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A Review of The Impact of National Carbon Trading on Namibian Electricity

[1]Erikka N. Mokanya, [2]Maduako Emmanuel Okorie, [3]Freddie Liswaniso Inambao

[1]PG Student, Department of Civil, Mining and Process Engineering, Namibia University of Science and Technology, Windhoek, Namibia

[2]Senior Lecturer, Department of Mechanical, Industrial and Electrical Engineering, Namibia University of Science and Technology, Windhoek, Namibia

[3]Professor, Department of Mechanical, School of Engineering, University of KwaZulu-Natal, Durban 4041, South Africa.

Abstract

Pro-environmental international agreements pressure developing countries to adopt transparent and robust programs to halt global emissions at an equilibrium point. As the global climate and its environment deteriorate, countries have accelerated the development of carbon markets worldwide. This paper seeks to contribute to the existing body of research as to whether the pursuit of a carbon market in a middle-income country with a small and open electricity industry in an African economy, Namibia, can improve its emission levels as well as foster cleaner power generation. Numerous research papers and articles that are related to the electricity market and the carbon market were used to get an understanding of the knowledge domains and evolution of carbon-electricity markets. The paper forms the basis of research on the carbon market and how it influences the nation's power-generating activities. Furthermore, the paper provides some context and examines the carbon market by trying to understand and gain a clearer picture of the market and its contribution to climate change mitigation.

KeywordsGreenhouse gases, Pro-environmental transitions, Independent Power Producers, Modified

Single Buyer, Ecological Modernization, Non-utility Generators, Pollution, Carbon Credits

1. Introduction

Climate change remains a global problem that requires a global solution. Several countries since the passing of the Kyoto Protocol have adopted several actions to minimize their environmental footprint. It is common agreement that the global rise in greenhouse gases (GHGs) has brought about a global consensus among most countries to minimize the levels of GHGs and to solve this ambitious challenge, country-level targets have been set to minimize emissions through the adoption of environmentally friendly actions. Among these actions and pro-environmental transitions is the adoption of carbon markets through the adoption of carbon abatement technologies and the sale of carbon credits. The carbon market utilizes acceptable technologies to minimize carbon emissions. In this paper, a review is conducted to understand the impact that the proposed national carbon market will have on the Namibian electricity industry, drawing from regional research as well as international research.

2. Background of the Namibian electricity industry

Over time, the government of Namibia has gradually opened the energy sector to private sector involvement in the production, transmission, distribution, and retailing of electricity. The state-owned utility Namibia Power Corporation (Pty) Ltd, or NamPower, has controlled the country's electrical market since its independence, and it has overseen the production, transmission, distribution, and trading of electricity to all end users [1]. However, it was not until 2019 that Namibia moved from the centralized model, which is dominated by one utility, to a Modified Single Buyer (MSB) framework [2]. This framework opened room for multiple independent power producers (IPPs) to generate and supply electricity to large power users, both locally and internationally, across the national transmission grid. Furthermore, the transition brought about a change in the national generation mix, which is said to attract foreign direct investment, especially in the renewable energy industry [2]. The model is

said to allow for a competitive energy market, allowing consumers to choose their energy sources, thus contributing to the promotion of renewable alternatives.

Namibia has great potential for wind and solar energy production. Because of this, the current state-owned utility has entered into power purchasing agreements with local independent power producers (IPPs) to increase energy supply [1]. Namibia's Electricity Control Board (ECB) oversees direct sales to customers through the regional electricity distributors (REDs) and municipality utilities, but NamPower continues to promote energy supply through government-mandated cogeneration projects and renewable energy initiatives, advancing rural electrification through remote networks and grids [2]. NamPower and six other non-utility generators, or NUGs, brought on by the restructuring process can create, transmit, and sell power in the energy market due to the nation's vertically integrated, diversified network. Despite this, the energy sector is still experiencing an energy deficit, which calls for the exploration of other options, such as carbon markets.

