resources such as geothermal, wave and tidal energies could constitute a national comparative advantage that should be exploited more aggressively. These indigenous and renewable energy resources could, in time, replace a significant portion of the fossil fuel energy that is currently paid for in hard currency. In addition, Namibia is endowed with natural gas resources, which if used wisely, can bridge the way into a low-carbon energy future, specifically in the transport industry. Such a transition will not happen overnight, and requires national commitment, supportive policy framework conditions and a pragmatic investor-friendly context. International experience shows that green energy industries promote local job creation, lead to enhanced local value addition, and the increased utilisation of local resources. At the same time, because of their non-polluting nature, green energy resources limit our impact on the environment. Investments in low- or no-carbon energy technologies are one important step in stabilising the Earth's climate, and reduce the potentially negative implications of continued global warming.

The energy sector offers some immediate opportunities to reduce emissions and save energy. Energy efficient practices and technologies can also immediately save costs, and bridge short-term electricity supply constraints. Their wide introduction is a way to focus consumers on the productive use of energy, while at the same time reducing greenhouse gas emissions. In the transport sector, a greater emphasis on fuel efficiency, and introducing emission standards in the national fleet, would save costs and reduce the emissions from liquid fuels.

Active and goal-oriented Government engagement, including the provision of special-purpose "greening" incentives and investments, are required to convert Namibia's natural resources, including our indigenous energy riches, while providing sufficient energy to allow for the country's ongoing development. The time has come for investments to develop Namibia's rich green and renewable energy endowments, while promoting and incentivising greater energy efficiency throughout our economy.

It is for us all to make smart forward-looking decisions. Let us begin.

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