3. Theoretical framework for carbon markets

The natural capital theory and the ecological modernization theory served as the foundation for this study's theoretical framework. These two theories attempted to explain, predict, and understand the subject of carbon trading within the limits of the critical bounding assumptions. Crucially, the study's theoretical foundation maintains and endorses the idea that carbon trading benefits Namibia's electrical industry. Other theories, such as administrative and economic rationalism, which describe the idea of optimizing economic fundamentals while simultaneously encouraging environmentally beneficial behaviours, may also be applicable in this situation.

3.1 The Ecological Modernization (EM) theory

The goal of the Ecological Modernization Hypothesis, which was formulated in the 1980s, is to explain how the economy and the environment interact [3]. The idea attempts to strike a balance between the pursuit of economics and the consideration of actions that lead to desirable environmental consequences. The notion of ecological modernization promotes the need for ecological awareness even in the face of a country meeting its economic goals [9]. Ecological modernization can be used in environmental policy analysis, and this provides an appropriate framework to decide on projects that best yield the most desired environmental outcome [4], like emission reduction projects. The theory acknowledges that there are different situations where it has not yet been applied, and hence there is a need for the theory to be tested against different societies, economic backgrounds, cultural, and political aspects. This theory must be tested against the Namibian background, as it offers different dynamics from the developed nations where the theory was introduced.

It is common knowledge that the carbon market is a mechanism developed to promote a sustainable environment and higher utilization of cleaner energy sources through the adoption, implementation, and enforcement of climate-friendly, low-carbon, and sound energy policies and measures. Effective environmental policies based on the ecological modernization paradigm have been developed in the majority of industrialized nations, including China and Japan, to support unilateral reductions in GHG reduction objectives [5]. Although this may be simpler to implement in developed countries, in emerging countries like Namibia, the application may not be as strong. Adopting the carbon market and putting a market value on GHG emission reduction can help the nation develop sound, environmentally friendly policies while creating new investment opportunities. Henceforth, there is a need to find mutual ground between economic gain and technological innovation if the best environmental outcomes are to be achieved.

As a result of its successful application in framing climate change-related policies in countries such as China, EM can be broadly replicated in other regions, like southern Africa. Of course, because of the nature of the countries in these regions, their focus may be highly oriented towards economic development and poverty eradication as opposed to emission reduction. However, given that they are the most vulnerable to the impacts of climate change, governments need significant financial support and to be capacitated to pursue a path of strong EM that is reinforced by regulatory stringency and an effective regulatory structure to achieve desired environmental outcomes.

3.2 The natural capital theory

The natural capital theory, which also provided the theoretical framework for this current study, argues that natural capital, such as forests, oceans, and soils, are essential for human well-being [12], and as such, there is a need to protect them for our long-term survival. The natural capital theory further argues that environmental regulation can lead to innovation and economic growth. This is because environmental regulation can create incentives for firms to innovate and develop new technologies that can help them reduce their emissions and improve their environmental performance. These new technologies can then be used by other firms, leading to a diffusion of innovation and a more sustainable economy. The theory operationalizes the ecosystem approach and facilitates policymaking for sustainable development. In developed nations, the theory is widely used as a framework for decision-making. Several studies [6], [7], and [8] have suggested that natural capital theory has been supported by some empirical studies, but it has also been criticized by others. Some critics argue that environmental regulation can be too costly for firms and that it can lead to job losses and a decrease in economic growth. Despite these critics, the natural capacity theory is gaining popularity in the modern day and age, as this is a concept that makes a connection between economic productivity and environmental imperatives. Natural capacity recognizes the value of preserving and restoring ecosystems domestically and internationally. Nowadays, the world is more inclined to emit less carbon, which is linked to human well-being. However, the dilemma is that most of these fuels that are used for power generation tend not to be clean and are coupled with huge carbon emissions. Hence, a balance must be drawn, and this study will highlight how the anticipated carbon market can affect the power industry in Namibia.

3.3 Other supporting theories

Apart from the theories mentioned above, carbon trading can also be governed by principles such as the precautionary principle, the polluter pays principle, and sustainability principles. The precautionary principle states that we should take action to prevent environmental harm, even if there is uncertainty about the risks. This is because the potential consequences of environmental harm can be severe, and it is better to be safe than sorry. The polluter pays principle states that the polluter should bear the costs of pollution. This is because the polluter is the one who is causing the environmental harm, and it is fair that they should be the ones to pay for the clean-up. Lastly, the sustainability principle argues that we should meet the needs of the present without compromising the ability of future generations to meet their own needs. This means that we need to develop sustainable practices that will not deplete our natural resources or damage our environment.

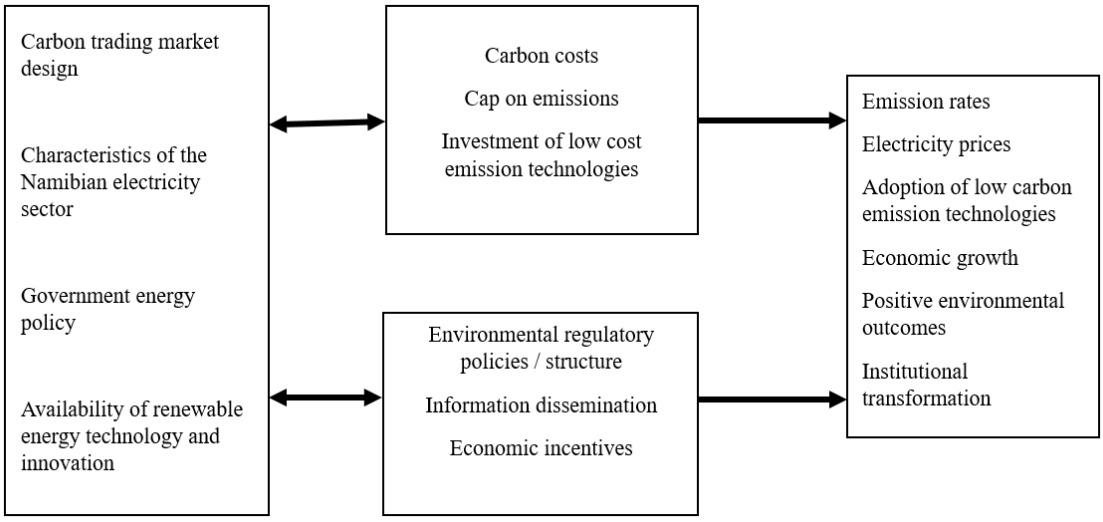

Figure 1: Conceptual framework ***Source: Researcher's Own Construct (2024)***

The conceptual framework above can be used to analyze the potential impact of the national carbon trading market on the Namibian electricity sector. It gives a snapshot of the key factors that will determine the impact of carbon

trading on the electricity market. This information can be used to design the carbon trading market in a way that maximizes the benefits and minimizes the costs for the Namibian electricity sector. For example, the impact on electricity prices will depend on the pass-through of carbon costs to consumers, which will in turn depend on the competitiveness of the electricity market, the available government energy policies, and the availability of substitutes for electricity. The impact on the emissions rate will depend on the stringency of the cap on emissions and the investment of low-carbon generation technologies in the electricity industry. The impact on the adoption of low carbon emissions technologies will depend on the price of carbon allowances, the government's support for renewable energy through economic incentives, available information on the carbon market and whether current national environmental regulatory policies or structures are favorable. All these factors operating together can result in economic growth institutional transformation and positive environmental outcomes.

4. The role of carbon markets in mitigating climate change

Several reforms have been developed by various countries to minimize GHGs and control pollution. The common ones are the Clean Air Act (United States) and the European Union Emissions Trading Scheme (EU-ETS). Apart from national frameworks, carbon trading is fast becoming a significant economic tool for promoting the low-carbon transition and the reduction of GHG emissions. The implementation of the more significant parts of carbon trading has been somewhat successful in lowering greenhouse gas emissions in the places where it has been implemented, thanks to the combination of these instruments, political will, and strong support systems [9], [10], and [11]. The European Union Emissions Trading Scheme (EU-ETS) is the main platform for carbon trading. This scheme was created to meet the generally binding Kyoto Protocol targets, which are to lower GHG emissions for the 148 participating countries, which include developing countries like Namibia. Owing to its noteworthy accomplishments, this program has offered a range of advantageous investment options and acts as a signal for those strategizing future energy investments by providing an estimate of future carbon costs. As the age of low-carbon energy begins, the carbon market has the power to persuade firms to embrace environmentally friendly and energy-efficient technology. The cost of the emission reduction will, according to proponents of the EU ETS business case, drive technology users' decisions. This will, in the long run, give those businesses a competitive edge in energy efficiency and technology development, strengthening the foundation of the trading scheme and the overall environmental benefits.

Carbon finance theorists also acknowledge that in the low-carbon field, carbon finance can resolve investment and financial bottlenecks, opening opportunities for green and low-carbon development. [12] observes that the introduction of a national carbon trading market could lead to the development of new technologies and practices that reduce emissions and improve energy efficiency. For example, a carbon trading market could create incentives for electricity producers to invest in renewable energy technologies, such as solar and wind power [13].These technologies are becoming more cost-competitive with fossil fuels, and they can help reduce emissions. According to [12], by creating a price signal for carbon emissions, carbon trading makes it more cost-effective for companies to invest in low-carbon technologies and energy efficiency measures, such as solar and wind power, electric vehicles, and energy-efficient buildings. [14] adds that by putting a cap on emissions and creating a market for carbon credits, carbon trading incentivizes companies to reduce their greenhouse gas emissions. This can lead to a reduction in the overall amount of greenhouse gases that are released into the atmosphere, slowing down the rate of climate change effects. However, effective operation often requires effective policy reforms and an enabling market that allows participants to use their credits while supporting the emission mitigation investment cycle [15].Since the Kyoto Protocol has been developed with emission targets or caps for developed countries and economies in transition, three flexibility mechanisms have been established: emission trading (ET), joint implementation (JI), and the Clean Development Mechanism (CDM) [16]. These options allow countries or economic actors to realize their GHG emissions reduction commitments at the lowest cost.

The international response to climate change can be said to consist of two separate efforts. The first is an arrangement under the United Nations International Panel on Climate Change, which is intended to set up the infrastructure for a regulatory regime and represents an incremental increase in the role of the international institution. The second is the Kyoto Protocol, which lays out rules for creating markets for tradable carbon, trans-

governmental emissions, non-compliance, and service loans. Given the anticipated increasing significance of the carbon market for Namibia's electrical sector, a more thorough examination of its components is imperative.

5. Carbon pricing mechanisms and instruments

Worldwide carbon emissions pricing seems all but inevitable, and given the unrealized potential in developing countries, it is important to consider the likelihood of more possibilities in the future. Wealthy countries will be convinced to participate in the global climate change dialogue by using inexpensive abatement methods, therefore assisting communities throughout the world in bearing the consequences of climate change. Carbon pricing policies are rapidly becoming an extremely profitable way to reduce greenhouse gas emissions [17]. It is thought that by putting a price on carbon, companies and consumers will be more inclined to consider climate change when making decisions about production, investments, and purchases, making it easier to adopt mitigation measures [18]. Mechanisms for mitigating climate change come in diverse forms and at different levels throughout the world. A variety of tools, such as carbon taxes and crediting systems, are now in place in addition to the well-known emissions trading schemes (ETS).

5.1 Emission Trading Schemes (ETS)

A cap or ceiling is imposed by the ETS on the overall emissions or the intensity of emissions within the covered industry sector. Only a certain number of emission permits, or allowances, are awarded to meet the emission reduction objectives for a given industry or sector [19]. This implies that for every tonne of CO_2 that a company emits, it must have authorization under the emission trading strategy for this sector. These companies have two options for getting the necessary allowances: they may either purchase them at auction from the state or they can receive some of them for free [20]. This makes it possible for the involved businesses to buy extra permits or, should they be successful in reducing their emissions, to sell allowances that they will no longer need [19], [20].

5.2 Carbon tax

Under these carbon pricing mechanisms, a price is levied per carbon ton emitted [20]. By doing so, a price is placed on emissions, encouraging businesses subject to the tax plan to cut emissions now and make long-term investments that will benefit the environment. Compared to the ETS, under this pricing instrument, no trading is involved, and businesses are afforded minimal flexibility as the price of carbon emissions is defined [19]. While this might be a stable form of carbon pricing instrument, there are several opinions on whether it is an effective way to meet emission reduction targets. [19], [20] believe that emissions can only be reduced if the tax imposed on CO_2 is high enough, as this will incentivize businesses to keep their emissions low to avoid tax.

5.3 Crediting mechanisms

In crediting mechanisms, participants in climate change mitigation projects, businesses, industries, or sectors are credited for their voluntary climate action through an issued tradable certificate [19]. Furthermore, when real emissions are lowered below a predefined ceiling related to a project or industry, certificates are granted. Since participation in a crediting process is voluntary, alternate means of creating demand for produced certificates must be found. In crediting mechanisms, participants in climate change mitigation projects, businesses, industries, or sectors are credited for their voluntary climate action through an issued tradable certificate [19]. Furthermore, when real emissions are lowered below a predefined ceiling related to a project or industry, certificates are granted. Since participation in a crediting process is voluntary, alternate means of creating demand for produced certificates must be found. One way to do this is by permitting the certificates produced by the crediting process to be exchanged in an emissions trading system or through a carbon pricing initiative, which means demand for crediting certificates can be created by those willing to offset emissions.

6. Successful business models, insights and experiences

The Clean Development Mechanism (CDM), a crediting system run under the Kyoto Protocol, provided the first significant worldwide experience with price-based climate action measures [16]. Using this instrument, projects and programs aimed at mitigating climate change can be registered under the CDM in developing nations by international standards, and the identified and certified emission reduction will be made using a globally

recognized methodology [16]. These certified emission reductions (CERs) can be used by companies covered by the EU Emissions Trading Scheme (ETS) to meet their emission reduction goals [21]. As a result, the reductions help to minimize the costs associated with implementing the agreed-upon emission reduction targets of the Kyoto Protocol. Experience has shown that the CDM can be productive in meeting emission reduction targets. Approximately 7,850 programs and initiatives aimed at reducing emissions have been recorded since 2004, resulting in savings of two billion tons of CO_2 equivalent [22]. Through its implementation, CDM was found to be flexible and adaptable, which is essential in a changing environment [23], [23], [24]. The need to invest in capacity development and monitoring was also flagged as it contributes to improved design, implementation, and control of climate change mitigation efforts under newer mechanisms [24]. Namibia is not the first African nation to face significant electricity-related difficulties. It is also not the only nation looking at the possibility of utilizing carbon market project financing for infrastructure related to the production of power. However, as a lesson from international carbon trading markets, there is a need for flexibility and adaptability, especially when designing and implementing emission reduction projects [25]. Furthermore, national policies designed to support carbon markets should also be flexible enough to accommodate market uncertainties.

7. Namibia's participation in the global carbon market

To improve the execution of its National Determined Contribution and move toward net-zero emissions and climate-resilient development in response to the climate emergency, Namibia has recently expressed interest in joining the global carbon market. The Ministry of Environment, Forestry, and Tourism has been working across the country to raise awareness about the carbon market while engaging a diverse group of stakeholders. Currently, the Namibian government is busy reviewing the designed carbon market framework, which is a step closer to joining other African countries in developing their frameworks for carbon market mechanisms. To reach its NDC reduction targets and increase its mitigation ambitions, Namibia has indicated an interest in taking part in carbon market-based mechanisms as a financial alternative. The goal of the Promotion of Carbon Markets in Namibia initiative is to provide the conditions necessary for Namibia to pursue opportunities under Article 6 of the Paris Agreement related to carbon markets. Guidelines for voluntary collaboration between parties in the implementation of NDCs are provided in Article 6, specifically in Article 6.2. This allows for stronger climate ambition and the achievement of greenhouse gas (GHG) emission reductions using carbon markets. By establishing carbon markets, Namibia may economically transition to a low-carbon economy, place a price on carbon, enable carbon trading, and create new market opportunities for the private sector, all while advancing its socio-economic development.

Although there are great aspirations to grow Namibia's carbon market, great care should be taken because the electrical industry is highly dependent on the fuel market, and fluctuations in fuel prices may affect the availability of both oil and energy. Namibia must therefore create more diverse power generation structures as a result of this fixed situation to guarantee that its citizens receive a steady and dependable power supply. More than 20% of the nation's GDP is currently derived from the import of fuel and the use of fossil fuels for electricity generation. This emphasizes how detrimental fossil fuels are to the national economy. However, renewable energy sources can help with this issue.

A variety of policy tools are being created to support the promotion of renewable energy as a result of Governments and the international community's growing concerns and activities regarding climate change. Namibia's involvement in this course has never been more crucial because of our shared responsibility to reduce GHGs and our international responsibilities as governments to combat climate change. Even though Namibia has one of the lowest income levels and one of the densest populations in the world—roughly 2 million people—local demand has mostly depended on natural energy resources. To meet the nation's electricity needs, hydroelectric power, biomass, and a tiny amount of imported electricity are used. Apart from conventional energy resources, Namibia possesses noteworthy renewable resources, with solar and wind being the most important at present.

The significance of the environmental issues that the world's fossil fuels have caused in recent years has made it possible for governments, producers, and consumers to learn about and find cleaner alternative energy sources,

and the carbon market is a great opportunity to promote renewable energy sources while reducing the nation's dependency on physical and financial risks associated with heavy reliance on imported oil.

8. Challenges and opportunities of carbon market integration in Namibia

Pre-combustion methane is the most significant greenhouse gas emission recorded by countries [26]. Curbing this and using more environmentally friendly electricity generation solutions in Namibia is highly dependent on the political will and the nation's environmental action to de-regulate the electricity market while also providing financial incentives. Namibia has several options for carbon sinks as well as sustainable energy generation from solar and wind power. The infrastructure of natural resources, particularly those in the energy sector, must therefore be carefully planned for, taking into consideration any sizable projects or sources that may be utilized to include, manage, and even sell carbon credits concerning greenhouse gases. Namibia runs the danger of missing out on this relatively new carbon market since its potential as a carbon sink, store, and exporter is currently underappreciated.This is made abundantly clear by the country's first national communications to the United Nations Framework Convention on Climate Change. The degree to which a country's infrastructure and industrial capabilities may enable it to reduce greenhouse gas emissions to the benefit of a company looking to voluntarily offset emissions is uncertain. Raising national revenue may have positive effects on the development of other businesses, especially the energy sector, in addition to providing opportunities for the construction of the social and industrial infrastructure needed for project formulation.

9. Policy recommendations for enhancing Namibia's participation in the carbon market

To increase Namibia's involvement in the carbon market, an environment that is conducive to investment must be established to fund capital projects that reduce emissions through the use of carbon taxes, carbon crediting mechanisms, ETS crediting schemes, or structured procedures under the Kyoto Protocol. To further push renewable energy sources, geothermal, wind, and hydropower projects, feed-in tariffs should be introduced and promoted. The carbon market development plan for Namibia should also consider the following: encouraging the adoption and use of grid integration and its effects considering Namibia's unique circumstances; creating policies and programs related to climate change; and assisting the nation in realizing certain benefits associated with climate change through incentives, favorable investment climates, and regulatory frameworks. Namibia's involvement in the global carbon market might be promoted by setting up public funds for financing projects, programs, and activities that decrease greenhouse gas emissions, in light of the past flaws and setbacks encountered during CDM. The creation of local and national carbon funds is one way to encourage investment in carbon offset projects. Furthermore, subsidies can be given for the development of revolving fund schemes, the encouragement of hydro-solar facilities, and the formation of a national public fund aimed at reducing large-scale greenhouse gas emissions.

10. Conclusion and future research directions

This review paper has served as a platform to demonstrate the potential developments the Namibian electricity industry can make as a result of its participation in the carbon market. The recognition of the importance of the carbon market industry makes it clear that various areas of the power sector could potentially evolve as a direct consequence. Theoretically, this should lead to more people using electricity more wisely due to internalized costs. On the other hand, the government will have an important role to play in this. Guidelines, standardizations, and criteria will have to be set to which new developments will have to adhere. The paper indicates that if a carbon market is developed in Namibia, considerable available funds should be allocated to these developments to promote technological innovation, economic gain, and environmental benefits. Carbon trading markets provide Namibia with a viable means of mitigating its carbon emissions and promoting sustainable development objectives. Namibia can make the transition to a cleaner, more resilient, and wealthier future by utilizing the potential of carbon markets.

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